2009 JOINT CONFERENCE

Lake Michigan: State of the Lake
AND
Great Lakes Beach Association

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ABSTRACTS

LAKE MICHIGAN
STATE OF THE LAKE

Lake Michigan
Lakewide
Management
Plan

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Biogeochemical Cycling Interrupted: Benthic Bivalve Filter-Feeding Alters Basin-Scale Nutrient Cycling, and Optical Parameters in Lake Michigan

Relocation of suspended particles from pelagic habitats to benthic biomass and sediment has been a hallmark of invasive mussels in Lake Michigan and Midwest inland lakes. Lake Michigan was once heavily colonized in the <25m coastal zone by zebra mussels (ZM), but they have now been displaced by quagga mussels (QM) with a much broader range (<6 to >90m). Concurrent dampening of seasonal ammonium, nitrate, phosphate, and silicate cycling suggested substantially reduced organic matter sedimentation to depositional areas. Mussel colonization and feeding have already been shown to exert considerable influence on both benthic and planktonic ecosystems. Deepwater phytoplankton communities shifted from diatoms to smaller phytoplankton, and light penetration nearly doubled. In Lake Michigan, deep water and winter had been refuges for large phytoplankton until QM invasion. After only three years with QM, dampened seasonal cycling of silicate indicated a basin-wide reduction of diatom production. The community was replaced with predominantly <5 µm unicellular algae and very large algae. This has also been shown with size fractions of chlorophyll in both coastal stations and in open Lake Michigan stations. Following establishment of persistent QM communities the observed seasonality of size distribution has subsided, leading to uniformly smaller size frequency throughout the year. Time-series analysis has demonstrated that systematic progression to smaller size class dominance is more spatially widespread than was initially expected. Phytoplankton species composition and size distribution analysis are key factors in the use of algae as ecological indicators in aquatic systems. Our techniques used for study of the phytoplankton community include *in vivo* fluorescence (CTD), extracted Chlorophyll a with size fractionation, autofluorescence microscopy for smaller cells. Each component imparts a different focus on changing phytoplankton species structure and total abundance.

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Current, Accurate Geographic Information is the Cornerstone of Effective Management, Monitoring, and Science

Whether you are studying non-point source pollution or climate change, beach health or invasive species, climate change or land cover change, a fundamental element of the analysis will involve a map. However, at this time no systematic effort exists to collect basic geographic information in the Great Lakes for management, monitoring, and science applications. Across the Great Lakes, the best information available is often the USGS topographic map, or other products derived from those maps. In most areas, that data is more than 20 years old; in some areas, that data is almost 70 years old.

The Great Lakes needs a comprehensive effort to collect the basic framework data – aerial imagery, elevation, hydrography, roads, land cover - that enable interpretation of patterns and processes across the landscape, monitoring of change, and inventory and management of resources. This presentation describes past and current data collection efforts and availability, and discusses possible avenues for organized regional acquisitions in the future.

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Phosphorus and Phytoplankton in Lake Michigan: Model Post-audit and Projections

The eutrophication model, LM3-Eutro, was developed in support of the Lake Michigan Mass Balance Project to simulate chlorophyll-a (phytoplankton), phosphorus and carbon concentrations in the lake. This high-resolution carbon-based model was developed and calibrated using extensive field data collected for the project in 1994-1995. LM3-Eutro has been applied to make long-term phosphorus and phytoplankton projections to evaluate the future trophic status of the lake. However, these projections were based on our best estimates of phosphorus loadings at the time, since very little has been measured over the past two decades. Recent work has been done to update phosphorus loadings for the Great Lakes, including for Lake Michigan. Preliminary results suggest that the loading to the lake remained relatively constant over the past decade. Here we will evaluate model performance by comparing and discussing our loading assumptions and model projections with the latest estimated loadings and in-lake phosphorus and phytoplankton concentrations. The results will also be shown in context with the target loads and lake concentrations that were established for Lake Michigan in the 1970s as part of the bi-national Great Lakes Water Quality Agreement. This abstract does not necessarily reflect EPA policy.

BALLMANN, ANNE , DVM, PhD, USGS National Wildlife Health Center, 6006 Schroeder Rd, Madison, WI 53711.

10 Year Review of Type E Avian Botulism Mortality in Lake Michigan

The National Wildlife Health Center (NWHC) maintains a long-term database recording avian mortalities attributed to intoxication by botulinum neurotoxin Type E. These may be from cases that were either submitted directly to our lab for diagnostic evaluation or that were reported to us by state, federal or nongovernmental partners as confirmed by other laboratories. Although the NWHC does not test every individual carcass that it receives for the toxin, reasonable assumptions are made as to cause of death based on the timing and proximity of collected carcasses to a representative subset undergoing testing. This talk will summarize the avian species involved in Type E botulism mortality events, the timing and duration of these events, and the estimated magnitude of type E avian botulism mortality events reported over the past 10 years from Lake Michigan. Similar data from the other Great Lakes during the same time frame will be presented for comparison. One challenge to trend data analyses over time for such a large geographic area is the changing emphasis on both passive and active disease surveillance methods. Establishing centralized reporting for avian mortalities and the collection of metadata surrounding search efforts increases the level of confidence in the extent and intensity of the seasonal Type E botulism events and allows for a better understanding of changes within the Lake Michigan ecosystem over time.

BARBIERO, R.P.[1], LESHT, B.M.[2], WARREN, G.J.[3] and RISENG, C.[4], [1]Computer Sciences Corporation and Loyola University Chicago, 1359 W. Elmdale Ave, Ste 2, Chicago, IL 60660, USA; [2]Dept. of Earth and Environmental Sciences, University of Illinois Chicago; [3]USEPA Great Lakes National Program Office; [4]School of Natural Resources and Environment, University of Michigan.

Recent Changes in the Lower Food Web of Lake Michigan

Between 2004 and 2006 the zooplankton community of Lake Michigan shifted from dominance by cladocerans, notably *Daphnia mendotae*, and diaptomid copepods, to dominance by the large hypolimnetic calanoid *Limnocalanus macrurus*. The average summer biomass of this species between 2004-2006 was roughly three times that of the period 1984-2003, and at levels unprecedented in our 22-year dataset. These increases, in association with the cladoceran declines, have resulted in *L. macrurus* accounting for over 50% of the large (> 0.9 mm) crustacean biomass in the lake in 2006. The shifts in zooplankton community structure have coincided with gradual declines in spring and summer epilimnetic chlorophyll and more marked increases in summer water clarity. Recent extinction coefficients are among the lowest recorded for the lake, and deepening light penetration has permitted increases in the size of the deep chlorophyll layer, presumably increasing food supplies for the deep-living *Limnocalanus*. Among the benthos, *Diporeia* populations have declined in all regions of the lake between 1997 and 2008, and this organism is currently no longer found at depths < 90 m. Populations at deeper (> 90 m) sites, however, have apparently stabilized since 2004. The size of these deep-living populations is significantly correlated with the magnitude of the spring phytoplankton bloom, which suggests that food limitation could be playing a role in the population dynamics of this species. These changes suggest an accelerating oligotrophication in the offshore regions of the lake and a diminishing resource base for forage fish, with consequences for energy transfer up the food web.

BARTHOLIC, JON, O'NEIL, GLENN, SHI, YI, and ASHER, JEREMIAH, Institute of Water Research, Michigan State University, 101 Manly Miles Building, East Lansing, MI 48823.

Clean Lake Environmental Action Resource: CLEAR

This new Great Lakes Basin-Wide decision support tool functions in support of advanced decision-making for assisting in sediment/nutrient reduction in the basin. For the Lake Michigan Basin all 12 digit watersheds have been characterized relative to their risk for contributing sediment to the rivers and ultimately the lake. This system allows for both basin-wide strategies, and local focusing of efforts as programs are implemented. Best Management Practice (BMP) placement using this system can result in sediment reductions several times greater than with most current approaches. The system can be accessed at the local watershed level and queried for detailed information down to the field level. The decision support system overlays high risk cell locations at either the 30 or 10 m square grid size over recent aerial photography using Microsoft Bing Maps. Thus, priority areas can be pinpointed by individuals in a local office or by landowners. Then the most cost-effective BMP selection can occur to maximize soil loss reduction. These BMP actions can be summarized and estimates of sediment reduction calculated in each sub-watershed. The sub-watershed results can then be accumulated to give total sediment reductions to Lake Michigan and/or the Great Lakes. This system will be explained, demonstrated, and the web address provided so those attending can rapidly utilize the system in their own operations.

BERKEN, GEORGE, FOX, RICK, HAHNENBERG, JIM, GROSSKOPF, JAY, and HILL, GREG, Natural Resource Technology, Inc., 23713 W Paul Rd, Ste. D, Pewaukee, WI 53072.

Lower Fox River Combination Remedy

Implementation of a combination remedy involving dredging, capping and sand covering of PCB-contaminated sediment has been ongoing in the Lower Fox River since 2004. As part of remediation, the upper 6 miles of river (i.e., "Operable Unit (OU) 1," a.k.a., Little Lake Butte des Morts) has been completed. The OU1 project has addressed about 910,000 cubic yards of PCB contaminated sediments and is one component of an overall Fox River cleanup that will address over 8 million cubic yards of contaminated sediments in OUs 1 through 5.

Pre-remediation concentrations of PCBs in the Lower Fox River were up to 3,000 ppm. An Action Level of 1 ppm PCBs is expected to result in meeting the cleanup standard of an average surface concentrations for PCBs of 0.25 ppm.

To date, this project has accomplished:

- Dredging/disposal of about 370,000 cubic yards of the most contaminated sediments;
- Capping with an armored cap of about 114 acres of sediments with moderate contamination; and
- Covering with sand of about 144 acres of lightly contaminated sediments.

As the remedy proceeds, long-term monitoring of fish, water, and cap stability will be implemented, along with cap containment and maintenance, as needed.

OU1 project costs to date are estimated at $100 million. Total expected costs for the Lower Fox River cleanup, OUs 1 though 5, are estimated to be $800 million.

Issues addressed regarding the cleanup include the protectiveness of caps (versus dredging); where to cap and where to dredge and limitations of each remedy; long-term monitoring; institutional controls; and cost effectiveness.

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Wild Link - Migration Corridors for Wildlife in a Changing Climate

The Conservation Resource Alliance (CRA), a nonprofit organization based in Traverse City, Michigan, is demonstrating a unique management approach to ensure that large connected habitats remain viable in the face of record-setting development and climate changes stressing the ecosystems of northern Lake Michigan.

Habitat fragmentation resulting from development in the popular recreation mecca of northern lower Michigan is constraining the ability of animals and fish to migrate and roam freely in search of food, shelter, and mating opportunities. This effect is recognized as a synergistic negative impact with Climate change.

Through Wild Link, CRA helps preserve high-value habitat, particularly the riparian corridors where most diversity occurs. CRA staff provide hands-on assistance to private landowners, developing detailed management plans, arranging funding, encouraging conservation easements, and assisting with habitat restoration and improvement projects.

The Wild Link approach is now recognized nationally as a unique example of green infrastructure at work on the ground. It has advantages of providing measurable benefits to water quality and wildlife; addressing the needs of *all* landowners (especially non-traditional family-based working operations); and improving natural resources regionally.

In the past three years, projects have been completed in an area of 4 million acres, focusing on 15 priority corridors and watersheds, such as the prized Pere Marquette and Manistee Rivers. Projects range from food plots and timber stand improvements to dam removals and stream crossing enhancements that improve habitat. Management plans currently recommend planting trees, like black gum, that are already at the northernmost point of their range, and restoring the natural flood control functions of large and small river corridors. Strategies like these help safeguard habitat against the negative impacts of shifting climate, and preserve diversity in a time of rapid changes.

BOOTSMA, HARVEY[1], WILCOX, ERIN[1], MAYBRUCK, BRIAN[1], LIAO, QIAN[1], AUER, MARTIN[2], TOMLINSON, LISA, and MAGRUDER, CHRIS[3], [1]UW-Milwaukee Great Lakes WATER Institute, 600 E Greenfield Ave, Milwaukee, WI 53204; [2]Michigan Technological University; [3]Milwaukee Metropolitan Sewerage District.

Nearshore Phosphorus Dynamics in Lake Michigan: The Dreissenid-*Cladophora* Connection

Recent studies and modeling of *Cladophora* dynamics and distribution in Lake Michigan provide strong evidence that the resurgence of *Cladophora* in the lake over the past two decades is due primarily to increased water clarity, which provides this benthic alga with more light and extends its depth distribution. However, because the light environment can not be managed directly, phosphorus management remains the only option for mitigating growth of this nuisance alga. In order to determine the relationship between P loading and *Cladophora* growth, and whether a significant reduction in *Cladophora* growth is even achievable, there is a need to better understand nearshore P dynamics. We present the results of *in situ* and laboratory experiments designed to quantify the role of dreissenid mussels as a P source in the nearshore zone, and the mechanisms linking P excretion by dreissenids to P uptake by *Cladophora*. Our results suggest that: 1) dreissenids have the potential to provide most of the P required by *Cladophora*; 2) the link between P excretion by dreissenids and P uptake by *Cladophora* is regulated by hydrodynamic conditions; 3) the dreissenid-*Cladophora* P link will modulate the *Cladophora* response to any temperature change in Lake Michigan.

BREEDERLAND, MARK, Michigan Sea Grant Extension, 520 W Front St Ste A, Traverse City, MI 49684.

Working Waterfront Issues along Lake Michigan: Planning, Protection, and Access

The term “working waterfront” has made headlines in Maine, North Carolina and Florida. In a national context, the problem in some coastal states is mounting economic pressure to convert working waterfronts to non-essential coastal uses, resulting in a gradual loss of water access and docking. Without these, water-dependent businesses are unable to operate, and related businesses, including the stores, shops, services and restaurants that cater to boaters, fishermen, and even to waterfront tourists, also suffer. This presentation gives an overview of these issues along the Lake Michigan shore, results from the Working Waterfronts in Michigan conference (March, 2009), and discusses waterfront community needs for working waterfront planning, protection and access with some case studies.

BRUESKE, STEVE, KAPELA, ANTON, and CRAVEN, JEFF.

Long-term Weather Trends on the West Shore of Lake Michigan

Temperature and precipitation data for Milwaukee and Madison from the mid 1800s to the present were examined for long-term trends. The results suggest that since the 1960s, there has been a noticeable increase in temperature, especially minimum temperature, in the Madison to Milwaukee, Wisconsin area. Similarly, there has been an increase in yearly precipitation as well as winter snow amounts. These changes, if they continue and become more widespread within the Lake Michigan drainage basin, may impact lake water levels.

BUSHON, REBECCA, USGS Ohio Water Science Center, 6480 Doubletree Ave, Columbus, OH 43229.

Testing and Validating the IMS/ATP Method for the Rapid Assessment of Recreational Water Quality

The immunomagnetic separation/adenosine triphosphate (IMS/ATP) rapid method for the detection of *E. coli* and enterococci in water has undergone optimization and refinement by the USGS and cooperating agencies since 2004. To improve the timeliness and accuracy of decisions about beach advisories, the IMS/ATP method was used to quantify the level of fecal contamination at several locations, including Great Lakes beaches, recreational rivers, and marine beaches. Linear regression was used to quantify the relations between the output from IMS/ATP, given in relative light units (RLUs), and bacterial-indicator concentrations determined by the traditional culture-based method. Data were analyzed to determine whether the relations between the IMS/ATP results and the traditional culture-based method results remained consistent in water collected from a variety of locations. Work was also done to validate the IMS/ATP method and establish method sensitivity, specificity, and minimum detection limits. The performance and utility of the IMS/ATP method in providing timely information will be discussed in comparison to other rapid detection methods.

BYAPPANAHALLI, MURULEEDHARA N. and WHITMAN, RICHARD L., United States Geological Survey, Great Lakes Science Center, Lake Michigan Ecological Research Station, Porter, IN 46304.

Indicator Bacteria and Pathogens in *Cladophora* in the Great Lakes: Implication for Water Quality

Cladophora (mostly *C. glomerata*) is commonly found in the Great Lakes, with significant accumulations along shorelines affecting recreational activities, potentially influencing water quality, and possibly causing economic losses. A series of field and lab investigations were conducted between 2002 and 2007 to determine the occurrence and population characteristics of fecal indicator bacteria, FIB (*E. coli* and enterococci) and associated enteric bacterial pathogens (shiga toxin-producing *E. coli* (STEC), *Shigella*, *Campylobacter*, and *Salmonella*) in *Cladophora* and to relate these findings to beach water quality. High densities of *E. coli* and enterococci were common in *Cladophora* mats, with counts often exceeding 100,000 CFU/g dry weight along four states bordering Lake Michigan, indicating near ubiquity within algal mats. *E. coli* increased in numbers by as much as 65% when the algal mats were incubated on a sand bed in full sunlight for 6 hours in August. *Cladophora*, even in small quantities, stimulated impressive *in vitro* growth of *E. coli* in sterile sand. *E. coli* isolates associated with *Cladophora* represented a unique group, distinct from *E. coli* isolates from human and animal feces. *Shigella* and STEC occurrence in *Cladophora* was rather sporadic relative to *Salmonella* and *Campylobacter*. While the *Salmonella* isolates associated with *Cladophora* (n=133) exhibited a high degree of genetic relatedness (≥ 92% similarity), the isolates were not all genetically identical. Distinct spatial and temporal relationships were evident, with isolates tightly clustering by year and location. In summary, these results suggest that *E. coli* and enterococci associated with *Cladophora* may be a recurring source of FIB to nearshore beaches of Lake Michigan. The association of potentially harmful pathogens with *Cladophora* warrants additional studies to assess the risk to public health and the impact on regulatory issues.

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Applying Great Lakes Coastal Wetlands Indices of Biotic Integrity to Inland Lakes of Beaver Island

Biological indicators or indices of biotic integrity (IBI) have been developed for some systems for land management and regulatory agencies to categorize the level of degradation of a given ecosystem. IBIs are most often used in lotic systems and those IBIs that can be used over wide geographic regions and/or many system types are deemed most valuable. Lacustrine systems have intrinsic complexity and multidimensionality making them very difficult to classify into similar groups. This in turn greatly affects the transferability of particular indices created for certain lakes. The robustness and transferability of IBIs created for macroinvertebrates and fish (Uzarski et al. in 2004, 2005) for fringing, lacustrine marshes of the Great Lakes are currently being tested on the inland lakes of Beaver Island, Lake Michigan. In contrast to many other IBIs that tend to be system specific, Uzarski et al.'s (2004, 2005) IBIs should be transferable since they assess food web structure and are therefore, not dependant on a specific species pool. However, species richness is a component that may need to be redefined for the lower diversity found in the inland lakes when compared to the Great Lakes. Inland lakes will be ranked a priori along a disturbance gradient based on land use/cover, observed disturbances, and chemical and physical parameters to determine the transferability of the IBIs. The macroinvertebrate IBI is based on abundance, diversity, richness and evenness. The Uzarski et al. fish IBI is based on community structure and patterns of diversity. The transferability of both IBIs is probable, however rescaling will be necessary in order to account for the lower diversity of the inland lakes compared to the Great Lakes systems. The transferability of both IBIs will be determined by relating rescaled scores with an established disturbance gradient.

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How to Find Snakes and Frogs: Testing Herp Monitoring Methods in the Milwaukee River Basin

Ever search for something, not find it, but wonder if you simply over-looked it? We investigated this problem for amphibian and reptile monitoring. Declines in amphibians and reptiles (herps) have been reported from many regions of the world. Effective monitoring programs are important for determining species' status, documenting changes in geographic distribution, and addressing rapid climate change. Many agencies and programs are interested in monitoring these species, but investigations into the effectiveness of various methods are scarce. We tested the effectiveness of several herp monitoring methods in the Milwaukee River Basin, and compared them to similar data for the Lake Superior Basin. We performed intensive surveys and over-sampled to develop detection probabilities (DP) for each method and species. We then calculated the minimum number of samples required for 95% confidence in detecting species if present. We obtained useful DPs for at least one method for most species. DPs varied widely among species, methods, and sites. Several species (e.g. spring peepers, green frogs, newts) were highly detectable with similar DPs across regions, making them valuable for use as regional large-scale indicators. Other species, especially snakes and turtles, had more variable DPs, generally decreasing with higher latitudes and near range limits. Although lower DPs make monitoring challenging for these species, range contraction or expansion will be readily noticeable only near range peripheries. For programs with sampling effort below the 95% confidence level, we recommend utilizing proportion-of-area-occupied modeling to correct for false negatives when modeling occupancy trends. This methodology allows for use of data from existing monitoring programs for large scale analyses (i.e. calling frog surveys). We identify overlaps in methods for detecting species and make recommendations for achieving best return on effort for monitoring programs. For inventories we provide recommendations for minimum sampling effort for high confidence in detection.

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Vulnerability to Climate Change in Amphibians and Reptiles

The amphibians and reptiles occupying the Upper Midwest have responded to periodic episodes of climate change, with range retractions, expansions, and evolutionary responses such as allopatric speciation. The most recent such event was the retreat of the Pleisticene ice sheets ca. 10,000 ybp. Prior to this retreat, glaciated regions of the Upper Midwest were essentially free of amphibians and reptiles, and the species present today are the result of recolonization of these glaciated regions from southerly refugia. Recolonization pathways are beginning to be reconstructed from molecular phylogeography studies. These studies illustrate the importance of refugia, changing climate, and barriers to movement such as the prairie peninsula and the glacial lakes, including in modern times the Great Lakes. I examine a suite of Upper Midwest, wetland dependant, amphibians and reptiles from a climate change perspective. Most climate models suggest that Wisconsin will become warmer, with drier summers. A number of species variables are relevant to this predicted climate change, such as range limits, reproductive potential, ecological specializations, and mobility; as well as sensitivity to variables related to changing climate, such as reduced summer soil moisture, lower summer water tables, lower summer stream flows, increased temperatures, and reduced snow and ice cover. This analysis suggests both negative and positive responses, depending on whether conditions favor or disfavor a particular species' ecological requirements, and how movements may be constrained where species must migrate with changing conditions in order to maintain occupation of favorable habitats.

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Wildlife Habitat Evaluation in Wetland Restoration: If You Build it Will They Come?

Spatial planning for green space is usually driven by concerns for flood abatement, water quality, and transportation needs, with wildlife habitat rarely considered. The Milwaukee River Basin Wetlands Assessment Project is a Wisconsin DNR initiative. For this project we developed a GIS based decision making tool to identify potentially restorable wetlands, based on hydrologic and soil parameters. We then added a wildlife tool to evaluate the wildlife value of any parcel or potential restoration. Herptile and bird umbrella species were selected to represent forest, grassland, and complex wildlife habitat needs. Species expert groups were convened to populate a matrix of wildlife value scores for each umbrella species and land cover type in the Milwaukee River Basin. A proximity analysis was then conducted to account for habitat patch size and connectivity needs. Cumulative Habitat Quality Index scores were calculated across the Basin for each umbrella species, resulting in a predictive model for umbrella species occurrence, and for restoration sites conveying the best wildlife value. Results were validated against an independent data set of herptile records. The model results of predicted habitat were significantly associated with actual forest (wood frog, $N=67$, $P<0.0000$) and complex (Blanding's turtle, $N=47$, $P<0.0000$) umbrella species occurrences. We found no significant association between the model results and the grassland umbrella species we chose (chorus frog, $N=63$, $P=0.1318$, df 1). We discuss successes and problems with the model. The tool will assist in maximizing the potential for preserving wildlife diversity in wetland restoration sites.

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Optical Scattering Imaging for Rapid Microbial Source Tracking

Microbial contamination of water is a major environmental and health concern. To meet the critical need for improving water quality, government agencies and commercial laboratories must first identify the source of microbial contamination, which requires accurate typing of pollution indicator microorganisms. In recent years, the focus of microbial source tracking (MST) has been on the use of various DNA typing and genomic technologies, which include both library dependent and independent methods.

In this study, we attempt to develop a simple and automated method for microbial source tracking, using *E. coli* as a model system. The method is non-invasive for individual bacterial colonies tested. It employs laser scattering imaging on bacterial colonies followed by high resolution optical scattering image analysis with information extraction and classification. The bacterial scattering image features are decomposed and extracted with the biorthogonal wavelet family after image preprocessing and normalization. The extracted features serve as the 'fingerprints' for each bacterial strain or subgroup from a specific host. Two variations of multi-category support vector machine are implemented as the main pattern classifier to identify the unknown bacterial scattering image by comparing the feature vectors of those in the database. Cross validation is used to statistically evaluate the robustness of the classifiers. Our preliminary results have shown high accuracy of identifying *E. coli* from four different host species with 419 scattering images. Approximately 95% of images (398 out of 419) were correctly assigned to their host species. The whole image analysis procedure from preprocessing, normalization, and feature extraction to classification and identification can be fully automated.

This method, which is simple, accurate, low cost and easy to operate, can be expanded to detect pathogenic strains of *E. coli*, *Listeria* and *Salmonella*, as well as Campylobacter, Schigella and Vibrio, the primary agents of disease originating from water and food.

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Microhabitat Association of Hemimysis on Fish Spawning Reefs in Northern Lake Michigan

Starting in 2006, the bloody-red mysis (*Hemimysis anomala*) was discovered as a new invasive species in the Great Lakes, specifically found in the Muskegon channel which flows into Lake Michigan. As predicted at the time of introduction, the bloody-red mysis has expanded its range in Lake Michigan as we have recently documented them in Grand Traverse Bay. Using a gear designed to sample lake trout and lake whitefish eggs during spawning, we found variable densities of bloody-red mysis within interstitial spaces of substrate particles across three nearshore reefs at Elk Rapids, Lake Michigan. The highest densities of bloody-red mysis were found at the reef with the highest quality fish spawning habitat defined as rounded cobble/rubble with the greatest amount of interstitial spaces, reef depth, and currents. Based on the association of bloody-red mysis with these habitat characteristics and the predominance of this type of spawning habitat in north-eastern Lake Michigan, we predict substantial expansion of bloody-red shrimp in this area. Additional evaluation is needed to determine the potential interactions with early life stages of native fishes.

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An Amphibious Robot for Near-Shore Monitoring of Sandy Beaches in Lake Michigan

Sandy beaches are a major avenue for non-point source pollution to enter Lake Michigan. There is, therefore, a critical need to regularly monitor the near-shore environment with adequate temporal and spatial coverage for reliable estimates of contaminant load and to provide data for forecasting models. The energetic nature of the near-shore region makes access a major obstacle to monitoring. Human entry from the beach is difficult and dangerous due to waves, storms and the risk of hypothermia. Boat access is also problematic because of waves, storms, shallow water and ice. Presented here is one solution to this access problem, a tracked robot capable of entering the lake from the beach and taking water samples and measurements throughout the near-shore environment.

The robot is basically a heavy flat box designed to resist waves and currents as well as to permit easy integration of a variety of scientific instruments. It is 1.22 m long, 1.00 m wide and .35 m in height with a dry weight of about 166 kg. Propulsion is provided by two polyurethane tracks on either side of the frame driven by DC motors; the vehicle is battery powered. A 1.5 m radio communications mast limits the operational depth to about 1.8 m. The robot operates in a supervisory control mode, it's onboard computer receives user commands from shore and controls the track motors to generate the desired trajectory. Onboard sensors and a water sampler can be controlled by the user or programmed to gather data and samples at predetermined times. The robot's trajectory is measured by high-accuracy optical tracking from the beach. Currently, robot is undergoing tests on Bradford Beach, Milwaukee. The rational and design of the robot will be presented along with the test results and prospects for future applications.

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Relationships between Fish Communities and Community Metabolism in Coastal Wetlands of Lake Michigan and Lake Huron

Coastal wetlands provide critical habitat for many fish species in the Great Lakes. Past research has demonstrated links between hydrology, chemical/physical conditions, and fish community structure in coastal wetlands. We hypothesized that gross primary productivity and respiration rates (collectively referred to as community metabolism) underlie many of the observed relationships between abiotic conditions and fish communities in these systems. To explore this hypothesis, we measured community metabolism and sampled fish communities in nine coastal wetlands of Lake Michigan and Lake Huron during the summer of 2008. When metabolism of all wetland ecosystem components were combined (water column, sediment, epiphytes, and macrophytes), gross primary productivity exceeded respiration in all nine wetlands, suggesting net organic matter production. Fish species richness was positively correlated with both primary productivity and respiration suggesting that the more productive wetlands harbored a greater number of fish species. Fish biomass collected per unit of sampling effort was also positively correlated with primary productivity. Our results demonstrate linkages between coastal wetland community metabolism and the composition and productivity of wetland fish communities. Therefore, the factors that influence community metabolism can be expected to influence fish communities as well.

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Factors Influencing Round Goby Use of Coastal Wetlands in Northern Lake Michigan

Round goby (*Neogobius melanostomus*) populations in the Great Lakes have the potential to disrupt invertebrate and fish community dynamics by invading coastal wetlands. The extent and factors influencing round goby use of wetland habitats has not been fully examined. We investigated the variation of round goby abundance in exposed coastal wetlands and adjacent habitats in the Beaver Archipelago of northern Lake Michigan and related abundance to biotic and abiotic variables. Round goby abundance was higher in exposed wetland sites than in open water habitats in Lake Michigan. Individuals captured in wetlands were of significantly smaller size than those of open water habitats. Additionally, round goby captured in wetlands had a higher probability of being immature whereas round goby in adjacent, open water habitats were dominated by mature individuals. Multivariate ordinations of the fish and macroinvertebrate communities and abiotic habitat variables revealed environmental gradients that were correlated to round goby abundance. Abundance was found to be greatest where nitrate-nitrogen, oxidation-reduction potential, and soluble reactive phosphorus were high and lowest where temperature and ammonium-nitrogen concentrations were high. Round goby abundance was also related to a macroinvertebrate gradient and was highest where Ephemeroptera were plentiful and lowest where the macroinvertebrate community was dominated by amphipods. It appears that round goby abundance is highest in the most productive areas of these mesotrophic/oligotrophic systems of northern Lake Michigan.

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Invasive Quagga Mussel Benthification Now Dominates Areal Carbon, Nitrogen, and Phosphorus Inventory on the Lake Michigan Mid-Lake Reef Complex (MLRC)

Formerly bare rock reefs in the MLRC (6% of lake bottom) of central Lake Michigan are now covered with up to 60,000 quagga mussels (*Dreissena bugensis*; QM) per square meter. Repeated observations at a series of coastal and mid-lake reef stations since 2004 have documented explosive growth of mussel population biomass and both local and basin-wide impacts on plankton communities and water column chemistry. Collapse of planktivorous fish populations (alewife, chub, whitefish) has been ascribed to QM clearing of seston by filter feeding and subsequent transfer of resources to the benthos. In summer of 2008, two offshore reef stations and a depositional control were analyzed from surface to benthos for dissolved, sestonic, zooplanktonic, and benthic macrofaunal carbon, nitrogen, and phosphorus. In mmol/m^2, organismal inventories ranged from 1000-10,000 C, 150-2000 N, and 5-50 P. QM living tissue accounted for 70-95% of inventory on the reefs, with areal totals 2-5 times greater than the deeper, depositional station. Seston C:N:P was 191:27:1, more P-rich than zooplankton (300:23:1) and less N-rich than mussels (194:38:1). All food web components were lean in P compared to the Redfield Ratio. Mussels therefore accumulate elements from water column seston beyond their immediate surroundings and enrich the benthos. Structural modification and organic matter deposition as (pseudo) feces have begun a major alteration in the biogeochemistry of formerly bare bottom habitats as well. The compost heap has encouraged substantial development of benthic macroinvertebrate communities beyond the mussels themselves.

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City of Toronto Beaches: Past, Present and Future

The City of Toronto prides itself in having 11 designated beach areas along it's Lake Ontario waterfront. In 2009, seven beaches received International Blue Flag status, having met the Blue Flag Program's 27 criteria, including strict water quality standards. In 2008, for example, these beaches were posted safe for swimming at least 87% of the summer. The City's ultimate goal is to have all beaches meet the Blue Flag criteria. Historically, however, many of the beaches were posted, by the City's Medical Officer of Health, as unsafe for swimming through most of the summer due to poor water quality conditions.

Until recently, the City's combined sewer overflow and storm sewer discharges were identified as the principal sources of bacteriological contamination along the waterfront. To address these impacts, and improve water quality conditions throughout the City, a Wet Weather Flow Master Plan was developed. The Plan incorporates a hierarchical approach to stormwater management, where measures are being implemented on individual properties, within the sewer system and at the "end of pipe" (eg. stormwater ponds or underground storage/treatment facilities).

Drawing on over twenty years of daily beach water quality testing, dramatic improvements in beach water quality have been realized where the direct discharge from combined sewer overflows and storm sewers have been intercepted. However, this data has also demonstrated that, where there are other significant pollution sources such as river or stream flows, their impacts can mask the improvements that would otherwise be expected from the interception of sewer discharges. Further, microbial source tracking has been effective in providing insights on the relative impacts from other bacteriological sources including birds, geese and wildlife. This has led to the development of varied and beach specific management action plans including: the reconfiguration of a sand dune and natural wetland area to intercept intermittent stream flows; the installation of a curtained beach enclosure where water is pumped through an ultra-violet disinfection system; improving beach grooming equipment and practices; using border collies to spur birds into flight; and implementing targeted public education campaigns.

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Southern-Tip of Lake Michigan Area of Concern: A Case Study of the Grand Calumet River Contaminated Sediment Restoration

Over a century and a half of industrialization has degraded the Grand Calumet River and the globally significant dune and swale habitat that surround the river. Industrial pollutants discharged from industry into the GCR, have negatively impacted the habitats of aquatic and terrestrial species. The authors analyzed participation (concepts, goals & strategies) by citizens interested in the restoration of the five miles of the East Branch of the Grand Calumet River. Citizens have supported the storage of the contaminated sediments in US Steel Corrective Action Management Unit (CAMU). 678,000 cubic yards of contaminated sediment have been confined to the CAMU. The authors examines the role of citizen participation in Remedial Action Plan (RAP) process with a special focus on the Community Involvement Team Effort (CITE) sponsored by US Steel Corp – Gary Works (USS Gary Works). USS Gary Works was required to provide citizens an opportunity to participate in the restoration process. The creation of the CITE exceeds the U.S. Environmental Protection Agency's requirement for civic engagement. The authors propose a new theoretical framework grounded in Public Administration and Economics to analyze and explain the role of citizens, USS Gary Works and citizens in this project.

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Meeting Nonpoint Source Pollution Goals by Illicit Discharge Identification and Elimination in Rural Watersheds

There are multiple pathways to meeting nonpoint source pollution goals that include complex as well as common-sense solutions. This paper targets the efficacy of an effort that can be categorized in the latter category, and has yet had tremendous impact on improving the water quality of Southeast Michigan streams.

Specifically, this paper describes a cooperative effort between two Michigan municipal agencies that implemented an illicit discharge elimination program beginning in 2002 to substantially improve the county's waterways. Using funding from a Clean Michigan Initiative grant, field staff from the St. Clair County Health Department and Drain Commissioner's Office spent thousands of hours systematically surveying streams and road drains in search of signs of pollution. Seven hundred, sixty-five failing septic systems were identified from the 11,000 outfalls that were surveyed. The majority of these systems were discharging untreated or partially treated sanitary sewage, while the remaining systems were discharging only grey water. On an annual basis, this equated to over 40 million gallons of sanitary waste water that was entering the county's waterways. Property owners have corrected approximately 80% of these septic systems through major and minor repairs, drainage field replacement or by connecting to ta sanitary sewer. This has resulted in the elimination of thousands of pounds of pollutants including an estimated 47,000 lbs/yr of biological oxygen demand, 2,300 lbs/yr of phosphorus, 11,000 lbs/yr of nitrogen and 25,000 lbs/yr of suspended solids from local waterways.

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Recreational Water Quality Communication Strategies

Background: A variety of communications approaches are used at the State and local level to communicate water quality at beaches. Little is known about the effectiveness of these programs. Methods: The University of Illinois Chicago School of Public Health conducted a telephone survey of communication startegies used in 30 states, and 18 county, city or local department beach programs. Some of the county/local level programs contacted as part of this survey were considered to be model programs by their state beach program manager and were investigated further.

Results: All programs used multiple methods of communication although a few had undergone systematic evaluations of their content, delivery methods, or effectiveness in promoting behavior change. While the use of signs and websites were common across all programs, hotlines, TV/radio and press releases were also frequently used. Over fifty percent of the programs interviewed said they used a variation of the color-coded system – including the use of colored flags on beaches, and colored postings on websites, with the 3 tier color-coded system being most popular. Four programs have introduced text message services, and 1 program recently joined Twitter to communicate beach closures/advisories in their area.

Discussion: Because people travel to out of state beaches, a uniform method of communicating water quality is desirable. Water quality information is relayed in two timeframes for different segments of the public. For those who have already arrived at a beach, a system of flags and signs is reasonable. In order to inform the public in advance (ie, people who have not yet arrived at the beach), the use of technology such as the websites of a department of environmental health or text messages; social networking sites; or systems such as Facebook or Twitter may be useful. The effectiveness of these approaches in promoting behavior change is unknown.

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No-Regrets Approaches to Adapting to Climate Change

Michigan Sea Grant co-sponsored a workshop titled "Preparing for Climate Change in the Great Lakes Region." The objectives were to identify policy changes to enable Great Lakes communities to adapt to climate change and protect major ecosystems, and to identify strategies for implementing those policy changes. Forty representatives from Great Lakes foundations, NGOs, agencies, and universities attended the workshop. Participants agreed that adaptation efforts should focus on restoring and promoting ecosystem resiliency by pursuing "no regrets" low-hanging fruit policies, policies that achieve both mitigation and adaptation, and policies that achieve multiple benefits. We should avoid reinventing the wheel – existing policies provide opportunities to address climate change adaptation, and we can incorporate adaptation efforts into work already being done. We should target actions at the scale (local, state, national) where implementation is most feasible and will achieve highest impact, and targeting policy initiatives on nonpoint source pollution, flooding, combined sewer overflows, shoreline management, and water quantity will have the most impact on restoring and promoting ecosystem resiliency, thus increasing capacity to adapt to a changing climate. These priority issues can be addressed by focusing a climate change adaptation strategy on policies in four key areas: fiscal setting, land use planning and community development, water conservation and efficiency, and wetland restoration. Integrated watershed management and problem-driven integrated assessments are two effective approaches to developing new policies and revising existing ones to adapt to the impacts of climate change.

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Updating Lake Michigan Total Phosphorus and Nitrate Mass Balances

Total phosphorus and nitrate loads to Lake Michigan were last estimated on a lakewide basis in 1995 as part of the Mass Balance Study. Through a grant received from the U.S. EPA, Great Lakes National Program Office (GLNPO), an effort has been made to update phosphorus and nitrate load estimation efforts for all of the Great Lakes starting with Lake Michigan. A combination of modeling and data analysis has been employed to evaluate whether target loads for total phosphorus established by the Great Lakes Water Quality Agreement (GLWQA) have been and are currently being met. A mass balance model for phosphorus and nitrate has been used to compare projections with direct estimates from measurements obtained primarily from the mid-1970s to the present. The analysis suggests that the target phosphorus load has been consistently met for the main body of Lake Michigan. However, high nutrient levels persist for Green Bay. Components of the total loading that will be considered are point sources, tributaries, atmospheric, and unmonitored area.

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CHEERS – An Epidemiologic Study of Limited Contact Water Recreation

Background: The US EPA's Ambient Water Quality Criteria (AWQC) were developed from epidemiologic studies of swimming at beaches. Activities such as rowing, paddling, fishing, and boating are common, yet little is known about the health risks of these activities, nor about the relationship between health risk and water quality. A quantitative microbial risk assessment (QMRA) has been conducted to address this question in Chicago, and is now being followed by an epidemiologic study.

Methods: The University of Illinois at Chicago School of Public Health is completing a 3-year prospective cohort study of limited contact water recreation activities. Participants are enrolled and water quality is measured at locations on the Chicago River system, Lake Michigan, inland lakes and other rivers in the Chicago area. Water is tested for indicator microbes (*E. coli*, enterococci, somatic coliphages, F+ coliphages), and pathogens (*Giardia, Cryptosporidium*, enteric viruses). A variety of supplemental studies address precipitation effects, objective measures of water exposure, and communicating water quality to the public.

Results: Over 10,000 participants have been enrolled in the study, representing a variety of recreational activities and demographic categories. Data analysis is ongoing, and will provide an opportunity to evaluate the inputs and approaches of the prior QMRA study.

Discussion: Rarely are QMRA studies and epidemiologic studies done in tandem. The Chicago study provides an opportunity to compare directly observed with modeled health risks. Model inputs and assumptions can be revised and anchored in the epidemiologic observations.

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Muskegon Lake Area of Concern Habitat Restoration Project under the American Recovery and Reinvestment Act

A major wetland and wildlife habitat restoration project on Muskegon Lake, Michigan, along the east shoreline of Lake Michigan has been funded by the National Oceanic and Atmospheric Administration with federal stimulus dollars. Muskegon Lake was designated as a Great Lakes Area of Concern due to historic filling of open water, wetlands and pollution discharges that contaminated the lake bottom. The Muskegon River flows into Muskegon Lake and then through a harbor channel to Lake Michigan. Muskegon Lake is also part of one of the world's largest assemblages of freshwater sand dunes. The lake provides habitat for fish and wildlife that reside in Lake Michigan and the Muskegon River.

The Great Lakes Commission received the $10 million grant and will be partnering with the West Michigan Shoreline Regional Development Commission to restore and protect the beneficial uses of fisheries and wildlife habitat in the Area of Concern; improve public access; create and retain jobs; and achieve long-term socioeconomic benefits related to improved habitat for fish and wildlife populations in Muskegon Lake, the Muskegon River and Lake Michigan.

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What Now? How Beach Managers Can Use the National Healthy Beaches Campaign in the Great Lakes

The National Healthy Beaches Campaign (NHBC) is a comprehensive coastal program designed to be an advocate for high standards of beach management and a primary source of dependable information for beachgoers. Our goal is to include Great Lakes beaches in the 2010 report. This listing can be used to promote tourism at Great Lakes beaches as well as encouraging local communities to make improvements at their beaches. In this talk, we provide an approach that beach managers can follow to use data from beach monitoring programs, sanitary surveys and other sources to nominate beaches in the Great Lakes for inclusion on the annual "Top Ten" list of beaches. In addition, we will discuss criteria for certifying beaches under the NHBC and seek input on tailoring these criteria to Great Lakes beaches.

DRISCOL, KEVIN, P.E., URS Corporation, 6737 West Washington St, Ste 2265, West Allis, WI 53214.

Surface and Subsurface Infiltration System Designs, Construction and Maintenance Plans for the Urban Corridor along McKinley Beach at Lake Michigan

Recent studies by the Great Lakes Water Institute indicate that storm water being discharged from various Milwaukee County Beaches, including McKinley Beach Park outfalls, at times contains elevated levels of e-coli. According to Milwaukee County's NR 216 permit, approved control measures needed to be implemented in a timely fashion. In response, the Milwaukee County Environmental Services Division solicited proposals and contracted URS to evaluate numerous options, hold a public meeting and design surface and subsurface storm water treatment measures at McKinley Beach Park prior to discharging into Lake Michigan.

This presentation addresses the development of two such measures: a surface infiltration system (rain garden) and sub-surface infiltration system. The surface and subsurface storm water control measures are designed to mitigate qualitative effects that impact Lake Michigan and handle peaks flows while addressing water quality with a treatment system that is practical and economical to construct, operate and maintain.

This presentation will focus on:

1. The development and evaluation of the solutions;
2. The implementation of the solutions;
3. Their effectiveness in meeting the project's objectives;
4. Potential ancillary benefits: aesthetic, education opportunities, attractiveness of lakefront, public relations; and
5. Lessons learned.

EDGE, TOM[1], HILL, STEPHEN[1], KHAN, IZHAR[1], LU, JINGRANG[2], SANTO DOMINGO, JORGE[2], SETO, PETER[1], MARSALEK, JIRI[1], STINSON, GARY[3], BOWERING, TED[3], and D'ANDREA, MICHAEL[3], [1]National Water Research Institute, Environment Canada; [2]United States Environmental Protection Agency; [3]City of Toronto.

Application of Microbial Source Tracking Tools at Toronto Beaches on Lake Ontario

A variety of microbial source tracking tools have been applied at urban beaches in the cities of Toronto and Hamilton on Lake Ontario in recent years. Some of these beaches are significantly impacted by fecal droppings from gulls and geese, and therefore they provided an opportunity to evaluate the application of different microbial source tracking methods. In early studies, *E. coli* antibiotic resistance analysis and rep-PCR DNA fingerprinting methods provided evidence indicating the importance of birds as sources of *E. coli* at several beaches that were also observed to be heavily impacted by gull and geese fecal droppings. DNA microarray fingerprinting of *E. coli* isolates from bird, wastewater, and pet fecal sources has not found host-specific virulence or antibiotic resistance genes to date, although combinations of genes may prove useful for source tracking in the future. More recent applications of 16S rDNA-based assays specific to human Bacteroidetes, and to gull and Canada geese feces have provided results consistent with other lines of evidence for identifying the prominence of bird droppings or municipal wastewater impacts at beaches.

EGGOLD, BRADLEY T., Wisconsin Department of Natural Resources, 600 E Greenfield Ave, Milwaukee, WI, 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 three years with the fourth year underway. Information compiled during these three 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.

EMMANUELLI, CAROLYN, U.S. Geological Survey, Center for Integrated Data Analytics, 8505 Research Way, Madison, WI 53562.

Web Services as a Tool for Beach Data Collection, Dissemination, and Model Support

One of the many challenges of running a beach program is the collection and sharing of data for making management decisions and advancement of beach-related research. Data is often widely distributed between various agencies and groups and is available in as many formats as there are data providers. As the data needs of managers become more intensive, the need for quickly acquiring, processing, and disseminating data, especially real-time data, increases. Web services are one type of tool that can help in the standardization and sharing of data across multiple platforms and for a variety of data use needs. This presentation discusses the acquisition of data through web services for use in beach modeling and research, the availability of standard data formats, and making data available through web services for others to use.

ENGEL, BERNARD A.[1], HUNTER, JAMES[2], CHAUBEY, INDRAJEET[3], FARNSWORTH, RICK[4], and THELLER, LARRY[5], [1]Professor and Head of Agricultural and Biological Engineering, Purdue University; [2]Post Doctoral Researcher, Agricultural and Biological Engineering, Purdue University; [3]Associate Professor of Agricultural and Biological Engineering, Purdue University; [4]Associate Professor of Forestry and Natural Resources, Purdue University; [5]GIS specialist, Agricultural and Biological Engineering, Purdue University.

Web-based Low Impact Development Decision Support and Planning Tool

Low Impact Development (LID) practices help to reduce pollution and hydrologic instability from stormwater arising from increases in impervious surfaces and land development practices. However, significant obstacles to the adoption of LID practices by federal, state, and local agencies may stem from the lack of tools to quickly and easily quantify the impact of LID practices within an area. LID models currently available for stormwater management and preliminary assessments preclude the use by a greater audience due to needed expertise. In response to increasing demands for information about LID and tools for comparing LID practices to conventional development practices, an easy to use web-based LID decision support and planning tool, L-THIA/LID (www.lthia.org/lid) has been developed as a simple to use screening tool to evaluate the benefits of LID practices. The Long-Term Hydrologic Impact Assessment (L-THIA) tool is a web-based spatial decision support system that provides support for decision makers who need information regarding the hydrologic impacts of water quantity and quality resulting from land use change. The L-THIA enhanced L-THIA/LID tool will enable various stakeholders to quickly and easily evaluate development within a watershed based on historic climate, soils, and land use data for an area. L-THIA/LID provides: (1) the impact of urban development on average annual runoff volume; and (2) the potential stormwater and pollutant reduction of proposed LID practices. Runoff quantity and water quality impacts of proposed land use change are displayed in tables, bar charts, and pie charts. A case study will be used to demonstrate the model's ability to assess the impact of LID practices within a watershed. The aim of the model is to enable decision makers to formulate effective watershed management plans to achieve desired stormwater management and water quality goals.

ENGEL, BERNARD A.[1], LIM, KYOUNG JAE[2], CHAUBEY, INDRAJEET[3], QUANSAH, JOSEPH[4], HUNTER, JAMES[4], and THELLER, LARRY[5], [1]Professor and Head of Agricultural and Biological Engineering, Purdue University; [2]Assistant Professor, Dept. of Agricultural Engineering, Kangwon National University; [3]Associate Professor of Agricultural and Biological Engineering, Purdue University; [4]Post Doctoral Researcher, Agricultural and Biological Engineering, Purdue University; [5]GIS specialist, Agricultural and Biological Engineering, Purdue University.

Web-based Tool for Flow and Load Duration Curve Development for Watershed Management

Flow and load duration curves (FDC/LDC) increasingly are being utilized for watershed management and in development of Total Maximum Daily Loads (TMDLs), as the USEPA has approved numerous TMDLs using LDCs. The development of these duration curves are typically done by importing flow and water quality data into spreadsheets and manipulating the data to analyze cumulative frequencies, percentages for flow values, exceedance probability estimates, data sorting and plotting flow values against percentage of time those values have been equaled or exceeded. However, this process can be complex, time consuming, and may introduce error, particularly if the stakeholder is not an expert in spreadsheet manipulation and formatting of flow and water quality data. To help solve these issues, a simple web-based load duration curve (WBLDC) (https://engineering.purdue.edu/~ldc) tool was developed which allows users to step through various options to rapidly develop duration curves using online data from USGS, or user-supplied flow and water quality data. The FDC/LDC developed establishes a relationship between stream flow and pollutant loading, allowing the characterization of water quality concentrations (or water quality data) at different flow regimes. This tool also provides a useful interpretation of the stream flow patterns/flow conditions that influence water quality impairments, thus allowing the user to estimate the frequency and magnitude of water quality standard exceedances and load reductions necessary for TMDL development. The use of FDC/LDC meet a variety of watershed planning and analysis needs as their use can be extended to federal, state, local stakeholders and watershed planners who regularly monitor concentrations of different pollutants in different sites within rivers and watersheds. The WBLDC will also support the forecast capability of the web-based decision support tool L-THIA (Long-Term Hydrologic Impact Assessment), which will enable beach managers to anticipate beach closures due to bacterial water quality exceedances for E Coli and Enterococci.

ESTES, TRUDY J., P.E., Ph.D., U.S. Army Corps Engineer Research and Development Center, CEERD-EP-E, 3909 Halls Ferry Rd, Vicksburg, MS 39180-6199.

When Physical Separation Doesn't Work

Various treatment technologies have been evaluated through technology demonstration programs over the last 20 years, including vitrification, thermal desorption, physico-chemical oxidation, and soil washing. As a result, our understanding of the requirements and challenges of sediment treatment has progressed significantly; the execution, however…not so much. The reasons are multi-fold, but the chief obstacles are the complexity of the media, the scale required of the processes and, ultimately, the cost.

Physical separation, the process of separating sediment particles based on physical properties, is sometimes utilized as a pretreatment for the more energy intensive contaminant destruction technologies previously mentioned, as the core of a soil washing process, or as a stand-alone volume reduction process. Physical separation is a relatively mature technology, although not widely practiced in the United States to date. The objective of separation is generally simple; to segregate contaminated from uncontaminated fractions, enabling beneficial use and minimizing disposal volumes and cost. Usually the goal is to recover the sand, with the expectation that the contaminants are associated primarily with the fine fraction. Sometimes this is successful. Often, however, contaminants are present in every size fraction, associated with carbonaceous particles or with clay or organic matter coatings on mineral surfaces. In order to determine the best approach for successfully achieving separation, it is imperative to understand the properties of these contaminated phases.

Relevant concepts are illustrated through the results of fractionation studies, conducted at ERDC, on New Bedford Harbor sediment samples taken from the full scale sand separation circuit in operation there. The contribution of different sorptive phases to contaminant levels in the sand fraction was evaluated through regression on corresponding contaminant data. The potential for improving removal of these phases from the sand fraction was evaluated through comparison of the physical properties of the sand and of the sorptive phases.

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Water Availability in the Lake Michigan Basin – Report on a Recently Completed Framework USGS Study

The USGS has constructed a regional groundwater-flow model of the Lake Michigan Basin and surrounding areas as part of the National Water Availability and Use Pilot project for the Great Lakes Basin. The work is part of a recently initiated series of framework studies aimed at evaluating the state of the resource from water-use and ecological standpoints. The transient, 20-layer, two-million-node model incorporates multiple aquifers and pumping centers with cones of depression that extend into deep saline waters. The model simulates the exchange of water between networks of surface-water bodies and shallow sequences of heterogeneous glacial deposits which, in turn, overlie stratified, dipping bedrock of the Wisconsin Arch and Michigan Structural Basin. These hydrogeological elements pose challenges for the model setup, the handling of variable density conditions, and the calibration strategy. The final model provides a multi-state framework for quantifying the regional sources and sinks of groundwater (including recharge, pumping, and groundwater flow to water bodies — all elements of the groundwater budget that change with time) and for mapping the direction and magnitude of flows in a series of aquifers (including the locations of groundwater divides at different depths on both sides of Lake Michigan and their movement in response to pumping). Modeling results are distilled into water-availability measures for the Lake Michigan Basin which show the long-term effect of pumping on the natural resource, including the effect on groundwater exchange with Lake Michigan itself. The necessarily coarse resolution of the regional model imposes limitations on its direct usefulness for management applications, but new techniques enhance our ability to embed fine-scale, child models to address local water-availability issues (associated, for example, with climate change) while leveraging the insight gained from the parent, regional model.

FERRON, DAVE[1]and VAIDYA, AJIT[2], [1]Business Improvement District #35, SE Milwaukee, [2]EPA, Great Lakes National Program Office, 77 W Jackson Blvd, Chicago, IL 60604.

Cleanup of the Kinnickinnic River and Economic Revitalization in Southeast Milwaukee

The cleanup of contaminated sediments in the Kinnickinnic River in Milwaukee is underway. The project will remove approximately 170,000 cubic yards of sediments contaminated with PCBs and PAHs. In addition to the obvious environmental benefits to the Milwaukee Estuary Area of Concern associated with this cleanup, the project also has an added economic benefit of promoting waterfront revitalization in Southeast Milwaukee. This presentation will outline some of the economic benefits resulting from the GLLA sediment remediation on the Kinnickinnic River. In addition, we will discuss how local property owners formed a Business Improvement District to support economic revitalization in the community.

FISHER, TIMOTHY G.[1] and HANSEN, EDWARD[2], [1]Dept. of Environmental Sciences, University of Toledo; [2]Hope College.

A Possible Proxy for Storminess along the Southern Great Lakes as revealed by the Geomorphic History of Lake Michigan Coastal Dunes

Coastal dunes along the Lake Michigan coastline record past wind climates and storm activities as revealed by their geomorphic histories. Dunes record periods of stability punctuated by growth and migration. In Northern Europe periods of dune migration appear to have been initiated by increases in storminess. Increased frequency and energy of storm surges and waves leads to foredune erosion in the back beach exposing sediment. Increases in the frequency and energy of winds enhance their ability to transport sand. A recent study of large parabolic dune migration near Holland, Michigan showed that nearly half the annual movement was associated with only two major storms. A detailed geomorphic history of coastal dunes along the southeast Lake Michigan coast covering the last 6000 years shows three periods of enhanced dune mobility (5.7 – 3.8 ka, 3.3 – 1.8 ka, 0.5 – 0 ka). Movement during these periods was episodic and may be in phase with the ~160 year quasi-periodic lake level cycle. This suggests that winds and storms recorded by dunes and the balance between evaporation and precipitation controlling lake levels may be tied to the same climate cycles, possibly linked to changes in the average track of extratropical cyclones. Changes in the paths of cyclones will also change the direction of storm winds across the lake. Thus a change in storm paths may have different effects along coastal segments with different orientations (for example southeast vs. northwest facing). We are currently testing the idea that changes in storm energy linked to changes in storm paths are responsible for changes in dune stability by:

1. Investigating the climate record in peat bogs associated with interior dune fields and
2. Examining the chronology of aeolian activity in a dune field along a southeastern coastal segment (Whitefish Dunes, Wisconsin).

GARRISON, PAUL J., GREB, STEVEN R., and LALIBERTE, GINA D., Wisconsin Department of Natural Resources, Bureau of Science Services, 2801 Progress Rd, Madison, WI 53716.

Western Coast of Lake Michigan Water Chemistry and *Cladophora* Growth

During the last 2 decades, the *Cladophora* population has become a nuisance along the Lake Michigan shoreline reminiscent of the Great Lakes eutrophication problems in the 1960's and 1970's. Large mats of *Cladophora* wash onto beaches and decay, creating significant aesthetic and public health problems. Changes in conditions in the lake, brought about in part by the actions of invasive dreissenid mussels, have led to these increases in *Cladophora*. For the period of 2004-07 the Department monitored the *Cladophora* distribution and selected water chemical variables along the coast. Phosphorus levels decline from south to north while nitrogen levels are similar along the coast. The highest phosphorus levels are associated with riverine inputs from areas with significant agricultural activity. The biomass of *Cladophora* is similar from the Sheboygan area north to St. Martin's Island, MI and then declines up to the Upper Peninsula of MI. Either the *Cladophora* growth is not responding to phosphorus or other phosphorus sources are important besides riverine inputs from the land. Although the input of off shore nutrients to the nearshore area occurred prior to the resurgence of the *Cladophora* problems around 1990, the change that facilitated *Cladophora* growth was the arrival of mussels in 1988.

GE, ZHONGFU[1], WHITMAN, RICHARD L.[2], NEVERS, MEREDITH B.[2], [1]Department of Civil and Environmental Engineering, Michigan State University, 1100 N Mineral Springs Rd, Porter, IN 46304; [2]United States Geological Survey, Great Lakes Science Center, Lake Michigan Ecological Research Station, 1100 N Mineral Springs Rd, Porter, IN 46304.

Bacteria Loading and Transport at a Beach: a Hydrodynamic Perspective

The Chicago 63rd beach in southwest Lake Michigan was studied to determine the influence of nearshore hydrodynamic effects on the variability of bacteria concentration in both knee-deep and offshore waters. Explanatory variables that could be used for identifying potential bacteria sources and transport mechanisms, such as bed shear stress due to a combined wave-current boundary layer near the opening of the embayment and wave runup on the beach surface, were derived from existing standard wave and current parameters. Based on the observation that onshore waves tend to result in a stimulated hydrodynamic system in the beach embayment, a further multiple linear regression analysis of onshore-wave cases indicated the significance of sediment resuspension and the interaction of swash with gull-droppings in explaining the variability of bacteria concentration in the knee-deep water. With prevalent longshore currents at the study beach, a small-scale circulation inside the embayment was likely to form. The existence of an internal circulation is consistent with the statistical results that identified 1) the submerged sediment as a secondary net source of bacteria for the offshore water and 2) a negative net contribution of the variability of bacteria concentration in the knee-deep water to that in the offshore water for longshore-current cases. The internal circulation also could be an important transport pattern that enables swash, as well as the bacteria supply in the foreshore sand, to be a significant bacteria loading mechanism under almost all hydrodynamic conditions. The statistical inferences of bacteria sources and transport in the present work will be further verified by field observations of nearshore flow parameters in future studies.

GLATFELTER, ED, Director of Water Conservation Programs, Alliance for the Great Lakes, 17 N State St, Ste 1390, Chicago, IL 60602.

Great Lakes Compact Implementation: Actions, Issues, Diversions, Milestones

Starting with the initial December 2008 meeting of the Regional Council, steps have been taken at the regional and state levels to implement the Great Lakes St. Lawrence River Basin Water Resources Compact. This presentation will, from an NGO perspective, review:

- actions taken at the regional level including policies adopted by the Regional Council in December 2008, and subsequent action of Regional Committees;
- implementation efforts by the states, including impacts of time and funding resources;
- the status of applications for diversions
- important milestones;
- issues raised, including: establishing baselines; defining the trigger for increased uses; what constitutes being consistent with Compact language; the need for rules and regulations; and potential conflict between state law intent language and the Compact;
- continuing efforts of NGOs to collaborate on Compact implementation; and
- expectations about the future.

GRAYSON, TREDA S.[1], and COLIANNI, GREGORY[2], [1]U.S. EPA Office of Water, 1200 Pennsylvania Ave, NW, Washington, D.C. 20460; [2]U.S. EPA Office of Water.

Water Quality Status of the Nation's Coasts: Incorporating the Nearshore Great Lakes into the National Coastal Assessment

Working with our partners in the states, tribes, and other federal agencies, the U.S. Environmental Protection Agency (EPA) is conducting statistical surveys of the nation's waters designed to provide nationally-consistent assessments of water quality we can use to gauge the impact of our national investment in protecting and restoring the nation's waters. In collaboration with the National Oceanic and Atmospheric Administration and the U.S. Geological Survey (USGS), EPA has produced three national reports since 2001. These reports present a clear message about the challenges facing our ocean and coastal resources.

Planning is now underway for the 2010 National Coastal Assessment which expands upon the previously conducted surveys, and includes a Great Lakes component . The survey is designed to answer three key questions: 1) what percent of the nation's coastal waters are in good, fair and poor condition; 2) how widespread are the most significant problems; and 3) what are the trends in marine coastlines and the baseline conditions of the Great Lakes nearshore area from which future trends can be measured?

Although previous reports included information on the Great Lakes, this is the first survey that specifically includes the Great Lakes in the survey design and field implementation. The Great Lakes portion of the National Coastal Assessment will help fill a critical gap in our understanding of Great Lakes by focusing on nearshore areas and providing statistically valid assessments of this critical resource. This talk will provide a brief overview of the national surveys and specifically the NCA, the assessment goals, the integration of the Great Lakes shoreline into the NCA, the design of the survey, the indicators that will be collected and plans for implementation.

GREEN, EMILY, Great Lakes Program, Sierra Club, 122 W Washington Ave, Ste 830, Madison, WI 53703.

Offshore wind in Lake Michigan—Protecting our Great Lakes while building a new economy and a new energy future

The Great Lakes region generates three-quarters of its energy from coal. The region's coal-fired power plants cause significant impacts to the Great Lakes ecosystem and the region's communities, such as mercury contamination, soot, smog, thermal pollution, fish impingement and entrainment, and global warming. Thus, we have many reasons to reduce our reliance on coal.

Offshore wind in the Great Lakes offers a tremendous opportunity to develop large-scale, reliable renewable energy close to major urban and industrial areas. It could help reduce the need for coal while contributing to economic growth. However, offshore wind development will cause some ecological impacts and will raise legal and regulatory challenges. It is critical to understand and manage these issues to the extent possible in order to ensure the long term protection of our Great Lakes.

This presentation will discuss the benefits of the development of offshore wind in Lake Michigan, while laying out considerations that must be addressed to ensure the protection of our Great Lakes. We will discuss some of the ecological impacts associated with offshore wind development and will review siting considerations that may encourage environmentally responsible offshore wind development. Finally, we will discuss possible next steps in the development of this potential energy source.

HAACK, S. K.,[1] DURIS, J.W.,[1] FOGARTY, L.R.,[1] BYAPPANAHALLI, M.,[2] FRANCY, D.S.,[3] SHIVELY, D.,[2] DUMOUCHELLE, D.,[3] and WHITMAN, R.L.[2], [1]US Geological Survey, Michigan Water Science Center, Lansing, MI; [2]US Geological Survey, Great Lakes Science Center, Lake Michigan Ecological Research Station, Porter, IN; [3]US Geological Survey, Ohio Water Science Center, Columbus, OH.

Patterns of Occurrence of Common Bacterial Pathogens at Two Great Lakes Beaches

Between 2003 and 2006, the US Centers for Disease Control reported four pathogens associated with the majority of ambient recreational water illness outbreaks: *Escherichia coli* O157:H7, *Shigella spp.*, *Cryptosporidium* spp., and norovirus. *Salmonella* and *Campylobacter* together accounted for fewer than 5% of cases, and in up to 15% of cases, the causative agent was not determined. In 2008, we used polymerase chain reaction (PCR) to test for presence or absence of pathogenicity genes associated with *Shigella*, *Salmonella*, enterotoxigenic (ETEC), and shiga-toxin producing (STEC) *E. coli* at two beaches having different characteristics and pollution sources. Analyses of the *Shigella ipa*H gene, *Salmonella inv*A and *spv*C genes, ETEC LTIIa and STII genes, and STEC *stx*1, *stx*2 and *rfb*O157 genes were performed on bacterial cultures grown from 100 mL of swimming, swash-zone, or ground water on standard media; therefore, each gene detection indicated at least one viable target organism in the 100 mL sample. At Ogden Dunes Beach, IN, one or more of the *E. coli* genes were detected in 15 of 16 samples, and *Shigella* or *Salmonella* genes in 5 samples, with little relation to indicator *E. coli* or enterococci concentrations. Pathogen gene occurrence varied with offshore conditions, and indicated several possible sources of contamination. At Edgewater Beach, OH, one or more of the *E. coli* genes were detected in 10 of 22 samples, but *Shigella* and *Salmonella* were never indicated, even when concentrations of indicator *E. coli* or enterococci exceeded 1000 CFU/100 mL. Pathogens may be present in Great Lakes beach waters, their presence may not be predictable by traditional fecal indicator bacteria monitoring, and much more needs to be learned about pathogen transport and fate at beaches.

HAEN, DEAN, Port Manager, Port of Green Bay.

Cat Island Chain Restoration Project

Historically, the Cat Island Chain of barrier islands protected extensive coastal (Great Lakes) wetlands in the lower Green Bay Area of concern from high energy wave and storm effects. Shallow waters and extensive beds of submergent and emergent aquatic vegetation have provided a major stopover for waterfowl and other migrating birds as well as habitat for diverse populations of water birds, furbearers, invertebrates, and native fishes. During extremely high water levels in the mid 1970s, a series of severe storms during ice breakup resulted in catastrophic erosion and ice damage to the islands. Remnant island and wetland habitat still remains; however, most of this habitat has been lost or degraded due to erosion over 30 years of higher than average lake levels.

Constructing the islands 2.5 mile long rock spine will acts as a wave barrier and provides the essential foundation for restoring the Cat Island Chain of barrier islands. The rock spine will provide immediate benefits protecting 1,225 acres of remaining wetlands and promoting emergent and submergent aquatic vegetation reestablishment. The spine provides the base for constructing 272 acres of habitat islands with beneficially reused fine sands dredged from the outer navigation channel. The spine will provide long term protection to the barrier islands and restored wetlands from future storm and ice damage.

The project will sustain the Port's ability to move more than 2.5 million tons of cargo valued at more than $315 million via 200+ ships annually. Green Bay's maritime industry provides over 725 direct and indirect well-paying jobs to members of the community and creates an economic impact of over $75 million per year. This project will provide a beneficial site for clean dredged material which supports maintenance of the navigation channel critical to the Port and Northeast Wisconsin.

HANSEL, JOEL, U.S. Environmental Protection Agency, Atlanta, GA.

State Experiences on Reporting and Using Assessment Data

State programs vary on their water assessment methodologies. This session will discuss the challenges states face with assessment data review and using the assessment decisions in water monitoring program management. This presentation is intended to facilitate interactive dialogue among partners and serve as a listening session by EPA to learn ways to: 1) improve assessment data entry, 2) facilitate data sharing on the Exchange Network, 3) create a data standard, 4)improve data viewing, and 5) improve data utility.

HANSEN, THOMAS F.[1], JANSSEN, JOHN[1], and WATTRUS, NIGEL[2], [1]University of Wisconsin – Milwaukee, Great Lakes WATER Institute, 600 E Greenfield Ave, Milwaukee, WI 53204; [2]Large Lakes Observatory, University of Minnesota.

Creation, Implementation, and Practical Field Use of a Real-Time Bathymetry Mapping System Created with Open-Source Tools as an Adjunct to Multibeam Surveys

Detailed bathymetry maps are vital to studies of Great Lakes aquatic ecological systems. However, the commonly available NOAA bathymetry charts are based on data which is typically at least 50 years old. In addition, in many research locations of interest the resolution available is too low to be useful.

In an effort to supplement the existing NOAA bathymetry, author Hansen, in 2006, installed an open-source database on a server computer aboard the R/V Neeskay, and programmed it to record the GPS and echosounder depth data produced by the ship's already existing navigational equipment.

More recently, in 2009, armed with nearly three years of collected soundings, Hansen created a system, using all open-source tools, to create bathymetry charts from the data. The system runs on the ship's computer, and is capable of continuously updating the chart display as the vessel is underway, incorporating the latest sounding data.

The system proved itself during a recent bathymetric study of Lake Michigan's Northeast Reef. Co-author Janssen used the real-time bathymetry display to direct the ship's path over the reef to map the sections of highest interest. The system also displays the paths of previous cruises – where data had already been collected incidentally – and thus allowed Janssen to concentrate on previously unvisited terrain. Janssen estimated that it cut the length of the cruise in half from what it would have been without the system.

Perhaps even more importantly, the resulting charts also allowed the follow-up multibeam study to pinpoint the most important spots, allowing co-authors Janssen and Wattrus to map the reef in about one-fourth the time originally estimated.

Complete system details, including operating system, software tools, data inputs and hardware requirements, will be discussed in detail, along with results of ongoing operation during this field season.

HARRIS, VICTORIA[1], PISTIS, CHUCK[2], CLARK, GENE[1] and EXL, JOE[3], [1]UW Sea Grant Institute; [2]Michigan Sea Grant; [3]Indiana Dept. of Natural Resources.

Protecting Lake Michigan Water Quality through Clean Marina Programs

The Great Lakes and connecting waters constitute one of the largest boater destinations in North America. Recreational boating is big business for the region annually generating more than $19 billion in direct and indirect economic expenditures and accounting for 250,000 jobs. With more than 4.3 million registered boats and thousands of facilities that store, service and repair boats there is real potential for adversely impacting Great Lakes and inland water quality. In the Lake Michigan basin three Clean Marina programs have been developed (Michigan, Indiana and Wisconsin) and become part of a network of 27 programs throughout the nation. Clean Marina Programs are voluntary and encourage implementation of Best Management Practices that prevent environmental pollution. Participants attend educational workshops, sign an environmental pledge, complete a self-evaluation environmental checklist and participate in an onsite facility review. Marina management guidebooks include specific BMP's for marina siting, marina design, stormwater management, maintenance and repairs, petroleum control, sewage handling, and solid waste management. Each state administers its program differently. In Michigan Clean Marinas is a partnership between MSUE Sea Grant, the Michigan Boating Industries Association and the Michigan Department of Environmental Quality. A team of industry led field inspectors provide technical resources. New projects include creation of a nonprofit foundation and the addition of web-based instruction and training. Since the program's inception in 2003, 27 facilities have been certified and more than 70 have signed formal pledges. Indiana unveiled its program in 2008 and currently has 6 pledged marinas. Indiana's program is a partnership between the Indiana Department of Natural Resources, Indiana Department of Environmental Management, and Illinois-Indiana Sea Grant. The program provides technical and financial assistance to participating marinas and engages boaters through education and outreach. In Wisconsin a new program is being developed by UW Sea Grant in partnership with marina and agency advisors. The program will be launched in late 2009 by the concurrently developing Wisconsin Marina Association.

HART, DAVID[1], HAGLEY, CINDY[2], and WORTLEY, A.J.[3], [1]GIS Specialist, University of Wisconsin Sea Grant Institute, Goodnight Hall, Rm 201, 1975 Willow Dr, Madison, WI 53706; [2]Minnesota Sea Grant; [3]Wisconsin State Cartographer's Office.

Great Lakes Mapping Mashups: How to Develop Your Own Great Lakes Web Mapping Application

The amount of data collected about the Great Lakes and its watershed is increasing at a rapid pace. Great Lakes data are collected by government agencies, academic institutions, commercial interests, non-profit agencies, communities, and even individual citizens. Increasingly, these data can be accessed on-line as web services. With a little training to provide knowledge about software tools and access to map and data services, it is possible to extend the use of innovative web mapping applications to multiple Great Lakes constituencies, providing them with the resources and knowledge to better utilize these new tools for sustainable management of the Great Lakes. The result will be an increase in both the use of existing decision support tools and the development of new innovative web mapping applications providing information about the Great Lakes.

This presentation describes (and promotes) workshops that are being held on each of the Great Lakes this fall. Each workshop will have three sessions – a morning session geared toward a general audience that demonstrates the state-of-the-art related to integration of Great Lakes maps and data and assesses the needs of selected Great Lakes constituencies for digital products that integrate these data; an afternoon session in a computer lab targeted towards a technical audience interested in developing their own Great Lakes web mapping applications; and an evening session for teachers. This presentation focuses on tutorials that demonstrate the use of Google Maps, Google Earth, and open source web mapping tools to develop the skills necessary for Great Lakes constituencies to develop their own mapping "mashups".

HART, DAVID[1], MCCLINTOCK, TOM[2], and STONE, JEFF[3], [1]GIS Specialist, University of Wisconsin Sea Grant Institute, Goodnight Hall, Rm 201, 1975 Willow Dr, Madison, WI 53706; [2]Land Information and Computer Graphics Facility, University of Wisconsin-Madison; [3]Association of State Floodplain Managers.

Visualizing the Impact of Changing Water Levels on the Great Lakes

Geographic information systems (GIS) and 3D visualization are tools that can effectively communicate the impacts of Great Lakes water level changes to coastal constituents. Schwartz et al. (2004) utilized GIS and an integrated topographic/bathymetric elevation dataset to model the impacts of changes in the water level of Lake Huron on the community of Goderich, Ontario. Their work incorporated water level scenarios from regional climate models and projected the impacts on harbor dredging, cargo vessel capacity, marina dredging, shoreline recreation, and municipal water supply. They concluded that LiDAR-derived digital elevation models would provide the current, high-resolution data needed to better understand the physical elements of climate change impacts and that animation and 3D display could improve communication of complex modeling to researchers, local decision-makers, and stakeholders. This presentation provides a review of the latest capabilities of visualization software, an inventory of LiDAR collection efforts along the U.S. shores of the Great Lakes, briefly explores the issues associated with constructing an integrated coastal terrain model from topographic and bathymetric data, and demonstrates methods for visualizing water level changes along the coast of Ozaukee County, Wisconsin.

HILLER, JAREN J., AECOM, Inc., 1020 N Broadway, Ste 400, Milwaukee, WI 53202.

Treatment of Stormwater Runoff at Public Bathing Beaches

Beach closures due to high bacteria levels are becoming a more frequent occurrence in many coastal communities. Stormwater runoff can be a major source of bacteria to beaches. AECOM has completed the design of stormwater treatment systems at two public beaches along Lake Michigan in Wisconsin.

In the City of Racine, a 60-inch diameter storm sewer outfall discharges into Lake Michigan at the City's North Beach. The sewer drains a 400 acre urbanized watershed. Historically, high levels of fecal indicator bacteria, such as *Escherichia coli*, in lake water adjacent to the outfall have resulted in beach closures. A study of potential sources of bacteriological contamination determined that stormwater runoff was a significant contributor of bacteria. In 2001, a stormwater treatment system was constructed consisting of sub-surface sedimentation chambers wetland / treatment / infiltration cells. Vegetation in and adjacent to the cells stabilizes sand dunes, and aids in lowering bacteria levels by processes including nutrient uptake. This wetland area not only provides stormwater treatment, but also provides wildlife habitat in this unique coastal environment.

The second beach is Bradford Beach, located in Milwaukee, Wisconsin. This beach has seven storm sewer outfalls that discharge stormwater onto the beach. These outfalls drain a total watershed area of approximately 30 acres. Monitoring by the University of Wisconsin – Milwaukee's Great Lakes WATER Institute have indicated that the stormwater runoff from these outfalls is a significant source of bacteriological contamination. To treat stormwater from these outfalls, seven infiltration basins on the beach itself, a bioretention system for a parking lot; three raingardens, rerouting storm sewer, a 72-inch diameter sedimentation chamber, and anti-bacterial inlet filters have all been designed and constructed. This comprehensive approach is expected to reduce the volume of stormwater from entering the beach by up to 90 percent annually.

HORNS, WILLIAM, Wisconsin Department of Natural Resources, 101 S Webster St, Madison, WI 53707.

Salmonine Stocking in Lake Michigan – Current Challenges

Fisheries agencies stock 12 million salmon, trout, and char annually in Lake Michigan. That stocking program has far-reaching ecological and economic consequences. As highlighted in "The State of Lake Michigan in 2005" (Clapp and Horns, editors), fisheries agencies on Lake Michigan are challenged to hold stocking within sustainable limits and to respond to the apparent conflict between the goals of sustaining current Pacific salmon fisheries and restoring naturally-reproducing populations of lake trout and other native species. Other presentations at this State of Lake Michigan conference will highlight ecological changes in Lake Michigan that add urgency to the situation. My presentation will discuss what the fisheries agencies are doing about this. I will review our approach to understanding the underlying biological issues and describe the inter-jurisdictional decision-making framework. The biological issues center around the ecological role of alewives. The questions include, "How many salmon can we stock before the alewives collapse?" and "Can we restore lake trout without crashing the alewives?" Fisheries agencies are responding to the challenges within a well-established policy-development framework. The foundation of inter-jurisdictional fisheries management on the Great Lakes is the A Joint Strategic Plan for Management of Great Lakes Fisheries, adopted by consensus of the management agencies in 1981 and revised in 1997. The Joint Strategic Plan highlights two strategies of particular relevance here: the "Consensus Strategy" and the "Ecosystem Approach to Fishery Management Strategy".

HUBERTY, BRIAN, American Society for Photogrammetry & Remote Sensing, Western Great Lakes Region, U.S. Fish and Wildlife Service, R-3 Ecological Services, 1 Federal Dr, Mail Stop 4056, Ft. Snelling, MN 55111-4056 USA.

Remote Sensing Technologies Overview for Lake Michigan

Remote Sensing technologies are critical to see the 'big picture' of what is happening in and around Lake Michigan. This presentation will highlight on-going remote sensing programs for Lake Michigan and the surrounding area. Discussion will also focus on future needs given climate change impacts will require more rapid assessments and actions in regards to changing conditions for Lake Michigan.

HUMMER, JOHN, Great Lakes Commission, Eisenhower Corporate Park, 2805 S. Industrial, Hwy. Suite 100, Ann Arbor, MI 48104-6791.

Introduction and Overview of the Great Lakes Wind Collaborative

The Great Lakes Wind Collaborative (GLWC) is a multi-sector coalition of wind energy stakeholders working to facilitate the sustainable development of wind power in the binational Great Lakes region. The coalition strives to achieve this goal through Issue-specific workgroups that focus on particular GLWC priorities. Current GLWC workgroups include (1) Economic Development, (2) Environmental Planning, Siting and Permitting, (3) Offshore Wind, (4) Regional Transmission, and (5) Great Lakes Wind Atlas. The GLWC strives for a broad, balanced membership. Members provide diverse perspectives and represent a wide array of societal sectors that work to achieve the purpose of the group. This presentation will illustrate how the GLWC reaches across sectors and disciplines to identify and address the technical, environmental, regulatory, educational and economic issues related to the deployment of wind energy resources in the Lake Michigan and Great Lakes basins.

JANSSEN, JOHN, University of Wisconsin – Milwaukee, Great Lakes WATER Institute, 600 E Greenfield Ave, Milwaukee, WI 53204.

Ecosystem Regime Change and Ecosystem Management Regimes

The Lake Michigan ecosystem, along with that of most of the other Great Lakes, has a biota imposed on it through diverse introductions and the resultant chimaera is increasingly marine in origin. This chimaera is the consequence of two rapid-fire transitions in the biota. The first transition was due to the invasions of sea lamprey and alewife. The management response was bold: Pacific salmons were intentionally introduced. The second transition is due mainly to the influx of Ponto-Caspian species. Hence management is dealing with an increasingly "marine" ecosystem and the appropriate management responses likely requires a marine type of perspective.

JOHNSON, BILLY E.[1], DOWNER, CHARLES W.[2],and BYRD, AARON R.[2], [1]Research Civil Engineer, Environmental Laboratory, Engineer Research and Development Center (ERDC), 3909 Halls Ferry Rd, Vicksburg, MS. 39180; [2]Research Hydraulic Engineer, Coastal and Hydraulics Laboratory, Engineer Research and Development Center (ERDC), 3909 Halls Ferry Rd, Vicksburg, MS. 39180.

Application of a Physically Based Distributed Watershed Model on the Upper Auglaize Watershed

Agricultural subsurface drains, commonly referred to as tile drains, are potentially significant pathways for the movement of fertilizers and pesticides to streams and ditches in much of the Midwest. Preferential flow in the unsaturated zone provides a route for water and solutes to bypass the soil matrix and reach tile drains faster than predicted by traditional displacement theory. While surface water can be drained via pumping and/or open ditches, tile drainage is often the best recourse for agricultural purposes. A high water table can be counterproductive to agriculture by preventing root development and inhibiting crop growth. A high water table can also limit access to the land, particularly by farm machinery. In terms of access, most modern agriculture depends on the usage of large machinery to prepare the seedbed, plant the crop, carry out any cultivation and applications during the growing season, and ultimately, to harvest the crop. Operating most machinery in excessively wet conditions may also result in soil degradation because of excessive soil compaction.

While the benefits of tile drains on farming operations is not questioned, the introduction of tile drains into the watershed does change the runoff response of the watershed and allows for an additional pathway for solute transport. Currently, watershed models try to modify standard runoff parameters to describe the response due to tile drains but traditionally watershed scale models do not account for tile drains in a mechanistic manner.

In 2008, a study was initiated between the EPA and USACE to evaluate the physically based distributed watershed model, Gridded Surface Surbsurface Hydrologic Analysis (GSSHA) modeling system. In this study, existing parameters were modified to evaluate the effectiveness of this model to accurately model the transport of flow from a heavily tiled drained watershed. This presentation will discuss the GSSHA model components and the application of the model on the Upper Auglaize Watershed.

JOHNSON, PETER, Program Director, Council of Great Lakes Governors, 35 E Wacker Dr, Ste 1850, Chicago, IL 60601.

"The Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement and the Great Lakes-St. Lawrence River Basin Water Resources Compact—What's Next?"

In recent years, the Great Lakes Governors and the Premiers of Ontario and Québec have worked aggressively to ensure that our region's waters are protected and restored. On December 13, 2005, they signed the Great Lakes—St. Lawrence River Basin Sustainable Water Resources Agreement (Agreement) and the Governors endorsed the companion interstate Compact (Compact). The Compact became law on December 8, 2008. These historic agreements were the result of nearly five years of negotiations facilitated by the Council of Great Lakes Governors.

Despite their relative abundance, there are threats to the Basin now, and they could increase in the future. Protective steps are needed to avoid conflicts and shortages, to ensure that water is used sustainably, and to help ensure that waters remain at healthy levels. And, we must preserve and protect these waters now and for future generations.

The agreements negotiated by the Governors and Premiers include historic protections. They will foster economic development through the sustainable use and responsible management of Basin waters. They ban new diversions of water from the Basin with limited exceptions. The States and Provinces will use a consistent standard to review proposed uses of Basin water, and will adopt programs to encourage water conservation and efficiency.

To that end, the Agreement and Compact also include a series of commitments that must be fulfilled at the jurisdictional and regional levels. Some of these commitments became effectively immediately, and some will come into effect over time. This presentation will provide an overview of the commitments contained in the Agreement and Compact, and highlight the deadlines for their implementation.

JONES, RACHAEL M., YU, YUE, DOREVITCH, SAM, and LIU, LI, School of Public Health, University of Illinois at Chicago, 2121 W Taylor St, Chicago, IL 60640.

Prediction of Pathogen Concentration or Presence from Indicator Organisms Measured in Waterways Designated for General Use and Secondary-Contact

As part of the Chicago Health, Environmental Exposure, and Recreation Study (CHEERS) two pathogens – cryptosporidium oocysts and giardia cysts – and four indicator organisms – male-specific coliphage, somatic coliphage, *E. coli*, and enterococci – were measured in the Chicago Area Waterways (CAWs) and in general use waterways (GUWs), including several of Chicago's Lake Michigan beaches , not impacted by point source sewage discharges, throughout the summers of 2007 and 2008. The ability of the indicator organisms to predict the pathogen concentration and pathogen presence/absence was explored using correlation coefficients, linear and logistic regression, and principal component regression. The coliphages were the most highly correlated with pathogen concentrations in both water types. Not surprisingly, correlations measured in CAWs were equal to or greater than those measured in GUW. Linear regression with single indicator organisms found that the coliphages best predicted pathogen concentrations in the CAWs, but the model fit was poor. Logistic regression found that each indicator had high positive predictive value for the presence of pathogens in CAWs and high negative predictive value in GUW. Principal component linear regression models containing 2-4 indicator organisms poorly predicted pathogen concentration; while principal component logistic regression models containing 2-4 organisms had good positive predictive value. These analyses highlight the limitations of using indicator organisms to infer the presence of pathogens in freshwater systems. These data suggest that male-specific and somatic coliphage are, in general, better indicators of pathogen concentrations than *E. coli* and enterococci.

JUDE, DAVID[1], HENSLER, STEPHEN[1], BARBERIO, RICHARD[2], JOHENGEN, THOMAS[3], AND BALCER, MARY[4], [1]University of Michigan; [2]USEPA, Loyola University; [3]University of Michigan; [4]University of Wisconsin, Superior, WI.

Return from the Dead: Lake Michigan Is Shifting Toward More Pristine Conditions Due To Phosphorus Reduction and Invasive Species

Lake Erie, once declared (erroneously) dead by the media in the 1960s, has joined at least two other lakes (Huron and Michigan) in a shift toward more oligotrophic conditions due to the dual, anthropogenic influences of P reductions through improved sewage treatment and reductions/shifts in algal communities due to the pervasive, filtering activities of zebra and quagga mussels. These reductions in nutrients have cascaded through food webs effecting declines in algae, then in zooplankton and *Diporeia*, which feed on algae, and recently severe reductions in major forage fishes, especially the alewife, have also been documented. In Lake Huron there have been severe drops in top predators, especially stocked salmon; Lake Michigan top fish predators may soon follow suit. As Lake Huron has moved toward more pristine conditions, there has been a dramatic comeback in emerald shiners, increased natural reproduction by lake trout, signs of resurgence of nearly extirpated lake herring, and spectacular increases in walleye natural reproduction in Saginaw Bay, due to reduced predation by alewives on larval forms. Lake Michigan seems to be lagging behind Lake Huron by a few years, so close scrutiny and attention needs to be applied to document changes. Some expected modifications based on the Lake Huron scenario may be: continuing problems with botulism, continuing declines in zooplankton and *Diporeia*, decline in alewives, increased recruitment of species that are affected by larval fish predation by alewives (e.g., yellow perch, deepwater sculpin, burbot), and declines in top fish predators as forage continues to decline.

KINZELMAN, JULIE[1] and LAVENDER, JENNIFER[2], [1]City of Racine Health Department Laboratory, 730 Washington Ave, Racine, WI 53403; [2]US EPA NERL, Cincinnati, OH.

Composite Sample Analysis - DST/Culture Methods vs. QPCR at Freshwater Beaches, Racine, WI

Current culture-based methods or their defined substrate equivalents require a minimum of 18 hours from receipt of sample to reporting of results to coastal beach managers. The EPA, as well as academic researchers, have developed rapid bacterial indicator methods (enterococci and *E. coli*) based on quantitative, real-time polymerase reaction (QPCR). These methods have the advantage of providing laboratory results within two (*E. coli*) or three (enterococci) hours of sample receipt. Although this is a significant improvement with regard to timeliness, there may be disadvantages, i.e. lack of technical expertise, cost, or the ability to composite samples, which could cause resistance to implementing this technology in state or local public health facilities. Racine, WI has composited samples for the purpose of routine water quality monitoring since 2004. In brief, water samples are collected daily from three or four equidistant transects along each of two public bathing beaches according to WI DNR sampling guidelines for recreational waters. From each sub-sample, well-mixed aliquots are combined to form a single composite sample. In 2008, composite samples were assayed for enterococci and *E. coli* using currently approved methods (mEI agar/EPA Method 1600 and IDEXX Colilert-18 respectively) and QPCR equivalent tests (as described in Haugland et al. 2005 and Blackwood et al. 2006 respectively). Sample agreement (number and regulatory action) was 84 - 94% (enterococci) and 95 – 97% (*E. coli*) demonstrating that composite sample analysis may be feasible using rapid, lab-based detection methods. Additional studies, examining the relationship between the composite sample and the daily arithmetic and geometric mean, are needed to verify this relationship. The ability to composite samples would significantly reduce the increased analytical costs associated with QPCR.

KLEINHEINZ, GREG[1], MCDERMOTT, COLLEEN[1], VANDE HEUVAL, AMY[1], and SADOWSKY, MICHAEL[2], [1]University of Wisconsin-Oshkosh, Oshkosh, WI 54901, USA; [2]University of Minnesota, Minneapolis, MN.

Relationship Between *E. coli* and *Cladophora* Mats in Lake Michigan Beach Water

Large mats of the green alga, *Cladophora*, have made a resurgence in the past few years along the shores of Lake Michigan, and recent research suggests that these mats may harbor large amounts of the microbial water quality indicator, *E. coli.* If mats of *Cladophora* are able to provide conditions suitable for the increased survival of *E. coli*, it is possible that pathogens associated with the presence of fecal material are also able to persist, posing an increased risk to swimmers in affected areas. While several studies have investigated questions related to the presence of *Cladophora* in the Great Lakes, this presentation will discuss both field and laboratory research projects investigating the relationship between *E. coli* and *Cladophora* mats in beach water. The results from the first two years of a 3-year field study will be presented. Field research indicates that *Cladophora* mats may harbor large quantities of *E. coli* in the mat proper, and given the correct conditions these mats may be contributing *E. coli* concentrations in surrounding '*Cladophora*-free' beach water. Additionally, genetic analysis of *E. coli* isolated from two locations suggest that unique relationships may exist spatially within *Cladophora* mats and temporally throughout the time a *Cladophora* mat is present at a beach location.

KLUMP, J. VAL, and WAPLES, JAMES T., Great Lakes WATER Institute, University of Wisconsin-Milwaukee, 600 E Greenfield Ave, Milwaukee, WI 53204 USA.

Consequences for Ecosystem Restoration and the Potential Effects of Climate Variability on the Residence Times and Biogeochemistry of Particles, Nutrients and Oxygen in Green Bay.

Observations over the last several decades have shown that the predominant summer wind field in Green Bay changes in response to a southerly shift in the typical storm track through the Great Lakes region. Meteorological data reported from NDBC buoys have been analyzed for the period of 1985 to 2006. This wind shift appears to alter the hydrodynamics of the bay, resulting in a reduction in water mass exchange with Lake Michigan, more efficient retention of particles within the bay, and a reduction in sediment resuspension during late summer. Time series measurements of currents, turbidity, dissolved oxygen, and the Be-7 activity of particulates in bottom sediments, sediment traps, and suspended particulates have been made from May-October over a 3 year period (2004-06) and have been compared with identical measurements made in 1990. These comparisons show significant increases in the organic carbon content of suspended matter, accelerated fluxes of organic carbon to the sediments, and enhanced late summer methane production in the lower bay in response to shifted winds. These regional scale meteorological changes have the potential to alter thermal structure, attenuate water mass exchange, and enhance benthic oxygen demand, increasing the frequency of hypoxia - a common feature of lower Green Bay that recent evidence suggests may be exacerbated, triggering severe oxygen depletion and fish kills.

KORB, GARY, SLAWSKI, THOMAS, and THORNTON, JEFFREY, Southeastern Wisconsin Regional Planning Commission/UW-Extension, W239N1812 Rockwood Drive, Waukesha, WI 53187-1607.

The Land-Water Connection: Part 3-The Human Dimension

Whether publicly owned and managed, regulated by ordinance, or privately controlled as to use, sound riparian corridors require that people be both convinced of the merits and equipped with knowledge to act. A key need is the present lack of regionally relevant guidance on the purpose, provision, and protection of buffers along Lake Michigan and its tributaries. This poses a major barrier to the implementation of plan recommendations for the improvement of water quality and protection of natural resources. Therefore, the Southeastern Wisconsin Regional Planning Commission has begun development of a comprehensive riparian corridor management guide to better address this deficiency in a practical and appropriate manner. The guide is intended to include not only information on buffer widths and composition, but also model ordinances applicable to local and county governments that will promote the inclusion of riparian buffers as a critical element of public policy and land use planning. Human influences affect terrestrial and aquatic ecosystems, water quality, aesthetics, and quality of life throughout a watershed. For example, farm owners and operators control vast riparian areas which can be of immense benefit to the watershed system if managed properly. Even in the most highly urbanized watersheds, opportunities exist for balancing human use with the protection and preservation of fish and wildlife habitat for the benefit of both humans and the natural system. The involvement of a wide range of stakeholders – including State, local, and county government; non-governmental organizations; riparian owners; and citizens – can target recommended management interventions to meet diverse stakeholder needs. These stakeholders represent the critical human dimension and challenging outreach opportunities on which this presentation will focus.

KOVALCIK, PAUL, Biohabitats, Inc., 2026 Murray Hill Rd, Rm 107, Cleveland, OH 44106.

Muskegon Lake, Ruddiman Creek and Nearby Shoreline Ecological Restoration Master Plan: Addressing Beneficial Use Impairments in an Area of Concern

USEPA and Biohabitats, Inc. in collaboration with multiple stakeholders have created a restoration master plan for Ruddiman Creek and the nearby shoreline of Muskegon Lake, in Muskegon Michigan. The area has been degraded as a result of shoreline fill, sediment contamination, and unregulated stormwater runoff. It is part of the larger Muskegon Lake Area of Concern and is listed as having Beneficial Use Impairments including loss of fish and wildlife habitat, degradation of fish and wildlife populations, and degradation of benthos. A major sediment remediation effort was completed in Ruddiman Creek in the fall of 2006; however, additional restoration is necessary to address the Beneficial Use Impairments. The Ecological Restoration Master Plan provides a suite of actions for the restoration of fish, wildlife, benthic habitats, water quality and human uses. These actions are intended to create ecosystem resiliency and diversity, and attract reproducing populations of desirable native species. The actions include improving riparian and upland forest buffers, debris removal, establishing wetland habitats on the lake shoreline, improving hydrology, biological monitoring, and public outreach/education. This plan is the outline for addressing Beneficial Use Impairments within this Area of Concern and ultimately, a template for restoring degraded habitats in the Great Lakes region.

KOVATCH, CHARLES, U.S. Environmental Protection Agency, Washington DC.

New Tools Available to Integrate and Share Water Data for Making Assessment Decisions

Beach managers have been successful in developing systems that store and display beach water quality data. The next step in a beach monitoring program is to assess beach water and identify sources which contribute to poor water quality. To assist in these efforts, the EPA has upgraded three key information systems to improve sharing water data and assessing water quality – STORET, ATTAINS, and WATERS. STORET is the EPA's repository for national water quality data. (1) Utilizing the WQX framework, water quality data can be submitted using XML and data can be pulled using new Web Services. (2) ATTAINS is the integrated system which displays assessment (305b/303d) and TMDL data. EPA is planning to upgrade this system to better meet user needs. (3) WATERS is a geo-data system that displays water events (beaches, facilities, stations, impairments) on a friendly mapping interface to perform geospatial analyses. All events are indexed to the National Hydrography Dataset which in part enables some complex water analyses to be performed.

KRATT, KEVIN, and CLELAND, BRUCE, Tetra Tech, 1468 W. 9th St, Ste 620, Cleveland, OH 44113.

Pilot Efforts to Strengthen TMDL Development and Storm Water BMP Implementation in the Great Lakes

Recognizing storm water runoff as a significant contributor to water quality impairments across the country, USEPA prepared a Handbook that provides a reference for TMDL practitioners and NPDES permit writers. The Handbook discusses methods being used to develop more detailed storm water source TMDL allocations, TMDL implementation plans including best management practices (BMPs), and methods for translating TMDL allocations into NPDES storm water permit requirements. To take advantage of local storm water management efforts, USEPA Region 5 initiated two storm water TMDL pilot projects in Michigan and Indiana. The intent of these pilots is to use information in the Handbook coupled with local experience to advance working knowledge of methods that strengthen the connection between TMDLs and storm water management program implementation.

The pilots include a wide array of implementation programs to address storm water sources that contribute to water quality problems. In one case, a regional planning commission completed a water quality management plan for the larger area and is working with the city in their efforts to develop a Storm Water Management Program. The other pilot also has a locally prepared watershed management plan that emphasizes low impact development and wetlands restoration. A key local organization has been an active player in education and outreach programs as well as efforts to design and implement targeted storm water BMPs.

An objective for both pilot efforts is to use TMDL technical assessments to strengthen storm water BMP targeting and implementation. Models are being used to identify hydrologic targets that also serve as watershed and sub-watershed benchmarks for BMP performance. Information on BMP effectiveness is coupled with cost information to identify the most economical options through an optimization step.

This presentation will summarize the pilot storm water TMDLs, as well as describe how technical analyses within each TMDL are helping to optimize design and implementation of storm water BMPs.

KREIS, JR., RUSSELL G.[1], ZHANG, XIAOMI[2], ZHANG, XIN[2], MURPHY, E.[3], ROSSMANN, R.[1], RYGWELSKI, K.R.[1], WARREN, G.[3], HORVATIN, P.J.[3], MELENDEZ, W.[4], BECK, S.J.[3], AND HINCHEY-MALLOY, E.[3], [1]USEPA, Office of Research and Development, NHEERL-MED-LLRFRB, 9311 Groh Rd, Grosse Ile, MI 48138; [2]Z-Tech Corporation, Grosse Ile, MI; [3]USEPA/GLNPO, Chicago, IL; [4]Computer Sciences Corporation, Grosse Ile, MI.

Lake Michigan Mass Balance Study Post Audit: Integrated, Multi-media PCB Modeling and Forecasting for Lake Trout

The Lake Michigan (LM) Mass Balance Study was conducted to measure and model polychlorinated biphenyls (PCBs) and other anthropogenic substances to gain a better understanding of the transport, fate, and effects of these substances within the system and to aid managers in the environmental decision-making process. A series of scenario forecasts were conducted using the linked LM2-Toxics and LM Food Chain models, supported by a suite of LM models. Forecasts of 5 to 6-year old lake trout for the Saugatuck region indicated that total PCB concentrations will continue to decrease and the Sports Fish Advisory Task Force's goal for unrestricted consumption could be achieved as early as the year 2033. Compared to PCB data for lake trout from the Great Lakes Fish Monitoring Program for a 10-year period, since the final year of the project in 1995, the model forecasts and data exhibit good agreement and suggest that the model forecasts are reasonable. Results are consistent with long-term decreases in all media and are subject to assumptions considering future loads, vapor phase concentrations, PCB decline rates in various media, food chain composition, and the pace of projected remedial actions. This abstract does not necessarily reflect EPA policy.

LAMMERS, BASTIAAN, 1611 State St, Green Bay, WI 54304; Fox River Cleanup Group existing of: Tetra Tech, JF Brennan, Stuyvesant Environmental Contracting.

Fox River, Wisconsin: The Largest Sediment Remediation Project in the World

The lower reaches of the Fox River in northern Wisconsin are seriously contaminated with PCBs over a distance of nearly 19 miles. During the 1970's and'80's, local paper mills manufactured carbonless paper containing the PCBs. Waste water from the processes were discharged directly into the river and thence into Lake Michigan. Following massive fish kills in the early '90s, the USEPA, along with the Wisconsin DNR took action, leading to a Consent Order eventually finalized in 2008 with two PRPs – Appleton Papers Inc and NCR Corp. This project addresses the areas known as OU 2-5; OU-1 was completed in 2009.

This project is the largest sediment remediation project in the world, involving the dredging and processing of more than 3.8 million cubic yards of material. Sediments are dredged hydraulically and delivered by pipeline to the processing facility where the material is screened, separated, and dewatered. Residuals are reused or disposed in accordance with the design at either a local or TSCA permitted landfill.

The project scope includes:

- Debris Removal
- Dredging
- Installation of Caps and Sand Covers
- Sediment Separation and Dewatering
- Water Treatment
- Beneficial Use and Upland disposal
- Monitored Natural Attenuation

The overall project is scheduled to take nine years. Dredging and processing can be performed for only seven months of the year due to severe winters and freezing of the river.

The Fox River Clean-up Team is led by Tetra Tech Inc. as the prime contractor and supported by JF Brennan Company performing the dredging and capping and Boskalis Dolman responsible for the sediment processing.

This paper will present the details of the dredging, processing, and residuals managements along with the current status and special issues related to the work.

LANG, PAUL J.[1], SCHNEIDER, JAMES A.[1], SMITH, KEVIN[2], and MCNEILAN, TOM[2], [1]University of Wisconsin-Madison, 2243A Engineering Hall, 1415 Engineering Dr, Madison, WI 53706; [2]Fugro Atlantic.

Foundation Considerations for Fixed Offshore Wind Turbines on Lake Michigan

Offshore wind has advantages over onshore wind in that it (i) is closer to high population areas; (ii) minimizes visual and noise impact of turbines; and (iii) is located in areas of faster and more uniform wind speeds. With these advantages comes the technical complexity of designing structures to handle combined wind, wave, and ice loading for various water depths. Selection of substructure geometry, and thus foundation loads and configuration, is largely dependent on water depth. To date, a majority of offshore wind turbines have been constructed (in the North and Baltic Seas) in waters with a depth less than 15m. Water depths in Lake Michigan rapidly exceed 60m, and requiring further examination of technical issues controlling design.

The shallowest portion of Lake Michigan that is greater than 15 miles from shore (approximate distance to eliminate visual sight of turbines) is known as the Mid-Lake Plateau. This presentation focuses on three areas within the Mid-Lake Plateau that have water depths less than 60m, and may be suitable for 'conventional' fixed platforms. Two of the areas can accommodate between five and ten 5 MW turbines, and would be suitable for pilot scale projects. The third area is much larger, and could accommodate approximately 160# 5MW turbines, or a potential capacity of 800 MW. Projects in these areas could therefore be a significant step towards achieving the renewable energy and energy independence goals of the State of Wisconsin as well as those of the US Department of Energy.

While there are many financial, legal, and regulatory concerns that must be addressed for offshore wind turbine construction on Lake Michigan, this presentation focuses on technical aspects that must be overcome. Specifically, loading conditions, subsurface geology, foundation design, and construction options will be discussed.

LEATHERMAN, STEPHEN P.[1], BRIGGS, SHANNON[2], DREELIN, ERIN A.[3] and ARIZA, EDUARD[1], [1]Laboratory for Coastal Research, Florida International University, Miami, FL 33199; [2]Michigan Department of Environmental Quality, Lansing, MI; [3]Center for Water Sciences, Michigan State University, East Lansing, MI.

Expanding the National Healthy Beaches Campaign to the Great Lakes

The National Healthy Beaches Campaign (NHBC) is a comprehensive coastal program designed to be an advocate for high standards of beach management and a primary source of dependable information for beachgoers. The NHBC is dedicated to educating the public about the delicate nature of coastal ecosystems and the potential hazards in these environments. It is the first scientifically-based beach certification program administered by a professional group of coastal experts focused on U.S. beaches. Understanding the nature of the human, social, and socio-economic relationships with beach environments, the NHBC is dedicated to creating a balance between the recreational use of America's beaches and maintaining the environmental quality and safety of this prized resource. With this mandate, we approach the task of beach ratings against 60 stringent environmental and service-based criteria. This rating criteria includes EPA water quality standards, beach cleanliness, safety, environmental quality and management and auxiliary services. The certification and ratings serve as the basis for the annual "Dr Beach's Top 10 Beaches List" which garners national media attention. The campaign currently only includes marine beaches; however, we are seeking to expand the campaign to the Great Lakes. Expansion of the campaign to the Great Lakes will require refinement of the ratings and certification criteria. Our goal is to include Great Lakes beaches for the 2010 report. This listing can be used to promote tourism at Great Lakes beaches as well as encouraging local communities to improve their beaches in order to make the list by meeting NHBC criteria.

LEGGE, JOHN[1], MARTINUS, WILLIAM[2], and DORAN, PATRICK[1], [1]The Nature Conservancy, 3728 West River Dr NE, Comstock Park, MI 49321; [2]Martinus & Associates.

Development of an Early Detection-Rapid Response Program for *Leymus arenarius* (lyme grass) in Eastern Lake Michigan.

Lyme grass (*Leymus arenarius*) is a non-native species that has become established along the shoreline of Lake Michigan where it often thrives in sandy habitats similar to native marram grass (*Ammophila breviligulata*). In recent years, reports of *L. arenarius* have increased in sandy coastal habitats around Lake Michigan, and control programs have begun in parts of Indiana and Wisconsin. However, little information was known about the species distribution in Michigan. In 2008-9, we initiated surveys for the entire Lake Michigan shoreline of the Lower Peninsula, from the Indiana border through Sleeping Bear Dunes National Lakeshore. These surveys report a significant prevalence of *L. arenarius*, with the distribution concentrated in certain parts of the coast. We are using the data to develop a rapid-response program to identify and treat priority locations. Data was also collected on prevalence of other invasives during the *L. arenarius* surveys. Combining these data with other efforts underway on coastal invasives, we are looking ahead to a basin-wide strategy for managing invasives that threaten the ecology of Lake Michigan coastal natural communities.

LUBNER, JIM, University of Wisconsin Sea Grant Advisory Services, 600 East Greenfield Avenue Milwaukee, Wisconsin 53204-2944.

COSEE Great Lakes: Educators and Scientists Learning and Working Together

With a five-year grant from the National Science Foundation and the National Oceanic and Atmospheric Administration, the Great Lakes Sea Grant Network established a Center for Ocean Science Education Excellence (COSEE) Great Lakes to bring scientists and educators together into closer collaboration to enhance Great Lakes and marine education in our region's schools. This presentation explores the variety of methodologies used in building the relationships and skills needed to accomplish this goal. Experiences from a number of successful scientist-educator workshops will be shared, along with curriculum materials and other educational resources. Information will also be provided on upcoming COSEE Great Lakes-sponsored educational opportunities.

MACNEIL, DAVID.

Understanding and Communicating Uncertainties of Climate Change

There is a consensus among scientists that climate change is poised to alter Great Lakes ecosystems and their bio-physical processes. Yet many stakeholders remain skeptical of the scientific evidence and subsequent predictions of climate change impacts. The skepticism can be attributable a general misunderstanding of the scientific process, the inherent stochasticity of nature, and the process of integrating scientific information into decision-making. Because climate change uncertainties escalate beyond the scientific evidence to policy development, it is recommended that outreach programs incorporate the concepts of uncertainty, and science mechanics, in an effort to not only restore credibility of science but to facilitate a more inclusive decision making process for stakeholders. This presentation takes a broad brush view of climate change uncertainty, from science to policy, based on recent literature.

MADENJIAN, CHARLES P., BUNNELL, DAVID B., WARNER, DAVID M., AND SCHAEFFER, JEFFREY S., U. S. Geological Survey, Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI 48015.

Prey Fish Population Status in Lake Michigan: Is the Alewife Population Headed for a Complete Collapse?

The Great Lakes Science Center (GLSC) has conducted lake-wide surveys of the fish community in Lake Michigan each fall since 1973 using standard 12-m bottom trawls towed along contour at depths of 9 to 110 m at each of seven index transects. Lake-wide biomass of bloater in 2008 was estimated at 3.33 kt, which was the lowest estimate since 1977 and 38% lower than the 2007 estimate. Rainbow smelt lake-wide biomass equaled 0.89 kt, which was only 0.01 kt higher than 2007, which is the lowest estimate in the time series. Deepwater sculpin lake-wide biomass equaled 5.23 kt, which is the fourth straight year of declining biomass. The 2008 estimate is the second smallest in the time series, and 39% lower than the 2007 estimate. Slimy sculpin lake-wide biomass remained relatively high in 2008 (2.75 kt), increasing 25% over 2007. Ninespine stickleback lake-wide biomass equaled only 0.50 kt in 2008, which was 79% lower than the 2007 estimate. The final prey fish, exotic round goby, increased two orders of magnitude between 2007 and 2008, from 0.02 to 4.65 kt. Round gobies now represent 18% of the prey fish biomass. Overall, the total lake-wide prey fish biomass estimate (sum of alewife, bloater, rainbow smelt, deepwater sculpin, slimy sculpin, round goby, and ninespine stickleback) in 2008 was 25.62 kt, which was the lowest observed since the survey began in 1973. The possibility of a complete collapse of the alewife population, which occurred in Lake Huron during 2002-2004, was also examined in attempting to predict the future of the Lake Michigan prey fish community.

MCAHRON, RON, Deputy Director, Indiana Department of Natural Resources, 402 W Washington St, Rm W256, Indianapolis, IN, 46204-2739.

Great Lake- St. Lawrence River Basin Water Resources Compact Indiana Implementation: "Mixed Blessings"

Implementation of the Compact in Indiana is the classic case of mixed blessings. On the positive side, Indiana has administered a water use registration and reporting program for Significant Water Withdrawal Facilities (withdrawal capability >100,000 gpd) since the mid-80s. Supported by statutory power to restrict groundwater withdrawals at Significant Water Withdrawal Facilities that impact other users, Indiana has managed an efficient and equitable groundwater use system that is well documented.

Uneven enforcement of WRDA was a key part of the stimulus for Annex 2001 and therefore ultimately the Compact. This was certainly true in Indiana with respect to diversions and groundwater. We are now challenged with identifying historically unregulated withdrawals that may constitute or contribute to diversions as defined under the Compact.

Other existing statutes and regulations in the area of water planning and water sales are serving as good models and tie ins for implementation of the Compact in Indiana. This paper will address the status of implementation as well as highlight some of the important issues and approaches Indiana is using to meet the challenges of implementing the Compact.

MCCORMICK, ROBERT, Project Leader Planning With POWER, 195 Marsteller, Purdue University, West Lafayette, IN 47907.

New Local Decision Maker Decision System for Communities

A new web-based GIS decision system called Local Decision Maker is available for use by planners and natural resource groups in Indiana. Its purpose is to improve comprehensive planning, resulting in a final plan that matches a community's economic, environmental, social, and cultural resources while planning for future development. To date, we have focused our efforts on inventory and analysis because it forms the foundation of every plan. Users follow a standard format that guides them through the inventory categories and gives them the opportunity to use a GIS map service to display and understand existing conditions and create *pdf* files for using in plans. Several natural resource and environmental layers are critical to protect natural resources and water quality in the Lake Michigan Basin. Several examples of Local Decision Maker and smart growth principles have been used in Porter and LaPorte Counties in Indiana bordering Lake Michigan to protect natural resources and mitigate land use development impacting the Lake Michigan Basin.

Local Decision Maker is a joint effort among Illinois-Indiana Sea Grant and Purdue University's Centers for the Environment and Regional Development and Extension. The program's website is www.purdue.edu/ldm

MCINTYRE, PETER B., ALLAN, J. DAVID, and PAPKE, REBECCA

Conserving Critical Ecosystem Linkages: Native Fish Migrations in Great Lakes Watersheds

Migratory animals have a unique ability to transport energy and nutrients across ecosystem boundaries. Salmon are the most famous example of fish providing material subsidies through their breeding migrations. Here, we evaluate whether native suckers serve a similar function in Great Lakes watersheds, and outline the major threats to such ecosystem linkages. We recorded thousands of suckers breeding in small tributaries in northern Lake Michigan, and fishery records and other sources indicate hundreds of thousands of fish using larger rivers. The sucker migration was closely associated with a pulse of dissolved nutrients, particularly in smaller streams. These lake-derived nutrients enhanced leaf-litter breakdown and alleviated nitrogen limitation of periphyton production. Fish migrations and the associated annual input of nutrients are frequently blocked by dams, and fish passage technologies are generally ineffective for suckers. Road culverts are a common obstacle in smaller tributaries, and recreational and commercial fishing also affect migrations in some cases. Following migrations, we also documented large numbers of sucker larvae returning to Lake Michigan, where they likely become an important seasonal food resource for nearshore fish communities. Our results suggest that native fish migrations play an essential role in tributary ecosystem functioning, and maintaining these lake-stream linkages should be a target of conservation planning and restoration efforts.

MCLELLAN, SANDRA[1], SAUER, BETH[1], SANDS, KAREN[2], MAGRUDER, CHRIS[2], and MCDONALD, BREANNE[2], [1]Great Lakes WATER Institute, 600 E Greenfield Ave, Milwaukee, WI 53204; [2]Milwaukee Metropolitan Sewage District.

Pathogens in Urban Stormwater: Identification and Mitigation of Human Sources of Fecal Pollution

In the Milwaukee Metropolitan area, urban stormwater adversely impacts the rivers, beaches, and subsequently Lake Michigan. Stormwater outfalls are located along the three urban rivers Milwaukee River, Menomonee River, and Kinnickinnic River which converge and discharge into the Milwaukee Harbor. The rivers have been found to consistently exceed recreational use (200 CFUs/100ml) or limited recreational use (1,000 CFUs/100ml) standards. The key to meeting these water quality standards is determining what the major sources of pollution are in the rivers so that remediation strategies can be put into place.

We tested more than 1,000 stormwater samples from 61 outfalls over a three-year period for the presence of the human *Bacteroides* genetic marker using polymerase chain reaction (PCR). A subset of samples was further analyzed using quantitative PCR (qPCR) methods. The results of this study demonstrated that sewage contamination in the urban stormwater system is widespread. Overall, 58% of samples were positive for human *Bacteroides.* A total of 43 of the 61 regularly sampled outfalls, e.g. nearly three quarters of the sites, tested positive for the human *Bacteroides* genetic marker over 50% of the time. Overall, this research demonstrates that unrecognized sanitary sewage inputs are a major source of fecal pollution in area waterways and Lake Michigan. This poses a serious health risk due to the likelihood of pathogen occurrence.

This research can provide the framework to progress to the next level of achieving better water quality in the Milwaukee metropolitan area. Quantification of human sources in stormwater discharges and surface waters will provide a benchmark from which the improvements due to investments in removing illicit connections and repairing or lining sewer lines (or laterals) may be measured.

MEADOWS, GUY, and PURCELL, HEIDI, University of Michigan, Marine Hydrodynamics Laboratories, 1085 S University, Ann Arbor, MI 48109-1107.

Community Partnerships in Support of GLOS

Since the inception of the Upper Great Lakes Observing System, the University of Michigan Marine Hydrodynamics Laboratories (MHL) has sought out partnerships within the local communities to aid in the support of the GLOS observing system. This approach has enabled the MHL to advance the system much further than was possible using the available funding received through conventional university channels. Over the past four years, partnerships have been formed with local organizations and businesses to help the MHL obtain equipment, deploy and haul out buoys, house receivers and servers, as well as aid in the service and maintenance of the system. With the latest deployment of GLOS buoys in both Traverse Bays, this concept has been taken one step further. Local businesses and the communities of the Little Traverse Bay area have organized a buoy support association. The MHL and GLOS will supply the buoy, while the association has agreed to apply for and maintain the necessary permits, deploy and retrieve the buoy annually, and aid in its maintenance and small repairs. Local businesses and organizations have donated funds to the association to cover the necessary expenses. The MHL will own the buoy, and archive and disseminate the data. This partnership proves to be a “win-win” situation for all involved. The community involvement allows the MHL to concentrate their resources on advancing the instrumentation and data dissemination; increasing the body of knowledge available to researchers and resource managers for use in ascertaining and maintaining the health of Lake Michigan Ecosystems. The community obtains real time local environmental data for both Grand and Little Traverse Bays, providing an extremely important tool for boaters, tourists and all those that utilize the Bay and its coastlines, helping them make informed decisions on how best to enjoy and preserve Lake Michigan resources.

MEDNICK, ADAM[1], HALL, JUSTIN[2], KINZELMAN, JULIE[3], KURDAS, STEPHAN[3], PARMAR, RAJBIR[4], WOLFE, KURT[4], WONG, JON[4], and ZIEGLER, DAN[2], [1]Wisconsin Department of Natural Resources, Bureau of Science Services, 101 S Webster St, Madison, WI 53707-7921; [2]Ozaukee County Public Health Department; [3]City of Racine Health Department; [4]U.S. Environmental Protection Agency, Office of Research and Development.

A Predictive Modeling Tool for Local Beach Managers: Virtual Beach-Model Builder

The use of multiple linear regression (MLR) models for real-time beach water quality prediction is well-established in the environmental science and public health literatures, and has been implemented successfully at several Lake Michigan beaches and elsewhere in the Great Lakes. Studies have shown that MLR models predict real-time concentrations of pathogen indicators, such as *E. coli*, with greater accuracy than traditional, culture-based monitoring. Additionally, MLR models can assist beach managers with the process of identifying individual contamination sources and contributing factors. The widespread adoption of this method, however, has been limited in the past by the absence of a free, user-friendly tool for building, evaluating, and implementing such models. Faced with limited resources, local beach managers are unlikely to have the combination of staff time, modeling expertise, and/or commercial software necessary to successfully build and deploy MLR models for predicting beach water quality. To fill this void, the U.S. EPA has developed the Virtual Beach-Model Builder (VB-MB) software, which enables beach managers to build and refine MLR models to predict pathogen indicator concentrations in real-time, based on meteorological, onshore, and near shore conditions. The Wisconsin DNR and the U.S. EPA have partnered to pilot-test VB-MB and conduct training for beach managers wishing to use the software. In this presentation we will introduce the VB-MB software and illustrate its key functionality through case-studies. We will also discuss data collection (including Web-based data), model validation, and future directions.

MILLER, BRIAN[1], HORVATIN, PAUL[2], ANDREN, ANDERS[3], COLTON, MARIE[4], and FACKLER, JENNIFER[5], [1]Director, Illinois-Indiana Sea Grant, 1011 W Peabody Dr, MC 635, Urbana IL 61801; [2]Environmental Protection Agency; [3]Wisconsin Sea Grant; [4]National Oceanic and Atmospheric Administration; [5]Illinois-Indiana Sea Grant.

Great Lakes Regional Research Information Network —Lake Michigan

NOAA requested regional development plans for U.S. coastal, ocean, and Great Lakes areas. The Great Lakes Regional Research Information Network (GLRRIN) is developing a comprehensive research and information plan that will help focus research, technology transfer, and outreach efforts on the highest priority issues within the Great Lakes region. The Network consists of five teams, each focusing on one of the Great Lakes. The Lake Michigan team compiled a comprehensive list of organizations with a strong interest in Lake Michigan and documented their key priorities. The results indicate that ecosystem, pollutants, education, aquatic invasive species, and water issues were the top five priorities for the majority of the organizations. The Lake Michigan team then worked with research agencies and institutions to identify the most pressing research challenge for Lake Michigan within these topic areas. The need to develop a lake-wide management model that predicts trophic level energy flow given current or predicted native/invasive species assemblages emerged as the top priority. Research and management agencies are coordinating data collection efforts during the 2010 field season to ensure that data gaps are filled to facilitate model development. A joint RFP between Wisconsin and Illinois-Indiana Sea Grant was issued to engage university scientists in filling needed data gaps. Further coordination among the agencies and institutions sponsoring and conducting research is needed to prioritize specific research questions and distribute agency attention and resources to these questions as conditions change. The implementation phase of this project engages scientists and funders in finding solutions to our Lake Michigan priority research issues.

MURPHY, ELIZABETH, MPA, U.S. EPA Great Lakes National Program Office, 77 W Jackson Blvd, Chicago, IL 60604.

Legacy and Emerging Contaminants in Lake Michigan Whole Lake Trout

The U.S. EPA's Great Lakes Fish Monitoring Program (GLFMP) has collected and analyzed a set list of chemicals in whole lake trout and walleye from all 5 of the Great Lake for over 30 years. This long term monitoring program is considered to be one of the most important data sets in the Great Lakes Basin. Recently, the GLFMP incorporated screening of emerging chemicals into its base monitoring program. Chemicals for screening were prioritized based upon an EPA funded project that ranked high production volume chemicals from the US Toxic Substance Control Act (TSCA) inventory and Canadian High Production Volume (HPV) Chemical Program for their persistent and bioaccumulative chemical properties. Toxicity was
assessed through best professional judgment, but was not used to rank chemicals. A discussion of long term status and trends of legacy contaminants, results of the screening, and the future direction of the Program will be discussed.

MURRY, BRENT[1], COOPER, MATTHEW J.[2], KAPUSCINSKI, KEVIN[3], COULTER, DAVID[4], CLAPP, DAVID F.[5], PAOLI, TAMMIE[6], RUETZ III, CARL R.[2], FARRELL, JOHN M.[3], and UZARSKI, DONALD G.[1], [1]Central Michigan University Biological Station and Department of Biology, Central Michigan University, Mount Pleasant, MI 48858, USA; [2]Grand Valley State University, Annis Water Resources Institute; [3]Department of Environmental and Forest Biology, State University of New York, College of Environmental Science and Forestry; [4]Biology Department, Central Michigan University; [5]Michigan Department of Natural Resources, Charlevoix Fisheries Research Station; [6]Wisconsin Department of Natural Resources.

Increasing Prevalence of the Non-indigenous Round Goby in Coastal Wetlands of the Laurentian Great Lakes: Implications to Native Fish Refugia

The round goby (*Neogobius melanostomus*), a recent benthic invader of the Laurentian Great Lakes, has altered food web relationships and negatively impacted several native fishes. Previous findings suggest that round goby prefer rocky substrate, while coastal wetlands may be less susceptible to invasion therein providing refuge habitat for native fish species. Understanding the capacity of round goby to invade wetland habitats is critical because over 90% of Great Lakes fishes utilize wetlands for some aspect of their life cycle. We examined fish assemblage data from three types of coastal wetlands (drowned river mouths, protected embayments, and open-exposed wetlands) throughout Lake Michigan, Lake Huron, and the upper St. Lawrence River from 2002-2008 to evaluate the extent of round goby wetland use and conversely the wetland refuge hypothesis for native fish. Though specific trends differed among systems, round goby were present at the majority of wetland sites by 2008 and their relative abundance often exceeded 10% of all fish sampled. Our results indicate that the outer emergent zone of wetlands and surrounding areas containing submerged aquatic vegetation, that are critical for native fish reproduction, can support round goby and therefore do not provide refuge for native fish species. These results certainly suggest the need for further study of the potential impacts of round goby on native fish recruitment and production processes in and around coastal wetlands.

NETTESHEIM, TODD G.[1], HITES, R.A.[2], VENIER, M.[2], and BASU, I.[2], [1]U.S. EPA Great Lakes National Program Office, 77 W Jackson Blvd, Chicago, IL, 60604; [2]Indiana University, SPEA Rm 410 H, Bloomington, IN, 47405.

Spatiotemporal Analyses of Long-Term Integrated Atmospheric Deposition Network (IADN) Data and Glimpse of Recent Data on Brominated Flame Retardants

IADN has measured the concentrations of hundreds of compounds in atmospheric samples collected at 5 U.S. sites for over 16 years. This presentation will attempt to explain the spatial and temporal variability in IADN data using a multiple regression of atmospheric partial pressures (P) of these compounds as a function of atmospheric temperature; human population; and time. The results suggest that PCBs are not going away anytime soon; that α-HCH (but not γ-HCH) is disappearing rapidly; and that DDT has both agricultural and urban sources. This presentation will also explore the spatial and temporal variability of a class of compounds that have just recently been measured by IADN – brominated flame retardants.

NEVERS, MEREDITH B.[1] and HAACK, SHERIDAN K.[2], [1]U.S. Geological Survey, Great Lakes Science Center, 1100 N Mineral Springs Rd, Porter, IN 46304; [2]U.S. Geological Survey, Michigan Water Science Center, Lansing, MI.

Complex Monitoring Policies and Practices Influence Interpretation of Great Lakes Beach Water Quality

With the widespread application of beach monitoring in the Great Lakes, a massive amount of data is being quickly accrued. Comparisons across municipalities, regions, states, and over time have been made based on these results and used to identify beaches for increased monitoring, funding, or remediation. Currently, there is no universal standard for sample collection and analysis or results interpretation, and highly variable monitoring policies are developed by individual beach management jurisdictions. Extensive prior research has revealed that policies for time, depth, and frequency of sampling as well as number of replicates collected and laboratory analysis techniques all influence the results outcome, statistical calculations, and interpretation of results. Further, the difference in swimming advisory and closure criteria across states sends ambiguous estimations of risk to the public. We have summarized across Great Lakes states and beaches the variations in sampling practices and policies known to influence *E. coli* concentrations, such as time of day and depth of water for sample collection, and number of samples collected per beach or during the swimming season. U.S. Great Lakes-wide *E. coli* monitoring data for 2007 and 2008 demonstrate complex patterns that may be influenced by these factors. Despite these complex factors, comparisons across sampling regimes are made, and broad generalizations about overall beach water quality have been, and continue to be, made. Current research is attempting to circumvent these complex issues by developing new tools and methods for beach monitoring, but an understanding of what is being reported is of critical importance to comparing beach monitoring data across spatial and temporal scales both with traditional and developing approaches.

NICHOLAS, JIM and REEVES, HOWARD, USGS, 6520 Mercantile Way, Ste 5, Lansing MI.

Understanding Hydrologic Variability in the Context of Great Lakes Water Levels and Compact Implementation

People's view of "normal" water levels, snowfall, river flows and other aspects of hydrology typically is strongly conditioned by personal experiences and anecdotal history. One can argue that historical and pre-historical variability in levels and flows suggests that there is no "normal". This presentation will focus on examples of hydrologic variability in the upper Great Lakes and their watersheds. Relevant spatial and temporal scales to understanding and coping with variability will be explored, and the relevance of stationarity, or lack of stationarity, to water management will be discussed. The presentation will provide a context for understanding and discussing current management issues related to Great Lakes water levels and Compact implementation.

NIHONGI, AI, OVEREEM, KATLIN R., HOUGHTON, CHRIS, and JANSSEN, JOHN, Great Lakes WATER Institute, 600 E Greenfield Ave, Milwaukee, WI 53204.

The Ponto-Caspian Mysid Shrimps *Hemimysis anomala* on Lake Michigan Aquatic Systems

Our preliminary investigations confirm that *Hemimysis* can be abundant along Lake Michigan's western coast. Along the Wisconsin open coast, we found *Hemimysis* in Age-0 yellow perch diets from 2006-2008. We documented large numbers (~40-50) in cavities under rocks by day (including active round goby nests), and also found daytime swarms similar to marine coastal mysids. In a series of nocturnal vertical tows at 10 m, we found a density of about 30 m-2. We have also found large numbers of *Hemimysis* in Milwaukee Harbor in traps at ~5m depth (September-November). In spring 2009, we found enormous numbers of *Hemimysis* in the traps left over winter (December to early April) under the harbor ice.

There appears to be great potential for a strong impact on coastal zooplankton. In preliminary feeding trials in the laboratory, we have found that *Hemimysis* can be highly zooplanktivorous In a 12-hour feeding experiment in dark, the number of prey consumed was correlated to the size of the *Hemimysis* with the largest *Hemimysis* consuming 30 *Daphnia*. In preliminary work, they also fed significantly on calanoid copepods. We observed that *Hemimysis* ingest the inside of *Daphnia* and leave the empty carapace.

O'DONNELL, PATTY, Northwest Michigan Council of Governments, PO Box 506 Traverse City MI 49685-0506.

New Designs for Growth Green Infrastructure Project and MI Low Impact Development Manual

Green Infrastructure Project:

Scenic views, spectacular bays, inviting lakes and streams, miles of Great Lakes and inland lakes shoreline, year-round recreational options, clean air, small town friendliness and overall quality of life are some of the many attributes stimulating rapid growth and development in the northwest, lower Michigan region. The Northwest Michigan Council of Governments brought together regional and local stakeholders to create the beginnings of a Regional Green Infrastructure Program to address these very important environmental assets on a regional level down to the site planning level. This project is assisting in the implement of the Northwest Michigan Council of Governments' New Designs for Growth vision – "Address development expansion and help the region prosper in a way that protects the natural resources, scenic beauty, rural landscape, and unique character of each community" and the Lake Michigan Lakewide Management Plan Subgoals. The tools and techniques that were utilized included introductory workshops; meetings with partners; a baseline inventory of natural assets; creation of maps; and the development of a Green Infrastructure Manual for local officials, staff, organizations, and the public.

Michigan LID Manual:

From a stormwater management perspective, Low Impact Development (LID) uses the basic principle that is modeled after nature: manage rainfall at the source using uniformly distributed, decentralized micro-scale controls. LID's goal is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff
close to its source. The Michigan Low Impact Development manual provides techniques that are
based on the premise that stormwater management should not be stormwater disposal and that LID practices address stormwater through small, cost-effective landscape features located at the lot level.

PAPPAS, VICTOR[1], BACH, DOUG[2], and GALARNEAU, STEVE[1], [1]Wisconsin Department of Natural Resources, 1155 Pilgrim Rd, Plymouth, WI 53073; [2]Short Elliott Hendrickson, Inc., 6808 Odana Rd, Ste 200, Madison, WI 53719.

Development of Delisting Targets for the Sheboygan River Area of Concern (AOC): Collaboration Lays Groundwork to Sustain Future Restoration Efforts

The Sheboygan River Area of Concern (AOC) was designated in 1985 as one of 43 Great Lakes "Areas of Concern" by the International Joint Commission. This designation was based on observed impairments to beneficial uses resulting from past discharges, agricultural practices, water course modifications, and land use changes. Listing a water body as an AOC infers that actions are necessary to address the impairments, and ultimately, to remove the water body from the list. Thus, all AOCs require delisting targets to determine at what point impaired beneficial uses can be considered restored. This presentation will present an overview of the AOC program and describe the collaborative process used to develop delisting targets for the Sheboygan River AOC. Perhaps most importantly, the presentation will highlight how the targets, and the process used to develop them, served to engage the community and provide a basis to sustain restoration efforts into the future.

In developing the delisting targets, the WDNR and its consultant worked closely with the Sheboygan River Basin Partnership (SRBP) to engage technical experts, local governments, industries and the public to provide input into the process. The project included a review of the region's history, land use transformations, ecological conditions, and progress toward restoration. The project team reviewed studies of the river that related to contaminated sediments and their effect on fish, wildlife and benthic organisms. The project team also reviewed the relationship of the delisting process to federal Superfund and other regulatory programs, and the applicability of delisting targets developed for other Great Lakes AOCs.

Before issuing the final delisting targets, the WDNR & SRBP sponsored a public meeting to gather input and identify general concerns related to the river. The meeting successfully engaged the public and has resulted in several restoration initiatives to be discussed in the presentation.

PARKER, TODD, Lake Michigan Forum, 53 W Jackson Blvd, Ste 230 Chicago, IL 60604.

Case Study: Benchmarking Environmental Performance at Ports, Harbors and Marinas in Muskegon, Michigan

Commercial ports and harbors are highly concentrated industrial areas near water and contain a variety of facilities including container terminals, boat repair shops, and industries related to the transportation of goods. However, the role of ports, harbors and marinas and their potential for improvement of environmental quality is relatively unexplored. Ports, harbors and marinas have a unique position between land and water, government and industry, public and private, and economic and environmental issues, which could be a powerful catalyst in fostering more sustainable practices and improve environmental quality and economic growth around Lake Michigan and the Great Lakes.

To this end, the Lake Michigan Forum tasked the Delta Institute, facilitator of the Forum, with benchmarking the environmental footprint of port and marina operations along Muskegon Lake in Muskegon, Michigan. Delta employed its ecosystem-based, environmental management systems (ECO-EMS) approach to document the emissions and discharges from facilities that have port operations or entities that directly service port operations, such as railroads.

The Lake Michigan Forum hopes that the environmental benchmarking of Muskegon ports and marinas will lead to the development of an implementation plan to address identified priorities. The implementation planning process will include the identification of stakeholders to participate in the project and give guidance to the realities of the area and the feasibility of implementation. The stakeholders would assist in creating a local consensus for port project and act as a unified entity while implementing activities in their own operations.

Delta will present the results of the ECO-EMS process as well as lessons learned from stakeholder engagement.

PETERS, CHARLES A.(CHARLIE), U.S. Geological Survey WI WSC 8505 Research Way Middleton, WI 53562.

National Monitoring Network: Lake Michigan Pilot Study — Preliminary Results and Future Plans

Lake Michigan is the sixth largest lake in the world and the only Great Lake entirely within the U.S. Projections are that by 2030, the built landscape surrounding southern Lake Michigan will grow by nearly 40% and the population will increase by 2 million. Various indicators suggest that the southern Lake Michigan area will face significant water-supply and water-quality challenges. The proposed National Monitoring Network (NMN) is designed to monitor water quality of eight resource components (atmospheric deposition, beaches, embayments, groundwater, near shore, off shore, rivers, and wetlands) that will help resource managers in coastal areas, like Lake Michigan, plan for the future. Current monitoring in the Lake Michigan watershed falls short of that proposed by the NMN. A pilot study of Lake Michigan was initiated in 2009 and will eventually demonstrate an example of a fully implemented water-quality monitoring network.

The initial phase of the Lake Michigan pilot study augmented sampling at 20 tributaries to Lake Michigan to meet the National Monitoring Network Tier I nutrient design criteria (http://acwi.gov/monitoring/network/design/). The 20 tributary sites in Michigan, Wisconsin, and Indiana have been monitored by the USGS and represent 72% of the total inflow to Lake Michigan. Additionally, semi-permeable membrane devices (SPMD) were deployed in the 20 tributaries to assess potential toxicity to fish. SPMD's are passive samplers (designed to mimic biological membranes) for assessing trace levels of hydrophobic organic contaminants. In 2010 the USGS will deploy an autonomous underwater vehicle (AUV) to map water-quality parameters in selected embayments and shallow near shore areas of Lake Michigan. This effort will be coordinated with monitoring in tributaries and the deeper near shore areas of Lake Michigan being planned by the Lake Michigan Monitoring Coordination Councils' near shore working group.

PFEIFFER, SHAILI[1] and EBERSBERGER, ERIC[2], [1]Office of the Great Lakes, Wisconsin DNR, PO Box 9721 OGL/3, Madison, WI 53707; [2]Water Use Section, Wisconsin DNR DG/5, PO Box 9721, Madison, WI 53707.

Implementing the Great Lakes Compact in Wisconsin

Wisconsin ratified the Great Lakes Compact (Compact) in May 2008 with extensive implementing legislation. The Compact subsequently became effective in all eight Great Lake States on December 8th, 2008. The Compact, and the parallel agreement that includes the Great Lake Provinces, is focused on the shared regional management of water quantity in the Great Lakes Basin and applies to groundwater, tributary streams, lakes and rivers, and the Great Lakes. The breadth of management and policy issues the Compact and implementing legislation covers is extensive: withdrawals, conservation and efficient use, consumptive uses, and diversions of waters of the Great Lakes basin. The Compact commits the states (and provinces through the parallel agreement) to specific requirements in each of these areas, while allowing the states and provinces broad discretion as to how to implement these requirements through state and provincial programs. A central focal point of the Compact is the Decision Making Standard that provides criteria for evaluating new or increased water uses in the basin for the potential for environmental harm to the water or water dependent natural resources in the Great Lakes Basin. Since the ratification, Wisconsin has worked to establish baselines for in-basin water withdrawers, evaluated and approved a diversion proposal from the City of New Berlin, and begun the rule development for the implementing legislation. This presentation will give an overview of Compact implementation and significant policy issues in Wisconsin.

PHILLIPS, SUSAN F., US Geological Survey, 8505 Research Way, Middleton WI 53562.

Advanced Capabilities for Beach Databases

The Wisconsin Beach Health website displays to the public real-time beach information from advisories, monitoring results and in lake monitoring devices. There are two components of the system: an internal application for health officials to enter and view data and the public website. The oral presentation will be an online demo of the advanced features of the Wisconsin Beach Health application. Advanced features of the public application include: RSS feeds and email notifications of beach advisories; a Wisconsin map allowing users to drill down to view the latest advisory and monitor data for individual beaches; and real-time hourly meteorological and sonde data. Advanced features of the internal application include: a sanitary survey form that allows the input of data from the 2008 Great Lakes Beach Routine On-Site Sanitary form and XML data output for the submission of data to the EPA as part of the USEPA BEACH Act.

PITTNER, PETER G., Miller Engineers & Scientists, 5308 South 12th St, Sheboygan, WI 53081.

Naturalized Engineering Approaches for Improving Beach Health and Storm Water Quality

This presentation will focus on how naturalized engineering approaches can aid in improving water quality at beaches. We will cite general techniques that are effective in restoring beaches to naturally functioning dynamic ecosystems that provide for sustainable and healthy environments. Examination of actual beach designs will point to examples of real world problems and the solutions designed to improve water quality, including infiltration and bio-filtration systems, elimination of point source stormwater discharge, and stormwater pre-treat systems. Particular emphasis will be placed on the use of beach nourishment and natural vegetation, and their role in general beach remediation/restoration. Attention will focus on how these beach naturalization techniques can aid in stormwater control while controlling wildlife and improving beach aesthetics. Finally, a review of Best Management Practices (BMPs) will show how these inexpensive techniques can be used in conjunction with engineered designs to enhance beach water quality.

PLENTOVICH, DEVANY, WOLF, AMY and HOWE, ROBERT, Department of Environmental Science and Policy, University of Wisconsin-Green Bay.

A Comparison of *Phragmites australis* Control Measures in Wisconsin Coastal Wetlands

The common reed, *Phragmites australis*, is a highly aggressive species that outcompetes native species on shorelines, wetlands and roadways across the Great Lakes Basin. Prior to my analysis glyphosate and imazapyr (Habitat 7) herbicides were applied to more than 600 acres at selected sites along the west shore of lower Green Bay. I explored alternative secondary control treatments for increasing the effectiveness of the aerial herbicide treatment. Sample plots were evaluated in 4 treatment categories: 1) herbicide 2) herbicide + burning, 3) herbicide + mowing, and 4) control (no treatment). Measurements within plots included percent cover of *P. australis* and all other plant species, average litter depth, and average height of *P. australis*. Results suggest that local eradication of *P. australis* is difficult, if not impossible, with one set of treatments. Treatment of *P. australis*, however, is the first step in restoring native wetlands to pre-invasion condition. Percent cover of native wetland species was much higher at treated plots compared with untreated plots. Certain native plant species can rather quickly re-populate treated wetlands after treatment. In this study, native species were found in untreated control plots, but the low species abundance and poor condition of plants in these plots suggests that time might be critical to the treatment of *Phragmites* stands. Native wetland plants probably will not persist for many years after *P. australis* invasion. I conclude that application of a secondary treatment of mowing or burning after herbicide application increases the success of *Phragmites* control and improves the ability of native species to re-establish populations in Great Lakes coastal wetlands.

PRICE, RICHARD A., USAERDC-EP-R, 3909 Halls Ferry Rd, Vicksburg, MS 39180.

Beneficial Use of 'Contaminated' Dredged Material: Assessing the Risk

The US Army Corps of Engineers (USACE) has responsibility for dredging waterways under its authority to maintain navigation depth for water vessels and maximizing beneficial use of dredged material where environmentally acceptable. Dredged material generally contains low concentration of contaminants associated with residential, agricultural, municipal, or industrial activities in the watershed. A general lack of understanding concerning the bioavailability of contaminants in dredged material and their potential risk to ecological and human health leads to a perception that dredged material is unsuitable for beneficial uses based predominately on detection of contaminants. The result is dredged material is more commonly disposed into confined disposal facilities (CDFs), an unsustainable solution as CDFs are rapidly being filled to capacity. This ultimately leads to economic impacts to all the communities served by water navigation in the watershed when dredging is delayed due to lack of disposal capacity. The potential for contaminants to migrate in the environment through various pathways (surface and groundwater, volatile and particulate emissions, plant and animal bioaccumulation) must consider various factors, such as organic carbon, pH, clay content, etc., that control the fate and transport of contaminants and ultimately, the risk to ecological or human receptors exposed to it. The Engineering Research and Development Center is developing a beneficial uses testing manual (BUTM) to provide guidance for determining risk-based suitability of dredged for beneficial uses. The goal of the BUTM is to facilitate a consistent approach for chemical and biological exposure testing of dredged material proposed for beneficial use and provide the basis for scientifically sound, risk-based decisions concerning suitable beneficial use alternatives. This will lead to cost-effective and sustainable management of sediment resources while providing more opportunities for environmental restoration projects within the watershed. Application of various aspects from the BUTM and data from case studies will be presented.

PRICE, RICHARD A.[1] and PLATZ, CARL A.[2], [1]USAERDC-EP-R, 3909 Halls Ferry Rd, Vicksburg, MS; [2]USACE Detroit.

Sustainable Dredged Material Management through Beneficial Use

Declining space in confined disposal facilities (CDFs) may delay dredging projects, resulting in negative impacts on water navigation. Removal and beneficial use of dredged material in CDFs can provide a sustainable solution to meeting future capacity needs. Skepticism of this concept can be addressed successfully through testing to ensure suitability for intended uses and elevated concentrations of contaminants of concern (COCs) do not exist or result in adverse effects. Recently, the Detroit District demonstrated an integrated approach to achieving CDF sustainability for navigation dredging in Grand Haven Harbor, Michigan. The historically used CDF was filled to capacity and an interim near-harbor facility was constructed to hold material for one dredging cycle. Following dewatering and analytical testing, this material was determined to meet the criteria set by the Michigan Department of Environmental Quality for beneficial use. The fine-grained texture of the material was not desired for construction fill making it difficult to find large volume uses. However, the city of Ferrysburg, MI had stockpiled unwanted leaf litter near the Corps interim facility. Greenhouse testing determined that blending the dredged material at a 9:1 ratio with leaf compost produced high quality topsoil suitable for landscaping purposes. This presentation will explain the evolution of this initiative, challenges faced, role of the local community, outreach and marketing strategies, and future potential for long-term development.

READ, JENNIFER., Assistant Director, Michigan Sea Grant *and* Executive Director, Great Lakes Observing System, 440 Church Street, Suite 4044, Ann Arbor, MI 48109.

Overview: Observing System Support for Lake Michigan Management Needs

The Great Lakes Observing System (GLOS) is one of 11 regional associations set up along the U.S. coasts supported by NOAA to coordinate and integrate coastal data and information that supports local, regional and national needs. GLOS is a non-profit, membership organization governed by an elected Board of Directors. Its focal themes are human health, ecosystem integrity, climate change and navigation. GLOS role is to identify Great Lakes user needs in these four focus areas and then connect users with the data and information they need to make safe and efficient/effective decisions, or bring them together with the technical experts who can develop observation-based products and tools to support their needs. This presentation will discuss the potential for regional observing systems to support ecosystem-based goals such as Great Lakes restoration, focusing on the advantages of coordinated and integrated data including the potential to support models and other decision-support tools.

REDISKE, RICHARD R.[1], HAGAR, JANEL[1], O'KEEFE, JAMES[1], HONG, YING[1], and DYBLE BRESSIE, JULI[2], [1]Annis Water Resources Institute, Grand Valley State University, Muskegon MI, 49440; [2]NOAA Great Lakes Environmental Research Laboratory, Ann Arbor, MI.

Assessment of Cyanobacteria and Associated Toxins in Recreational Waters of West Michigan

The increasing prevalence of algal blooms arising from cultural eutrophication and the action of non-indigenous species is creating issues related to the use of water for recreational purposes. Cyanobacteria are well known for their ability to produce potent toxins which have been responsible for animal deaths and human health problems. Seven drowned river mouth lakes in western Michigan were investigated in 2006 to examine the spatial and temporal variability cyanobacteria and cyanotoxins (4 events, 6 samples/lake, beach and open water locations). Microcystins were measured by PPIA, ELISA (LR) and LC/MS (LR, RR, YR, LW) methods. In addition, anatoxin-a and cylindrospermopsin were measured by HPLC/MS. Cyanobacteria were the dominant phytoplankton species in all of the study lakes. In general, ELISA methods were found to significantly overestimate the concentration of microcystin LR due to cross reactivity with RR. PPIA results also were significantly higher than HPLC/MS and ELISA indicating that other microcystin analogues were present. No difference in microcystin LR levels between beach and openwater samples was found in 6 of the 7 lakes. There was no significant correlation between WHO recommendations for cyanobacteria density, chlorophyll *a*, and microcystin LR concentration. *Cylindrospermopsis raciborskii* was present in 5 of the seven lakes studied. *C. raciborskii* counts exceeded 1000 trichomes/ml in 3 of the lakes; however the toxin, cylindrospermopsin was not detected. PCR analysis revealed the absence of the PKS gene, indicating that the strains present the study lakes were not capable of producing cylindrospermopsin.

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

Allocation of Nutrient Inputs to Lake Michigan by Source and Tributary Using SPARROW Models

Lake Michigan receives water and nutrients from many tributaries that drain areas ranging from pristine forests, to intensively farmed land, to large urban centers. As a result of this loading, eutrophication problems have developed in many areas around Lake Michigan, for example Green Bay. In an attempt to reduce the eutrophication problems, specific target loads for phosphorus (P) were established as part of a Great Lakes Water Quality Agreement, and detailed TMDLs are being developed for specific tributaries. Detailed water quality and streamflow data are required to determine the status of the nutrient loading to Lake Michigan and from its individual tributaries. Most tributaries, however, are not monitored, and in recent years, the number of monitored tributaries has been shrinking. Without detailed monitoring data, it is difficult to determine basinwide or tributary loads, the location of the largest sources of nutrients (basin ranking/targeting), and what are the main sources of the nutrients (source identification). In an attempt to address these issues, in the absence of more complete monitoring data, we developed SPARROW (SPAtially Referenced Regression On Watershed attributes) models for P and nitrogen (N) using water-quality data assembled from the major sampling agencies and available watershed (nutrient-source and environmental-characteristic) information for the Great Lakes and Upper Midwest area. Results from the SPARROW models are used to: 1) determine the total nutrient loading to Lake Michigan (~4.1×10^6 metric tons of P and 71×10^6 metric tons of N) and from each of its tributaries; 2) rank the individual tributaries based on their total loadings and relative yields (highest yields were from the central part of the watershed and from intensively urban areas); and 3) determine the relative importance of different nutrient sources (atmospheric, point sources, fertilizers, manure, fixation, and forested and urban lands) to instream loads.

SADOWSKY, MICHAEL J.[1,2], HAMILTON, MATTHEW J.[3], HADI, ASBAH Z.[3], and GRIFFITH, JOHN F.[4], [1]Dept. of Soil, Water, and Climate, [2]BioTechnology Institute, and [3]Dept. of Microbiology, 439 Borlaug Hall, 1991 Upper Buford Circle, Saint Paul, MN 55108; [4]Southern California Coastal Water Research Project, 3535 Harbor Blvd, Ste 110, Costa Mesa, CA 92626.

Detection and Characterization of Potentially Pathogenic *E. coli* in Water Using High-Throughput Genomic Methods

Contamination of recreational waters with fecal indicator bacteria, primarily *E. coli* and enterococci, is a widespread problem that results in recurrent beach closures and loss of recreational activity. While *E. coli* is still used as an indicator of fecal contamination, many strains are also potentially pathogenic for humans. Few studies, however, have examined the presence of pathogenic *E. coli* strains in beach waters. Here we report on the use of several genomic-based methods, high throughput colony hybridization, PCR-based analyses, and DNA fingerprint analyses determine the frequency of genes encoding for virulence factors in *E. coli* strains isolated from beach water. While adaptable to any location, the techniques were initially tried at Avalon Beach, on Santa Catalina Island, CA. A total of ~ 25,000 *E. coli* isolates were examined for the presence of shiga toxins (stx1 and stx2), intimin (*eaeA*), and the virulence- associated EAF plasmid. Our analyses showed that 3.6% of the 24,493 isolates were positive for the *eaeA* gene, indicating that these isolates were potential EPEC strains. On five dates, however, >10% of the strains were potential EPEC, suggesting that the incidence of virulence genes at this beach had a strong temporal component. None of the strains were found to contain the *stx1* or *stx2* genes, indicating that no EHEC were detected and only one of the potential EPEC isolates was found to carry the EAF plasmid. Phylogenetic analyses indicated that the potential EPEC isolates mainly belonged to phylogenetic groups B1 or B2 and carried the beta intimin subtype. DNA fingerprint analyses of the EPEC strains indicated that while the isolates belonged to several genetically diverse groups, some were clonal in nature across dates and sampling locations. While the presence of virulence factors cannot be used to solely determine whether strains are pathogens, our results nevertheless show that potential EPEC strains can be found in water obtained from contaminated beaches and this may raise health concerns.

SADOWSKY, MICHAEL J., Department of Soil, Water, and Climate, and BioTechnology Institute, University of Minnesota, St. Paul, MN 55108.

The Trials and Tribulations of Quantitative PCR-based Microbial Source Tracking Methods

Microbial source tracking (MST) tools can generally divided into two major categories: library-dependent and library-independent methods. The development of many of these methods has been driven by requirements for TMDL determinations. Due to problems associated with genetic diversity among populations of fecal indicator bacteria, a lack of representation of all sources in a watershed, the omnipresence of many fecal bacteria, and large size requirements for libraries, over the last several years researchers have explored the use of library-independent, PCR-based methods to determine sources of fecal bacteria in waterways. Primers for PCR have mainly targeted members of the phylum Bacteroidetes, anaerobic gut bacteria, but marker genes targeting traditional fecal indicator bacteria (*e.g. Enterococcus*) and viruses have also been developed. More recently, most laboratories have adopted quantitative PCR (QPC) methods to determine animal sources contributing to bacterial loading of waterways. While these methods are relatively easy to use, they too are prone to problems that have been rarely addressed. These problems mostly stem from method-required tradeoffs in issues of sensitivity versus specificity, lack of correlation between traditional fecal bacterial counts and QPCR values, cross-reactivity of primers to non-target microbial groups, lack of definition of what is an adequate detection limit, detection of non-living organisms, and matrix-associated suppression of signals. In this presentation I will discuss the trials and tribulations of QPCR-based MST tools and some ways to overcome some of the current limitations of this technology. I will also present possible future tools that can be used for MST studies and TMDL determinations, and discuss rational approaches to understanding the relationship between sources and sinks of fecal bacteria in the environment.

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Changes in the Great Lakes Nearshore Areas 1996-2008

In 1996, a nearshore waters paper was prepared for the State of the Lakes Ecosystem Conference (SOLEC). This paper was updated for SOLEC 2008 with a focus on changes in the nearshore issues between 1996 and 2008. Current issues prevalent to Lake Michigan include botulism, harmful algal blooms, viral hemorrhagic septicemia (VHS), and non-indigenous species. Lake Michigan issues appear to cluster around nutrient-related stressors and non-indigenous species. For example, harmful algal blooms, *Cladophora*, and botulism are all affected by nutrient-related stressors, while non-indigenous species and VHS are directly related to ballast water discharge or other means of introductions. Our understanding of these stressors has improved over the past 12 years. However, many physical, chemical and biological challenges remain in the nearshore environment.

SCHOEN, MARY E.[1] and ASHBOLT, NICHOLAS[2], [1]Post-doctoral Fellow, Office of Research and Development, National Exposure Research Laboratory, U.S. Environmental Protection Agency, 26 W Martin Luther King Dr, Cincinnati, OH 45268; [2]Title-42 Senior Research Microbiologist, ORD, NERL, U. S. EPA.

The Birds Did It!

The US EPA and WHO have set recreational water quality standards based on epidemiologic studies to protect human health at beaches. These studies have largely been limited to sewage-impacted sites, and resources are unlikely to be available to assess the myriad of other impacted sites. Here we describe how quantitative microbial risk assessment (QMRA) can be used to assess unstudied pathogen sources in a systematic way to describe risk uncertainty. A QMRA was constructed based on a recreational beach primarily impacted by seagull feces, assumed to contribute only *Campylobacter* and *Salmonella*. The pathogen dose distribution was derived from the concentration of the fecal indicator in the water column using an uncertain ratio of indicator to pathogen concentrations. The probability of gastrointenteritis was calculated using dose-response relationships from the literature. All uncertain model parameters were represented by probability distributions and sampled in a Monte Carlo analysis, allowing subsequent parameter importance analysis. Based on the high uncertainty of human-infectious pathogens in gull feces, the predicted probability of infection from gulls is of potential concern when the water quality indicator is near the single sample water quality standard (104 enterococci / 100 mL). This pathogen uncertainty is common with many animal sources of fecal contamination; hence, it is important that future research focus on specifying pathogen densities to allow comparison of risk estimates from epidemiologic studies with QMRA, which may ultimately allow risk characterization from unstudied sources of fecal contamination at recreational beaches.

SCHOENKNECHT, DAVID, Assistant Professor of Religious Studies, Rockford College, 289 Garden Dr, Elgin, IL 60124.

"Bioregional Awareness" The Value of Identifying, Understanding and Protecting "My" Place in the Basin

Contemporary mobilities have increased the opportunities to immigrate to other locales while global economies have altered many a cultural or socio-economic "place" to the point where illocality seems the norm. Zen Buddhist and naturalist Gary Synder asserts in *The Practice of the Wild* the importance of something he calls "bioregional awareness", the realization that:

Our relation to the natural world takes place in a place, and it must be grounded in information and experience. …There are tens of millions of people in North America who were physically born here but who are not actually living here intellectually, imaginatively, or morally. …For the non-Native American to become at home on this continent, he or she must be *born again* in this hemisphere.

A spiritually and morally empowered "rediscovery of the local" would not only be the amplification of the eco-logical voice of those presently and actively connected to a particular place, but a reclamation of the environmental beneficial texts and traditions – the ancient voices – of those whose connection to this place we call the Great Lakes Basin was significantly more intimate than our own. Rather than being understood merely as a cause for territorial tensions, diverse, religious voices are reevaluating their core beliefs along biophilic lines and are speaking out on behalf of the places we all share. This connection between "bioregional awareness" and environmental activism is something that I propose to illustrate by way of an oral, multimedia, presentation.

SCHUMACHER, SUSAN, We Energies.

Environmental Resources and Wind Turbines: Should Turbines be Installed on Land or in the Lake?

Why has there been an abrupt increase in the number of proposed wind farms? How many more wind farms will be constructed in the midwest and where will they be installed? Part of the siting and construction process for a wind farm involves a review of environmental resources and potential impacts. We will use the Blue Sky Green Field wind farm (located in Fond du Lac, WI) as a case study, and discuss environmental resource concerns for land based and offshore wind farms. In addition, we will discuss the steps currently being taken by We Energies to examine feasibility of wind turbines in Lake Michigan.

SCHWAB, DAVID J., NOAA's Great Lakes Environmental Research Lab, 4840 S State Rd, Ann Arbor, MI 48108.

A Real-time System for Prediction of Nearshore Circulation and Pathogen Transport at Great Lake Beaches.

A combination of deterministic and statistical models is at the heart of a real time beach water quality forecast system. A modification of the Princeton Ocean Model uses wind stress, lake bottom topography, earth's rotation, and temperature fields to compute at any point in the Great Lakes, wave heights and direction, wind velocity, lake currents, temperature fields, and water levels. To provide estimates at the dimensions of a beach, a nested grid hydrodynamic model with a 100-meter grid adaptation of the lakewide grid used in the POM model is needed. The operational Ocean Observing Systems in the Great Lakes allow parameters such as rainfall, wind direction, wind velocity and lake currents to be forecasted at three hour intervals for several days. Modeled lake currents have shown agreement with currents measured by acoustic Doppler current profilers and dye release studies sufficient for use by the National Weather Service in forecasts. Grand River plume aerial photography and model simulations show agreement. Schematic flow charts linking the deterministic and statistical models will be presented. The resulting model shows how the various explanatory variables of Great Lake currents, temperatures, waves and meteorology, river pathogen loading, nearshore hydrodynamics and waves, near field mixing, bacterial transport and fate are linked to beach water quality forecasts of beach E. coli. In the next 18 months a generalized process for beach forecasting product delivery will be developed.

SCHWAB, DAVID, NOAA's Great Lakes Environmental Research Lab, 4840 S State Rd, Ann Arbor, MI 48108.

Combining Observations, Models, and Delivery Systems to Predict the Impact of the Grand River Plume on Water Quality at Michigan Beaches

Contaminants and fecal pollution from the Grand River may pose health risks to swimmers at nearby Michigan beaches and may resuly beach closures. In 2006 and 2007 NOAA's Center of Excellence for Great Lakes and Human Health sponsored a multi-institutional study of the Grand River plume as it enters lake Michigan. The goal was to develop predictive computer models to determine the fate and probability of beach contamination from the river and to aid forecasting water quality along the beaches. Four intensive field experiments on the plume dynamics were carried out in the summers of 2006 and 2007. Artificial tracers (SF6 and Rhodamine WT) were added to the river upstream and profiles of plume properties were obtained by boats in the lake. In addition, currents, winds and waves were continuously measured from moored instruments and aerial photographs of the plume were obtained. It was found that the river plume forms a buoyant surface jet which is extremely sensitive to nearshore current patterns. The results of this research are already being incorporated into real-time simulations of water quality in nearshore areas to aid in predicting beach closures.

SLAWSKI, THOMAS, THORNTON, JEFFREY, and KORB, GARY, Southeastern Wisconsin Regional Planning Commission, W239N1812 Rockwood Dr, Waukesha, WI 53187-1607.

The Land-Water Connection: Part 1-The Watershed

The Southeastern Wisconsin Regional Water Quality Management Plan 2007 Update emphasizes a watershed-based approach to improving water quality and enhancing natural resources. An integral part of this is the protection and preservation of environmental corridors, especially along major streams and associated tributaries. Environmental corridors can fulfill multiple purposes, including protection of water resources through groundwater recharge, infiltration of runoff, filtering of pollutants, and improvement of habitat. This presentation summarizes the key features of several ongoing projects that focus on the Menomonee River and Kinnickinnic River watersheds as part of the Southeastern Wisconsin Watersheds Trust (SWWT) planning program. These two watersheds exhibit a range of conditions typical of much of the Great Lakes basin, with the Kinnickinnic River being the most intensively developed and the Menomonee River watershed containing somewhat more open land that presents greater opportunities for interventions. Despite the developed nature of the Kinnickinnic River watershed, the possibility exists for the implementation of innovative streambank practices such as concrete removal, daylighting of enclosed channels, de-fragmenting streams and corridors to promote fish passage, and re-meandering previously channelized reaches. In contrast, the Menomonee River watershed can accommodate a wider range of interventions to improve ecosystem characteristics. These include potential improvements related to fish and habitat, stormwater management, flood control, aesthetics and recreation. A first step in improving habitat in both watersheds is an assessment of the drivers affecting the physical environment and imposing constraints in these urban systems, leading to the design of practices that enhance ecosystem structure and function within the stream corridor. Riparian buffers are an integral part of this design process. Key considerations in riparian buffer assessment and design will be presented.

STEUER, JEFFREY[1], and BALES, JERAD[2], [1]U.S. Geological Survey, 8505 Research Way, Middleton, WI 53562; [2]U.S. Geological Survey, 3916 Sunset Ridge Rd, Raleigh, N. Carolina 27607.

Hydraulic Metrics Using HEC-RAS: A Tool for Determining Management-Oriented Variables Associated with Watershed Change and Stream Biology

Aquatic biological conditions may be influenced by both hydrologic (i.e. magnitude, duration, frequency, rate of change) or hydraulic (i.e. depth, Froude number, shear stress) conditions. In a 2004 NAWQA Effects of Urbanization on Stream Ecosystems study we utilized a 1-dimensional hydraulic model (HEC-RAS) with habitat and continuous stream stage data to calculate hydraulic characteristics at 30 small (11-119 km^2) Western Lake Michigan watersheds. Utilizing correlation and multi-variate regression tree modeling we evaluated the association between aquatic communities (fish, invertebrates, and algae) and hydraulic characteristics based upon hourly and daily time series resulting from 1-dimensional hydraulic modeling. Conceptually, the hydraulic characteristics provide insight about the link between watershed change, instream physical conditions, and stream biology. Furthermore, the hydraulic time series variables may provide deterministic or process insight not obtainable from the more general flow regime hydrologic metrics. Values of hydraulic variables may also reflect modifications at the immediate reach scale thus providing a potential link between channel modification and biology. Hydraulic characterizations of reach conditions should be considered as one quantification approach in a much larger tool box.

STOW, CRAIG[1], DYBLE BRESSIE, JULI[1], PEACOR, SCOTT[2], PETERS, KIM[2], DZIEKAN, DIANNA[2] and FRANCOUR, STEVE[3], [1]NOAA Great Lakes Environmental Research Laboratory, 4840 S State Rd, Ann Arbor, MI 48108; [2]Michigan State University; [3]Eastern Michigan University.

Insights Into the Benthic Algal Community in Saginaw Bay, Lake Huron

Beach accumulation of decomposing algal material ("muck") is a significant issue for the residents around Saginaw Bay, Lake Huron due to the decreased aesthetic value of the beach as well as concerns about the harboring of pathogens. These beach deposits are hypothesized to be the result of benthic algae washing up on the beach, but the algal source and mechanism of beach accumulation have not been established. Unlike Lake Michigan, in which *Cladophora* is often the dominant benthic algae contributing to beach muck, Saginaw Bay has a diverse and patchy benthic algal community. We will present data from surveys of Saginaw Bay shorelines and nearshore areas to provide insight into the spatial and temporal distribution of both beach muck and major benthic algal genera as well as data from experimental work to determine the role of nutrients and dreissenid mussels in structuring the benthic algal community. This work will be discussed in light of the larger context of this project, which is identifying the interacting role of multiple stressors such as invasive species, changing land use and climate change on water quality in Saginaw Bay.

STRIGEL, MICHAEL, Executive Director, Gathering Waters Conservancy, Gathering Waters Conservancy, 211 S Paterson St, Ste 270, Madison, WI 53703.

The Lake Michigan Shorelands Alliance: Collaborative Land Conservation Protecting Critical Natural Resources in the Lake Michigan Basin

Gathering Waters Conservancy's (GWC) mission to help communities, land trusts and landowners protect the places that make Wisconsin special. In 2003, GWC convened the ten land trusts operating along the Lake Michigan coastline, along with federal, state, tribal, and regional partners to form the Lake Michigan Shorelands Alliance (LMSA). We have helped these organizations develop strategies for protecting the most critical lands near the shoreline and along tributaries that flow into the lake.

This alliance has been invaluable in building regional momentum for strategic watershed-scale conservation. One of the first projects that LMSA undertook was the development of a regional conservation vision for Wisconsin's Lake Michigan Basin: *Landscapes of Opportunity*, a report identifying high-priority conservation sites in the basin. This report has catalyzed significant conservation action and raised the profile of these critical areas.

Last fall, GWC and the LMSA members hosted the *Great Lake Gatherings.* This series of four community forums was held in key communities along Lake Michigan and encouraged creative partnerships to conserve local natural resources. Participants included more than 450 government officials, economic development leaders, planners, land trust members, and landowners concerned about protecting natural treasures throughout the watershed.

Moving forward, we will update and expand *Landscapes of Opportunity,* creating detailed, map-based plans to focus land protection and restoration efforts in the watershed. To accomplish this, we will use the Trust for Public Land's proven *Greenprint* model for conservation planning. Using this innovative modeling tool, we will combine the science behind water quality, habitat, and other resource protection goals with the art of working with stakeholders to identify community values around land conservation and habitat restoration to develop a regional conservation plan. Our success will result in targeted and efficient conservation, and will be measured in acres protected and natural treasures preserved for future generations.

STRYKER, ROB[1] and GAREAU, JOANNE[2], [1]CH2M HILL, Milwaukee, WI; [2]Ryba Marine Construction Company.

Innovative Air Bubble Curtain Replaces Silt Curtain as Turbidity Control Measure during Kinnickinnic River Dredging

A common concern when dredging contaminated sediments is controlling the material that is released in the water column during the dredging operations and stopping its movement outside of the dredging boundaries. The industry standard practice is to deploy silt curtains, which often create implementability issues when they are moved to allow boat passage. An innovative alternative means to control turbidity at a contaminated sediment clean-up site was deployed during the Kinnickinnic River Great Lakes Legacy Act project. Air curtain technology was used to create a vertical barrier of air bubbles within the river at the downstream end of this mechanical dredging project. Performance monitoring data collected during the dredging project demonstrates the effectiveness of this technology to control downstream migration of suspended particles, while allowing easy boat passage into and out of the project area.

SZARLETA-YANCY, ELLEN[1], and DA SILVA, ALEXANDRE F.[2,3], [1]The School of Public and Environmental Affairs, Indiana University, Northwest, Dune Professional Building, 3400 Broadway, Gary, IN 46308; [2]Department of Political Science, Northern Illinois University, DeKalb, IL; [3]Calumet College of St. Joseph, Hammond, IN.

Assessing Environmental Preferences: A Case Study of Indiana's Beach Program Public Notification System

This work assesses the water quality notification system implemented by Indiana's Beach Program. In total 178 face-to-face surveys were performed. Subjects were asked to assess the current notification system. The objective of the study was to 1) gain a greater understanding of the opinion beach goers of current notification system and 2) identify the preferences of citizens to transition to a flag system. Participants in the study demonstrate varying views on the current notification system, including many related current condition of the beach, socio-economic and preference issues. The participants, including those who were generally supportive of the current notification system, identified issues improvement strategies, including the issues of changing the warning and closure language, lacked causal knowledge and expressed uncertainty about the meaning of the sign language. This is the first study to document how citizens perceive the current notification system being used in the Great Lakes. Participants believed that the notification system was not ideal, but needed. The current notification system has certain deficiencies due to a lack of knowledge about the water quality issues, and issue complexity.

TANK, KATHY, and DONLEVY, KAE, Wisconsin Harbor Towns Association.

Wisconsin Harbor Towns Association

The Wisconsin Harbor Towns Association (WHTA), which includes nearly 20 communities along Wisconsin's 1,100 miles of scenic Great Lakes coastline, is a collaborative organization of marinas, convention and visitor bureaus (CVB) and chambers of commerce. The organization was formed in 2001 to promote tourism in Wisconsin's unique and authentic harbor towns along Lake Michigan's and Lake Superior's coasts.

Beginning in 2008, the WHTA received financial support from the Wisconsin Department of Administration's Wisconsin Coastal Management Program to implement initiatives focusing on eco-tourism and promoting boating in collaboration with the University of Wisconsin Sea Grant Institute, Wisconsin Department of Tourism, Wisconsin Department of Natural Resources and harbor town marinas.

Since the summer of 2008 the initiatives of this project included beach and harbor cleanups to promote September Wisconsin Coastal Awareness Month, the creation of a new ***Wisconsin Harbor Town Travel Guide*** and the ***Simple Solutions to Great Lakes Health Resource Guide*** for tourists and boaters, the development and creation of a new Wisconsin Marina Association in March 2009 and presence on the Wisconsin Clean Marina Program Planning Committee to help create best management practices for marinas and launch the program in fall 2009 in partnership with UW Sea Grant Institute.

TEMTE, JO and BALDWIN, AMALIA, WI DNR, 101 S Webster St, Madison, WI 53707.

Wisconsin Department of Natural Resources Great Lakes Outreach

The Wisconsin DNR is involved in a variety of Great Lakes outreach efforts. Our goal is to raise awareness of Lake Michigan and Lake Superior and promote the involvement of people of all ages in Great Lakes issues.

In August 2008, the DNR Office of the Great Lakes (OGL) produced its first annual "*Discover Wisconsin's Great Lakes*" calendar and launched an annual photo contest. Calendars are distributed at State Fair and through State Parks and visitor centers.

The *Spirit of Collaboration* (a *Wisconsin Natural Resources* magazine supplement) focuses on collaborative efforts to protect and restore Wisconsin's Great Lakes. *Wisconsin's Great Lakes Strategy* brochure outlines Wisconsin's plan for protecting Lake Superior and restoring Lake Michigan. This publication is intended for state legislators, local decision-makers and interested citizens.

The OGL plans continued outreach through our website utilizing podcasts and other new technologies. A State of Wisconsin's Great Lakes report is also planned. We are excited about collaborating with others on these outreach efforts.

The WI DNR also administers Project WET, a national environmental education program. The primary component of the program is a curriculum guide filled with water-related, fun, hands-on, and easy-to-use activities related to atmospheric, surface, and ground water, water history, water rights, conservation and stewardship. Project WET is delivered to educators at full day workshops. Participants receive the activity guide, participate in a variety of activities, and learn how to implement these activities with K-12 students and other audiences. The DNR has adapted Project WET activities to cover Great Lakes subjects including aquatic invasive species, the Great Lakes Compact and water conservation, water quality and beach closings, and the history of Great Lakes water use.

Photos from the first Great Lakes Project WET workshop will be shown and a short demonstration of a Project WET activity will follow the presentation.

THORNTON, JEFFREY, SLAWSKI, THOMAS, and KORB, GARY, Southeastern Wisconsin Regional Planning Commission, W239N1812 Rockwood Drive, Waukesha, WI 53187-1607.

The Land-Water Connection: Part 2-The Water's Edge

The Lake Michigan shoreline in Southeastern Wisconsin represents a dynamic and varied environment in which humans and their activities interact. Superimposed on this are natural processes including changing lake levels, varying degrees of urban development, and differing landscapes that range from relatively undeveloped gradually sloping beaches to highly urbanized bluffs. Each of these landscapes presents its own challenge. This paper highlights the results of a recent Lake Michigan shoreline stability assessment in the Southeastern Region and identifies opportunities for integrating human aspirations for proximity to the lake with the uncertainties of coastal erosion during a period of lake level change. Traditional mitigation measures such as shoreline protection structures and shoreland zoning and management practices are contrasted with innovative land management strategies designed to minimize human impacts on the coastal zone and the impacts of coastal processes on human economic activities. To this end, this presentation will focus on the role of riparian buffers as instruments for transitioning the built environment into the coastal zone. Such buffers provide a range of ecosystem benefits including serving as visual amenities, recreational use zones, and habitat areas for both humans and wildlife.

TUCHMAN, MARC L.[1] and BOEHME, SUSAN E.[2], [1]U.S. EPA Great Lakes National Program Office, 77 W Jackson Blvd, Chicago, IL 60604; [2]Illinois-Indiana Sea Grant College Program

The Great Lakes Legacy Act: Six Years of Sediment Remediation in the Great Lakes

The Great Lakes Legacy Act is a program specifically designed for remediating contaminated sediments in Great Lakes Areas of Concern. This Program has been used to accelerate the pace of sediment remediation through the development of partnerships between U.S. EPA and non-federal partners, the communities and the state agencies. The Program was reauthorized in 2008 for an additional two years. To date five remediation projects have been completed, removing over 800,000 cubic yards of contaminated sediments at a cost of about $97 million. Another three remediation projects are currently underway including two in the Lake Michigan basin: Kinnickinnic River in Milwaukee and Grand Calumet River in Hammond, Indiana. The presentation will provide an overview of what has been accomplished to date by the Program, and discuss progress on projects underway and update future work anticipated.

TYNAN, TIMOTHY J.[1] and KARL, JOHN[2], [1]Life Sciences Communication, University of Wisconsin-Madison, [2]Science Communicator, University of Wisconsin-Sea Grant Institute, 1975 Willow Dr, Madison, WI 53706-1177.

All Washed Up: Videos and a Rich Internet Application to Promote Awareness and Understanding of the Causes of the *Cladophora* Problem, its Impacts and Solutions

The problem of excess algae (*Cladophora*) on Lake Michigan beaches may be painfully familiar to many people attending this conference, but many more people know little about the impacts, causes, or even the existence of the problem. This is problematic, because addressing the problem requires awareness—and action—by many in urban, suburban, rural and agricultural sectors. A new video and an innovative online learning activity have been developed by Wisconsin Sea Grant to raise awareness of the problem and the many facets of its solutions. This presentation will show short segments of the video and demonstrate and discuss the online activity.

The video examines the impacts, causes, and solutions to the problem. It has been produced as a DVD containing an 18-minute version and a 7-minute version for flexibility in screening situations. Both versions can also be viewed online at www.seagrant.wisc.edu/algae.

The online learning module is a Rich Internet Application (RIA) combining Flash technology, motion graphics, animation, video and audio to create an interactive, inquiry-based learning activity that allows students and others to explore complex, interrelated concepts at their own pace. Users add mussels to the lake and observe changing water clarity, and they control light intensity reaching the lake bottom while observing the effects on Cladophora growth. Supporting information is presented via video and audio with text summaries, or via text alone. Optional quiz questions reinforce users' mastery of key concepts. The module was developed the presenting author, a certified broad-field science teacher and Ph.D. candidate at UW-Madison specializing in multi-cultural science learning that links rich media with instructional design.

TYNER, EMILY[1], MORASKA LAFRANCOIS, BRENDA[1], BALLMAN, ANNE[2], BLEHERT, DAVID[2], BOOTSMA, HARVEY[3], GETCHELL, ROD[4], GLASE, JAY[1], HYDE, KEN[1], KETELES, KRISTEN[1,5], LEONARD, JILL[6], OTTO, CHRIS[1], RILEY, STEPHEN[7], VAN SUMEREN, HANS[8], [1]National Park Service, St. Croix Watershed Research Station, 16910 152nd St N, Marine on St. Croix, MN 55047; [2]USGS National Wildlife Health Center; [3]UW-Milwaukee Great Lakes WATER Institute; [4]Cornell University; [5]Environmental Protection Agency; [6]Northern Michigan University; [7]USGS Great Lakes Science Center; [8]Northwestern Michigan College Great Lakes Water Studies Institute.

Exploring Causes for Recent Botulism Outbreaks at Sleeping Bear Dunes National Lakeshore: Results from Pilot Studies

Recent outbreaks of avian botulism (type E) in northern Lake Michigan have caused high bird mortality and captured public attention. During 2007 and 2008, we investigated a widely proposed causal pathway involving *Cladophora,* dreissenid mussels, and round gobies, and explored other potential causes for outbreaks at Sleeping Bear Dunes National Lakeshore. Sediments, *Cladophora*, dreissenids, crayfish, macroinvertebrates, and round gobies were screened using a qPCR assay (which detects a fragment of the toxin gene) and/or an ELISA (for toxin presence); no evidence of the toxin gene or toxin presence was found, regardless of site, depth, season, or year. Gut content analysis indicated that at least one-third to one-half of affected birds had consumed dreissenids and gobies, respectively. Preliminary food web studies using stable isotope analysis suggested that benthic organisms relied primarily on benthic algal carbon sources, rather than on phytoplanktonic carbon filtered by dreissenids, and that round gobies had consumed more than just dreissenids. Continuous water quality data showed that although botulism outbreaks in 2007 and 2008 were unrelated to dissolved oxygen conditions near the lake bottom, they followed changes in nearshore water temperatures, suggesting that internal mixing may stimulate toxin production or facilitate its transfer. In general, results of these studies provide some support for the hypothesized botulism pathway, but also highlight new complexities. Currently we are exploring long-term relationships between botulism outbreaks and such large scale factors as lake levels and temperatures; preliminary results show that outbreaks have occurred in years with significantly lower lake levels, suggesting that coastal and inshore processes may be important. Using remotely operated vehicles, we are also exploring spatial and seasonal patterns in goby distribution as they relate to outbreaks. Given that hydrologic, climatic, and food web conditions are changing rapidly, scientific and management solutions to this ecological puzzle will be anything but simple.

UGORETZ, STEVEN, Wisconsin Dept. of Natural Resources, Office of Energy.

Environmental Considerations in Wind Energy Siting in Wisconsin DNR

Wisconsin has long-standing involvement in wind facility siting and environmental issues. The state has a Renewable Portfolio Standard and other programs that encourage renewable energy sources. WDNR has worked with the Public Service Commission of Wisconsin and other interested agencies and organizations to guide wind development in environmentally-sound directions. The DNR has outlined an approach to screening sites to minimize potential impacts, and developed study protocols to document actual impacts. These are currently being applied at several land-based wind farms in the State, and results will be used to refine that guidance to make it more precise and effective.

UZARSKI, DONALD G., Department of Biology and CMU Biological Station, Central Michigan University, Brooks 156, Mount Pleasant, MI 48859.

Potential Hydrologic Factors Impacting Great Lakes Coastal Wetlands: Regulation of the Superior Outflow

After losing greater than 50% of our Great Lakes coastal wetlands to development and agriculture, we are just realizing the importance of these systems to the overall health of the Great Lakes. Coastal wetlands are the interface between water and land and serve many critical physical, chemical, and biological functions. The IJC International Upper Great Lakes Study is currently addressing, among other things, water level regulation via the Superior outflow. Alteration to natural water level regimes can have large-scale impacts on wetlands. Hydrology dictates the formation, as well as the structure and function, of these systems. Emergent macrophytes, and thus wetlands, only establish where there is protection from extreme hydrologic energy. Where wetlands do establish, a natural and dynamic hydrologic regime creates 5 distinct plant zones. Interannual water level fluctuations expand plant zones while triggering their migration lake- or landward. Stabilized hydrology compresses plant zones and can reduce the number of zones to only two. Plant zonation is paramount to the establishment of diverse communities and associated chemical and physical processes that society values. The timing and duration of seasonal water level fluctuations are also critical. Annual lows occur during winter as evaporation continues, but little water is returned. Shoreline sediments are exposed to atmospheric oxygen during early spring which allows seeds to germinate. As the shoots grow, water level rises, but a portion of the shoot must remain emerged to move atmospheric oxygen to the roots, or the plant will drown. Short-term water level fluctuations at the scale of days to hours are important to these systems as well, but alterations to these fluctuations will be minimal via upper Great Lakes water level regulation. If either the timing or duration of Great Lakes water level fluctuations is altered, there may be large-scale ecological consequences in Great Lakes coastal wetlands.

VAIDYA, AJIT and MALLY, DIANA, U.S. EPA, Great Lakes National Program Office, 77 W Jackson Blvd, Chicago, IL 60604.

Cleanup of the Kinnickinnic River: Implementation of a Legacy Act Sediment Remediation Project

The much anticipated sediment cleanup of the Kinnickinnic River is now underway in Milwaukee, Wisconsin, with initiation of sediment dredging activities in June 2009. The estimated $22 million project is jointly funded through the U.S. EPA's Great Lakes Legacy Act (GLLA) program and the Wisconsin Department of Natural Resources. Sediment mechanically dredged from the Kinnickinnic River using a closed clamshell environmental bucket is being transported by barge and disposed of at the Milwaukee Area Confined Disposal Facility (CDF), which is owned by the Port of Milwaukee and operated by the U.S. Army Corps of Engineers. It is estimated that the project will remove 170,000 cubic yards of contaminated sediment, resulting in the removal of about 1,200 pounds of PCBs and 13,000 pounds of PAHs.

This presentation will outline the steps involved in the field implementation of this GLLA project. The first phase of implementation began in fall 2008 with the construction of a special cell to contain the contaminated Kinnickinnic River sediments at the Milwaukee Area CDF. During fall and winter 2008/09, shoreline stabilization measures were installed to protect riverbank areas in the KK River project area. In spring 2009, a sediment off-loading platform was constructed at the CDF. Sediment dredging and disposal activities began in June 2009, and are expected to be completed in fall 2009, followed by deployment of a cover layer to manage the impact of generated residuals. Other project implementation activities include utility relocations and control of sediment resuspension.

VALENTA, TRACY, Green Bay Metropolitan Sewerage District, 2231 N Quincy St, Green Bay, WI 54301.

Depletion of Oxygen in Lower Green Bay

The Green Bay Metropolitan Sewerage District has been actively monitoring water quality trends in lower Green Bay since 1986. Data collected from continuous monitors located approximately four miles north of the Area of Concern in southern Green Bay indicates there are numerous times during the sampling season when the measured dissolved oxygen concentrations fall below the 5 ppm standard. Both a drop in temperature and specific conductance accompany the decrease in dissolved oxygen. These events are generally observed along the eastern shores of Green Bay, but have been documented moving as far south as the mouth of the Fox River. The induced period of anoxia has been known to last from several hours to a week or more before it begins to dissipate. Previous research has shown that on occasion large, cold water intrusions from Lake Michigan push down anoxic hypolimnetic water from central Green Bay into the lower bay. These events have far reaching impacts on the Area of Concern in terms of limiting the survival and reproduction of benthic macro-invertebrates such as the *Hexagenia sp.*, a species that was once prevalent and abundant in Green Bay.

VAN SUMEREN, HANS[1], and BREEDERLAND, MARK[2], [1]Great Lakes Water Studies Institute, Northwestern Michigan College, 1701 E Front St, Traverse City, MI 49686; [2]Michigan Sea Grant Extension, 520 W Front St Ste A, Traverse City, MI 49684.

Botulism Food Web – Pre and Post Storm Event Observations

Recent Remotely Operated Vehicle (ROV) investigations conducted in northern Lake Michigan have provided insight to *Cladophora* sloughing and round goby migration in relation to storm events. ROV investigations conducted in August 2009 showed a dramatic change in the presence of *Cladophora* and round gobies just before and just after a moderately strong weather system moved through the area.

Using a ROV for size and distribution analysis at several study locations, round goby and *Cladophora* algae were present and abundant across all types of substrate including sand, shell and cobble. Two investigations at multiple depths, one conducted August 19 and the second conducted August 27, confirmed the same results. A third investigation, conducted August 31, yielded a much different story. Across all depths previously investigated, zero round goby were observed and much of the *Cladophora* algae had disappeared. A single weather event had moved through the region during the night of August 29. No visible algae mats were on the surface and none had been identified on shore. Where did the *Cladophora* and round gobies go?

VERHOUGSTRAETE, MARC[1], UREN, SARAH[2], [1]Michigan State University, Dept. of Fisheries & Wildlife, 13 Natural Resources, East Lansing, MI 48824-1222; [2]The Watershed Center Grand Traverse Bay, 13272 S West Bay Shore Dr, Traverse City, MI, 49684.

Healthy Beaches Program for Grand Traverse Bay Region

The Watershed Center Grand Traverse Bay is a nonprofit organization based in Traverse City, Michigan whose mission is to advocate for clean water in Grand Traverse Bay and protect and preserve the Bay's watershed. The Grand Traverse Bay region receives a large amount of tourism every summer, with many visitors coming to enjoy our bounty of beautiful freshwater. The region has a total of 181 miles of Lake Michigan shoreline and more than 130 public beaches and access points to Grand Traverse Bay and Lake Michigan. Additionally, the use of Grand Traverse Bay, inland lakes, and rivers for swimming is a valuable recreational resource for residents and visitors to our region. Having healthy beaches is not only important to the local economy, it's important for the residents of this area who enjoy our bounty of freshwater each and every day. The Watershed Center recently kicked off our Healthy Beaches program and we have learned that just because our monitoring doesn't show problems at local beaches doesn't mean that remediation measures are not necessary. Our annual beach monitoring takes place on a specific day per week, but additional monitoring shows problems typically occur after major rain storms. As part of this year's Healthy Beaches program we are conducting a source tracking study on local beaches in conjunction with our local health departments and Michigan State University to determine if sources of E.Coli are animal- or human-derived. The samples will be taken during baseline and wet weather conditions. Additionally, we have ramped up our outreach program with a series of print ads and a variety of radio spots. We have also expanded our online content on Facebook, Twitter, our gtbaynews.wordpress.com blog and our Watershed Moments e-newsletter. Future activities for our Healthy Beaches program include educational signage and pet waste stations.

VIMONT, DANIEL J., LORENZ, DAVID, KUCHARIK, CHRIS, NOTARO, MICHAEL, and VAVRUS, STEVE.

Downscaled Climate Change Projections for Wisconsin.

A new set of statistically downscaled daily precipitation and maximum and minimum temperature projections have been developed for Wisconsin as part of the Wisconsin Initiative on Climate Change Impacts. The statistical downscaling methodology is based on the idea that statistics of sub-grid scale (regional) variations are conditioned on the large-scale variations (e.g. output from a global climate model, or GCM). For example, if a climate model predicts that a particular large-scale region will be wet on a given day, then the probability of precipitation at any region (sub-grid scale) is increased. The new set of climate projections provides debiased information about daily precipitation and maximum and minimum temperature at a ~10km resolution, for fifteen different climate models, for the late 20th century (1960-1999), mid 21st century (2046-2065) and for the late 21st century (2081-2100).

There are a few advantages to the statistical downscaling approach that we use. First, the data format allows a great deal of flexibility in climate impact assessments. The probability distributions can be used 'as is' for a risk assessment, synthetic data sets (time and space) can be generated for spatio-temporal modeling, or specific historical events can be mapped into the future for examination of policy response scenarios. Second, by downscaling the probability distribution (rather than a specific variable), extreme event characteristics are well captured, and uncertainty is easily propagated through the assessment activity. Third, the downscaling technique is true to the actual physical relationship between information that a GCM provides and the actual sub-grid scale variations that may be observed.

A brief description of the statistical downscaling methodology will be presented, as well as some results from the downscaled data. Additionally, methods for integrating this downscaled data in an assessment process (e.g. the Wisconsin Initiative on Climate Change Impacts, or WICCI) will be discussed.

The Wisconsin Initiative on Climate Change Impacts is a partnership of the University of Wisconsin, Wisconsin Department of Natural Resources, and other agencies. This statewide collaboration is assessing the potential consequences of climate change for Wisconsin's natural resources, ecosystems, industries, farms, human health, and our way of life— and forming practical adaptation strategies to address the needs Wisconsin’s citizens, economy, and resources.

WALTER, MARK[1], and PIERCE, ANGELA[2], [1]Executive Director, [2]Natural Resources Planner, Bay-Lake Regional Planning Commission, 441 S Jackson St, Green Bay, WI 54301.

Bay-Lake Regional Planning Commission Green Infrastructure Efforts in Northeast Wisconsin

The Bay-Lake Regional Planning Commission ("Commission") began defining and mapping its green infrastructure in 1997. Green infrastructure in the Bay-Lake Region is comprised of wetlands, wetland buffers, waterways, waterway setbacks, 100-year floodplains, and steep slope. Green infrastructure identification and mapping efforts were completed on a county-by-county basis.

By 2005, the Commission had developed documents detailing the nature and extent of the green infrastructure in each of the region's eight counties, as well as a regional comprehensive report. The Commission's green infrastructure efforts have identified over 2.5 million acres of natural areas, wetlands, riparian lands, floodplains, and waterways throughout northeast Wisconsin.

The Commission is continually working to implement protections for green infrastructure, even though it has no regulatory authority to do so in most areas of its region. The most effective means by which the Commission is able to provide protection for these resources is through its influence in local planning and zoning efforts.

By assisting communities with defining their future land use plans, the Commission ensures that communities are cognizant of green infrastructure, and encourages them to implement low impact development.

The Commission was recognized in 2009 as a *Regional Center of Excellence* by the National Association of Regional Councils (NARC) for its regional green infrastructure efforts in northeast Wisconsin. With assistance from NARC, the Commission is working to promote green infrastructure planning by raising awareness of its regional green infrastructure mapping and the importance for preservation.

By the end of September 2009, the Commission will be able to unveil its newly developed green infrastructure promotional mini-posters. The mini-posters, illustrating green infrastructure in the region and the benefits of protecting sensitive resources, will be distributed throughout northeast Wisconsin.

WALZ, KIM[1] and MACKEY, SCUDDER[2], [1]Office of the Great Lakes, Wisconsin DNR, PO Box 9721 OGL/3, Madison, WI 53707; [2]Habitat Solutions NA.

International Upper Great Lakes Study (IUGLS): Update from the Ecosystem Technical Work Group

The purpose of the International Upper Great Lakes Study (IUGLS) is to investigate improvements to the regulation of the outflow of Lake Superior given the impacts regulation may have on water levels, flows, and consequently affected resources throughout the upper Great Lakes system. It also will closely examine the physical processes driving current Great Lakes water level conditions, and possible ongoing changes in the St. Clair River and their impacts on river flow and Lakes Michigan and Huron levels. These two issues are interrelated in that the outflow of Lakes Michigan-Huron, through the St. Clair River, plays a direct role in determining lake level, which in turn affects the regulated outflow from Lake Superior and the regulation objectives of the IJC Orders.

Work on this study began in 2007 and is schedule to be completed in 2012. The focus of the study is to investigate improvements to Lake Superior outflow regulation and to further our understanding of how changes in the St. Clair River affect regulation, as well as levels and flows in the upper Great Lakes. Lake Superior's outflows are regulated by structures on the St. Mary's River. As the needs of the interests in the upper Great Lakes system continue to evolve and our concern with global climate change grows, the question put to the study board is, "Could the current methods used to regulate the system be improved to better meet the needs of the interests?"

This session will provide an update and overview of the work to date by the members of the Ecosystem Technical Work Group, the overall approach of the study and how the various pieces fit together as it relates to water levels in the Great Lakes.

WANG, JIA, GLERL/NOAA.

Seasonal, Interannual, and Spatial Variability of the Great Lakes Ice Cover in Response to Climate Change

Seasonal and interannual variability of lake ice cover in the Great Lakes is investigated using historical and satellite measurements for the period 1962-2008. After climatology of the seasonal cycle is derived for lake ice season, large anomalous interannual variability is found in response to atmospheric teleconnection patterns. Nevertheless, spatial variability of ice cover in the five Great Lakes shows regional differences and characteristics. A principal-component or EOF (empirical orthogonal function) analysis is applied to lake ice anomalies to derive major spatial and temporal patterns, which can be explained by major atmospheric variability controlled by well-known climate patterns: Arctic Oscillation (AO) and ENSO (El Nino and Southern Oscillation). Thus, a normalized ice anomaly index is derived by combined five Great Lakes ice normalized by its individual standard deviation, which can be used to be regressed atmospheric forcing field. Lake ice reduction rate over the last three decades in each lake is estimated. Dynamic mechanisms controlling lake ice temporal and spatial variability are investigated in the context of regional climate changes.

WANG, YUTTA, and JANSSEN, JOHN, Great Lake WATER Institute, 600 E Greenfield Ave, 53204, 414-382-1733.

The Extended Period of Larval Production and Feeding of age-0 Burbot Larvae in Lake Michigan

The burbot *Lota lota* is the only fresh water member of cod family (Gadidae). The burbot reportedly spawns in the winter or early spring at low water temperatures (1-4ºC) In Lake Michigan it is reported to have an extended period of larval production apparently from March to June, based on coastal sampling by Mansfield et al. We have found that larval production extends beyond June into early July with the last larvae likely being produced at the mid-lake reef complex. We propose the extended period of larval production is due to differences in the timing of spawning with a temporal sequence of cohorts from coastal rivers, littoral zone, to deepwater (including the mid-lake reefs).

The different cohorts will encounter different initial prey types and densities that may impact relative survival. According to Fischer, the endogenous feeding (yolk sac stage) lasts about 11-23 days (until 4.4 mm to 5.5 mm in total length). After that larvae migrate to the surface water column and start the pelagic period. Elsewhere it has been found that burbot larvae first feed on phytoplankton and then switch to zooplankton including copepod nauplii, juvenile and adult copepods, and cladocerans. We will present a comparison of diets for larval burbot from cohorts from mid spring and early summer.

WAPLES, JAMES T.[1], ORLANDINI, KENT A.[2], KLUMP, J. VAL[1], [1]Great Lakes WATER Institute, University of Wisconsin-Milwaukee, Milwaukee, WI 53204; [2]Argonne National Laboratory, Argonne, IL.

Measuring Dreissenid Mussel Clearance Rates and Rapid Particle Dynamics with Short-lived Radionuclide Tracers: Y-90/Sr-90 & Th-234/U-238

Evidence for the interception, retention and re-packaging of suspended material by dreissenid mussels and attempts to quantify this flux have primarily relied on (i) observations of changing inventories over time; (ii) extrapolation of small-scale laboratory and field experiments and (iii) modeling studies. We propose that particle (nutrient and energy) clearance rates in the water column can be measured directly using naturally occurring short-lived particle reactive radionuclides. Th-234/U-238 ratios have been utilized for decades in marine and freshwater systems as a tracer for particle flux – where a low activity of particle-reactive Th-234 (half-life: 24.1 days) relative to its conservative parent U-238 indicates particle removal on a time scale of *days to weeks*. A new tracer we have developed utilizes Y-90/Sr-90 disequilibria – where a low activity of particle-reactive Y-90 (half-life: 64 hours) relative to its conservative parent Sr-90 indicates particle removal on a time scale of *hours to days*. Here, we present data from nearshore Lake Michigan demonstrating that: (i) Th-234/U-238 disequilibrium accurately measures the net offshore flux of material from nearshore Lake Michigan and (ii) Y-90/Sr-90 disequilibrium is able to measure the rapid (temporary) removal of material from the water column by dreissenid mussels. Calculated *in situ* per capita mussel clearance rates (based on measured Y-90/Sr-90 disequilibria) range from 1.2 liters mussel^{-1} day^{-1} after a large resuspension event to 7.3 liters mussel^{-1} day^{-1} and fall within rates measured in laboratory settings.

WARREN, G.J., HORVATIN, P.J., and OSANTOWSKI, E., U.S. Environmental Protection Agency, Great Lakes National Program Office, 77 W Jackson Blvd, G-17J Chicago, IL 60604.

Long-term and Short-term Trends in Lake Michigan Offshore Nutrients and Water Quality

Offshore monitoring of Lake Michigan nutrient levels and water quality parameters is part of the long term monitoring program at U.S. EPA, Great Lakes Nation al Program Office. The surveys to measure these parameters have run on a regular basis since 1983. The data that will be discussed are mainly from the spring surveys which begin on or around April 1 every year. There are significant trends on many of the measured parameters over the twenty-seven year monitoring period. Decreases have occurred in phosphorus and alkalinity, while there have been increases in nitrate+nitrite, silica, chlorice and specific conductance. Changes in nutrients, especially soluble reactive silica and total and particulate phosphorus have accelerated since the early 2000s and may be related to invasive dreissenid mussels.

WARREN, G.J.[1], MAY, J.[2], HORVATIN, P.J.[1], ADAMS, J.M.[3], HINCHEY, E.K.[3], [1]U.S. Environmental Protection Agency, Great Lakes National Program Office, 77 W Jackson Blvd, G-17J, Chicago, IL 60604; [2]Federal Occupational Health, 536 S Clark St, Chicago, IL 60606; [3]Illinois-Indiana Sea Grant College Program, Purdue University, U.S. Environmental Protection Agency, Great Lakes National Program Office, Chicago, IL 60604.

U.S. EPA Great Lakes National Program Office Nearshore Monitoring of Lake Michigan using the Triaxus Towed Instrument Platform

Nearshore monitoring is an important factor in assessing the ecosystem health of the Great Lakes, but it often presents a challenge due to the limited availability of research vessels and difficulty in surveying the extensive (>10,000 miles) shoreline. The U.S. EPA Great Lakes National Program Office (GLNPO) recently acquired a Triaxus 3D towed undulating vehicle that is being deployed from the *R/V Lake Guardian* in all five Great Lakes. A nearshore survey of Lake Michigan will be completed in mid-September following the 20 m depth contour. The Triaxus sensors will provide date that allow insights into the water quality, biological and habitat characteristics of the nearshore. The Triaxus will also be used to supplement the GLNPO open water surveys. Details of the Triaxus specifications, the various sensors it carries, and preliminary results from the 2009 nearshore survey will be presented.

WATERMOLEN, DREUX J., Bureau of Science Services, Wisconsin Department of Natural Resources, P.O. Box 7921, Madison, WI 53707-7921.

The Evolution of Decision Support Systems and Their Applications for Watershed Management

The development of decision support systems (DSS) has drawn on knowledge and theory from disparate disciplines. In the early 1960s, researchers began investigating the use of computerized, quantitative models to aid planning and decision making. Not long after, business journals began publishing articles on information systems for semi-structured and unstructured decisions and the term "decision support systems" arose. Theoretical studies of organizational decision making and technical work on interactive computer applications provided a foundation, and researchers identified preliminary design criteria for these models and systems: robustness, ease of control/use, simplicity/intuitiveness, and completeness of relevant data. The resulting tools span a continuum ranging from data-oriented query and retrieval tools to model-oriented simulations, and address personal, group, and organizational decisions. Artificial intelligence, expert system, and geographic information system (GIS) technologies have broadened the applicability of these tools to areas of environmental focus, including watershed management. The Worldwide Web, global Internet, and related network and communications technologies now provide a platform for further extending the capabilities and deployment of DSS. Although the history of DSS is neither linear nor orderly, it provides both a record of the ideas and actions that have advanced DSS theory and practice, and a guide for future activity as concepts and technologies continue evolving. DSS research, development, implementation, and evaluation will exploit technological advances and use faster, real-time access to larger and more integrated databases and "open source" applications. The field of DSS science will become more rigorous, accountable, and clearly delineated.

WEBER, NATHAN C.[1] and HUTCHENS, JAMES[2], [1]Project Engineer, [2]Senior Project Manager, RMT, Inc., 150 N Patrick Blvd, Ste 180, Brookfield, WI 53045.

Sediment Remediation Technical Update

After decades of costly studies and implementation of expensive remedies that too often failed, sediment remediation is finally being addressed with clear scientific and engineering principals that offer hope of successful solutions for decades old sites. Recent experiences applying USEPA's 2005 guidance have resulted in better understanding of the problems as well as creating adaptive solutions that integrate in-field observations as part of an evolving remedy. As evidence today, an impressive list of contaminated sediment sites, that languished for years without decisions, have finally come to action. The engine behind the action at these sites was assisted by several critical technical components that have been developed, primarily, at the federal level. This presentation will focus on presenting these components and summarize where additional information is needed. The components include USEPA finalizing the Contaminated Sediment Remediation Guidance for Hazardous Waste Sites in December of 2005 that stresses the importance of utilizing site conceptual models and employing source control. This guidance also supports multi-component remedies and adaptive management strategies that utilize multiple technologies and sequencing on a single site. Thus recent remedy selections acknowledge that a single technology may not be the best answer. In addition, important technical information has been learned regarding the differences between
navigational and environmental dredging, new cap technologies have emerged and there is better understanding and guidance regarding the assessment and effectiveness of monitored natural recovery remedies.

WELCH, LYMAN C., Water Quality Program, Alliance for the Great Lakes, 17 N State St, Ste 1390, Chicago, IL 60602.

Volunteer Beach Sanitary Survey Water Quality Data Collection at Great Lakes Beaches through Adopt-a-Beach™

Through the Adopt-a-Beach™ program of the Alliance for the Great Lakes, over 7,000 volunteers collect data and trash at over 200 beaches in five states around the Great Lakes using forms aligned with EPA's beach sanitary survey forms. The Alliance for the Great Lakes uses the data collected by its volunteers to identify and communicate how pathogens may be entering recreational waters of the Great Lakes. Beyond identifying the sources of pollution, the Alliance is providing the tools and resources to begin addressing them. This presentation will cover: (1) Who is the Alliance for the Great Lakes; (2) Adopt-a-Beach™ and the volunteer sanitary beach survey; (3) our new online data entry system for volunteers; and (4) how volunteer beach survey data is shared with local and state agencies. Headquartered in Chicago, the Alliance for the Great Lakes is the oldest citizens' Great Lakes protection organization in North America. Its mission is to conserve and restore the world's largest freshwater resource using policy, education and local efforts, ensuring a healthy Great Lakes and clean water for generations of people and wildlife.

WILUSZ, ED, Wisconsin Paper Council, 250 N. Green Bay Rd, Neenah, WI 54956.

Industrial Water Users Perspective on Great Lakes Compact Implementation

The Great Lakes Water Resources Compact creates a comprehensive regulatory system for water withdrawal in the Great Lakes basin. From the perspective of water using industries, this regulatory system should assure continued access to the resource by existing water users, consistent with the Compact's environmental goals, and provide a clear and reasonable framework for new water users. It should not place unnecessary burdens on existing water users nor create disincentives for responsible new users. Among the Compact implementation issues of most interest to industrial water users are recordkeeping and reporting, conservation requirements, determinations of consumptive use, application of the decision-making standard, and authority of the Regional Body. This presentation will provide a brief overview of why these issues are important to industrial water users and what specific issues may raise concerns.

WIRE, DON[1], EGGERDING, RICK[1], MEADOWS, GUY[2], and PURCELL, HEIDI[2], [1]Tiara Yachts a Division of S2 Yachts, 725 East 40th St, Holland, MI 49423-5392; [2]University of Michigan, Marine Hydrodynamics Laboratories, 1085 S University, Ann Arbor, MI 48109-1107.

The TIDAS 900 Series the Design of an Environmental Monitoring Buoy for Great Lakes Coastal Applications

In an effort to provide a low cost solution for environmental monitoring on the Great Lakes and Coastal Oceans, S2 Yachts has teamed up with The University of Michigan in the design and manufacture of the TDAS coastal monitoring buoy. Striving for "Operational Efficiency" led the University of Michigan to join forces with S2 to design a monitoring platform that could be built and maintained for a fraction of the cost of most commercial buoys on the market today. The goal was not only low acquisition cost, but also low costs for maintenance (deployment, extraction, and servicing). The TIDAS (Total Integrated Data Acquisition System) is designed for ease of deployment and extraction on a single point mooring. The buoy is a compact single unit that does not require a large vessel for deployment and extraction making it possible for organizations without access to these large vessels to maintain a monitoring buoy. The buoy is designed as a "plug and play" platform, giving the user significant flexibility in measured parameters and making it possible to add sensors as funding and research permits. It contains a data logger as well as a telemetry system for transmission of real time data via radio, cellular, or WiFi technology. The TIDAS also carries a directional inertial wave sensor designed by the University of Michigan that satisfies the "First-5" standard as defined in the IOOS National Operational Wave Observation Plan. This makes the buoy suitable for use in the IOOS surface-wave monitoring network for the United States once it is implemented. The low initial cost, low maintenance cost, and high quality monitoring capabilities make the TIDAS buoy an essential tool for monitoring the health of the Great Lakes' Ecosystems.

WITTENBERG, ROY E. and ZIMDARS, JULIE A., Natural Resource Technology, Inc., 23713 W Paul Rd, Ste D, Pewaukee, WI 53072.

Blatz Pavilion/Milwaukee River PCB-Contaminated Sediment Remediation, Milwaukee, Wisconsin

The Blatz Pavilion, located on the Milwaukee River, represents an historic Milwaukee structure and community asset located within Lincoln Park and directly upstream of Estabrook Park. Sediment within the embayment adjacent to the Blatz Pavilion was contaminated with polychlorinated biphenyls (PCBs) from unidentified historic releases. Directed by the Wisconsin Department of Natural Resources using state funds, the embayment was the first section of the Estabrook Impoundment/Milwaukee River to be remediated. The embayment was selected first because it contained the highest concentration of PCBs in the Estabrook Impoundment.

Natural Resource Technology, Inc. was contracted by the Department to evaluate remedial options to meet applicable regulatory requirements and risk-based remedial action goals protective of human health and the environment. Based on a review of several technologies, removal and landfilling of approximately 4,700 cubic yards was selected based on long-term effectiveness and implementability, limited requirements for institutional controls, and lower cost when compared to other in-situ or ex-situ treatment technologies.

Remedial action was implemented during spring/early summer 2008, when the Estabrook Dam was open and the sediment in the embayment was exposed and dewatered. Excavation in the “dry” was conducted by dividing the embayment into cells and removing the sediment in layers containing less than and greater than 50 mg/kg PCBs from each cell for off-site disposal. Each cell was restored before proceeding to the next to limit the exposed area. Segregation of PCB contaminated layers was accomplished using a portable high-accuracy global positioning system (GPS) to target layers at predefined elevations. A remedial action goal of 1 mg/kg PCBs was established based on a screening level risk assessment using the

consensus based sediment quality guidelines (CBSQGs) and consistency with goals established at other PCB sediment sites in Wisconsin. Following removal, the embayment was restored with granular fill for future recreational use.

YASVINSKI, GORDON, Health Canada, Water, Air and Climate Change Bureau, 269 Laurier Ave W 3rd Floor, AL 4903D, Ottawa, ON K1A 0K9.

Update of the *Guidelines for Canadian Recreational Water Quality* – Highlights and Status

Health Canada is in the process of updating its *Guidelines for Canadian Recreational Water Quality*. As the steward for these Guidelines, Health Canada has worked closely with the provinces and territories to develop recommendations that represent the needs specific to Canada, with the goal of protecting the health and safety of Canadians These Guidelines are designed to provide guidance, information and tools which can be used by the provinces, territories and other jurisdictions as a basis for developing their own policies and actions.

The Guidelines provide information on managing recreational waters in Part I, while Part II contains technical information on the hazards that can be encountered in Canadian recreational waters.

At the heart of the management information is the proposal for a preventive, comprehensive management strategy. This is consistent with the direction currently being taken by many jurisdictions worldwide. A "multi-barrier" approach - a system of actions, guideline values, policies and communication strategies to identify, mitigate and reduce human exposure to hazards – is recommended. Guideline values represent but one important part of an overall strategy for risk management.

Indicators of fecal contamination (*E. coli* for fresh water, enterococci for marine water) and their respective guideline values have been reaffirmed as the recommended approach for fecal monitoring. New material in the updated document includes guideline values for cyanobacteria and their toxins, and for fecal contamination in areas with secondary contact activities. Information is also provided on topics of emerging interest such as Swimmer's Itch, beach sand and fecal source tracking.

This is the first update of this document since the 1992 publication of the second edition. The draft Guidelines will soon be posted for a period of public consultation, and the comments gathered will be evaluated in preparation for the publishing of the final document.

YERMAKOV, ZHANNA, Dept. of Natural Resources, Chicago Park District, 541 N Fairbanks, Chicago, IL 60611.

Chicago Lakefront Dune Restoration

The Chicago Park District owns and manages over 7800 acres of land in Chicago, including 26 miles of recreational beaches and waters along the Lake Michigan shoreline. Even though the Chicago shoreline has been completely reconstructed, one third of our beaches have a natural areas component: areas where native plants and endangered species thrive, and migratory shoreline birds find refuge. This talk will summarize what we have learned from our other beach and dune nature areas and how the Chicago Park District is transforming 10 acres of barren beach sand at 63rd St Beach into an ecologically rich habitat.

ZEPP, R.[1], CYTERSKI, M.[1], WHITE, E.[1], MOLINA, M.[1], WOLFE, K.[1], OLSEN, L.[2], WONG, J.[2], ZHANG, S.[2], HUNTER, S.[2], DUVALL, E.[2], VARNER, J.[2], PADDOCK, R.[3], MUELLER-SPITZ, S.[3], MCLELLAN, S.[3]; and BRUESCH, M.[4], [1]US EPA, NERL/ERD, Athens GA 30605; [2]Student Services Associate US EPA, NERL/ERD, Athens GA 30605; [3]Great Lakes WATER Institute, U. Wisconsin, Milwaukee WI; [4]City of Milwaukee, Milwaukee WI.

Empirical Modeling of Fecal Indicator Bacteria, Enterococci and *E. coli*, at South Shore Beach, Milwaukee

Empirical models that predict fecal indicator levels are increasingly being used as decision support tools at Great Lakes beaches. Hydrometeorological and biogeochemical data were used to develop empirical models for enterococci (culturable and qPCR) and culturable *E. coli* at South Shore Beach in Milwaukee, Wisconsin. *E. coli* data for summer 2006-2008 were provided by the City of Milwaukee and enterococci data for summer 2008 were measured by ERG, Inc. and EPA, Athens GA. A primary objective of this research was to compare and contrast the effectiveness of models developed using a variety of available datasets for this site: (1) NOAA meteorological data from General Mitchell International Airport located about three miles southwest of the site and weather stations located at the site and two miles north of the site; (2) water quality data from sonde monitors located at the north and south ends of the beach; (3) underwater spectral UV data for 2008 obtained by automated sensors at the beach; (4) acoustic doppler current profile data for 2008 measured at the north end of the beach; (5) UV-visible and dissolved organic carbon data for 2008. The second objective was to compare *E. coli,* culturable enterococci, and enterococci qPCR measurements for water samples that were taken at approximately the same date and time in the summer of 2008 to determine the relationship among the three indicators.

ZHANG, XIAOCHUN[1], and BURZYNSKI, MARSHA[2], Wisconsin Department of Natural Resources, [1]101 S Webster St, PO Box 7921, Madison, WI 53707-7921; [2]Southeast Region.

Overview of the Kinnickinnic River Sediment Remediation Project: Phase I to Phase III

The Kinnickinnic River Sediment Remediation project started in 2001 and was realized in 2009. The primary objectives of the project are to improve water quality in the area and to reduce transport of contaminated sediment from the project area to Lake Michigan by removing up to 170,000 cubic yards of sediment contaminated with polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and heavy metals. The project was carried out in five phases. This presentation will cover an overview of the project from Phase I through III. During these three phases, the project area was defined, the extent of contamination was assessed, remedial actions were evaluated, and an engineering design for removal was completed. Upon completion of Phase III and with some overlap, Phases IV and V have been carried out under the Great Lakes Legacy Act. Over the course of the early three phases, a cooperative partnership has been established among federal and local government agencies and riparian property owners adjacent to the project area. Key partners include USEPA-GLNPO, US Army Corps of Engineers, Port of Milwaukee, Milwaukee Metropolitan Sewerage District, and Kinnickinnic River Business Improvement District #35, and Wisconsin Department of Natural Resources. The effective collaboration among partners and integration of science with management policies are important factors in making a remedial decision and having a successful project for an urban river, such as the Kinnickinnic River.

BARRETT, KATE[1] and SULLIVAN, JERRY[2], [1]Office of the Great Lakes, WI Department of Natural Resources, PO Box 7921, Madison, WI 53707-7921; [2]Science Services Section, WI Department of Natural Resources, PO Box 7921, Madison, WI 53707-7921.

The Challenges of Data Discovery for Basin Wide Assessment

The Great Lakes Regional Collaboration calls for a more coordinated approach to restoration and protection of the Great Lakes. Environmental indicators are a way to measure successful implementation of the GLRC. Yet often data collection and data storage are done independent of other programs, making it difficult to perform assessment or evaluation for an entire basin. The Indicators and Information Strategy Team of the GLRC identified many of the problems associated with true data integration. Data discovery alone can be a major hurdle. Users must determine the geographic extent of the data, whether the projection and coordinate system has been properly documented, and if data formats and classification systems used are compatible with other data. This poster will highlight the challenges of pulling together data to address specific goals articulated in the Wisconsin Great Lakes Restoration and Protection Strategy.

CALI, SALVATORE, DAS, D., PIATEK, J., LOPEZ, R., DOREVITCH, S., and SCHEFF, P., University of Illinois at Chicago, School of Public Health, Environmental and Occupational Health Sciences Division, 2121 W Taylor St, Chicago, IL 60612-7260.

Development of Method and Preliminary Field Results for Measurements of Skin Exposure during Secondary Water Contact Recreation

The Chicago Health, Environmental Exposure, and Recreation Study (CHEERS) is an epidemiological study conducted by the University of Illinois at Chicago School of Public Health (UIC SPH) to investigate the health risks of engaging in recreational, secondary water contact activities along Chicago rivers and lakes. In order to support the health assessment, several exposure assessment sub-studies are being performed to estimate dermal, ingestion and inhalation exposure to water and mist.

We developed a method for estimating skin exposure to water during secondary water contact recreation activities such as canoeing and kayaking. The method quantifies the volume of water that contacts targeted areas of the body using fecal indicator bacteria as a tracer. The exposure is expected to consist primarily of transitory water splashes on the body and face. A literature search indicated that most research on skin contact to microorganisms, especially on hands, had been investigated in health care settings, and the methods used would not answer the research questions of concern to this study.

Laboratory experiments demonstrated that small sterile sponges inoculated with live water quality indicator organisms could retain organism viability for at least four hours. The recovery fraction was quantified and is approximately 60-70% for the four-hour period. The exposure evaluation method that grew out of the laboratory findings utilizes sponges placed adjacent to skin as personal exposure monitors for recreational water at locations with relatively high indicator microbe densities. Field samples are being collected during the summer of 2009. After field sampling, the number of organisms on the sponges will be compared to the organism concentrations in the recreational waters to estimate the volume of water splashing to the target areas of the skin. This presentation describes the preliminary laboratory and field evaluation results of this exposure assessment.

BUSCH, MICHAELA.[1], FROHNE, NATHAN[1], HUG, KRYSTAL[1], RINK, ELIZABETH[2], MCDERMOTT, C.[1], KLEINHEINZ, G.[1], [1]UW-Oshkosh and [2]Lake Superior State University.

Comparison of Two Analytical Methods, Defined Substrate and Petrifilm^{R}, for Detection of *E. coli* Concentrations in Beach Water in Door County, WI

Door County beaches are monitored for microbial contamination using *E. coli* as a microbial indicator. The approved methods for enumeration of the organism are defined substrate (Colilert^{R}) and membrane filtration. These methods require a substantial amount of expense equipment and are not accessible to private individuals wishing to monitor their own beach fronts. Many homeowners and lakeshore associations utilize another method for detection of *E. coli* in recreational water, Petrifilm$^{R.}$ While the method is suitable for certain applications (food industry), to our knowledge no analysis of the efficacy of the method for enumerating *E. coli* in beach water has been undertaken. This study will compare the concentration of *E. coli* enumerated from beach water by the defined substrate and Petrifilm^{R} methods. Ten beaches in Door County, WI will be analyzed for *E. coli* concentration by the two methods two days/week for eight weeks in 2009. Resultant *E. coli* concentrations will be compared and the Petrifilm^{R} method will be evaluated for determination of *E. coli* concentrations by private individuals. Preliminary results seem to indicate that the Petrifilm^{R} method underestimates *E. coli* concentrations in beach water.

BUSCH, MICHAELA, FROHNE, NATHAN, HUG, KRYSTAL, RINK, ELIZABETH, MCDERMOTT, C., and KLEINHEINZ, G., UW-Oshkosh and Lake Superior State University.

Relationship Between *E. coli* Concentrations and Beach Physical Factors at Door County, WI Beaches

Lake Michigan is a vital recreational and economic resource for communities along its shore. Door County beaches are monitored for microbial contamination using *E. coli* as a microbial indicator. There are 27 Great Lakes beaches in Door County and all have unique characteristics and factors that impact water quality. Past research in Door Country, WI has indicated that various physical factors may influence concentrations of *E. coli* present in daily beach samples. Additionally, each location may have different physical factors that influence *E. coli* concentrations in each beach's water. This study will investigate physical factors such as wave height, avian counts, wind speed, wind direction, or algal presence and their relationship to daily *E. coli* concentrations. These relationships will be important in understanding daily *E. coli* concentrations as well being useful in developing predictive models in the future.

DRISCOLL, KEVIN, P.E., URS Corporation, 6737 W Washington St, Ste 2265, West Allis, WI 53214.

Surface and Subsurface Infiltration System Designs, Construction and Maintenance Plans for the Urban Corridor along McKinley Beach at Lake Michigan

Recent studies by the Great Lakes Water Institute indicate that storm water being discharged from various Milwaukee County Beaches, including McKinley Beach Park outfalls, at times contains elevated levels of e-coli. According to Milwaukee County's NR 216 permit, approved control measures needed to be implemented in a timely fashion. In response, the Milwaukee County Environmental Services Division solicited proposals and contracted URS to evaluate numerous options, hold a public meeting and design surface and subsurface storm water treatment measures at McKinley Beach Park prior to discharging into Lake Michigan.

This presentation addresses the development of two such measures: a surface infiltration system (rain garden) and sub-surface infiltration system. The surface and subsurface storm water control measures are designed to mitigate qualitative effects that impact Lake Michigan and handle peaks flows while addressing water quality with a treatment system that is practical and economical to construct, operate and maintain.

This presentation will focus on:

1. The development and evaluation of the solutions;
2. The implementation of the solutions;
3. Their effectiveness in meeting the project's objectives;
4. Potential ancillary benefits: aesthetic, education opportunities, attractiveness of lakefront, public relations; and
5. Lessons learned.

GORMAN, WENDY[1] and CORE, ALYSSA[2], [1]Northland College; [2]Environmental Projects Coordinator for City of Ashland, Northland College, 1411 Ellis Ave, Ashland, WI 54806.

Effect of a Stormwater Outfall on *E. coli* Levels in a Small Tributary of Lake Superior

Bay City Creek is a 7-mile long stream that flows through agricultural land and residential areas in the city of Ashland, WI before draining into Lake Superior. It is a warm-water stream that receives runoff from agricultural areas as well as stormwater from the City of Ashland, and typically has high sediment load and *E. coli* levels. Little is known about the dynamics of *E. coli* in this stream or effect of stormwater outfalls into the stream. We chose a single stormwater outfall on the campus of Northland College to biweekly examine the *E. coli* levels in the outfall as well as in Bay City Creek in the fall of 2007 and 2008. We also considered prior rainfall, stream flow, and turbidity. In both years, *E. coli* levels fluctuated dramatically but fluctuations did not always correlate with a rainfall event. *E. coli* levels in the stormwater outfall were higher in both years than in the stream, but the effect of the stormwater appeared to diminish by about 0.25 km downstream. The testing of nearby catch basins in the spring of 2009 prior to a large spring rainfall indicated that the standing water in them was not a source of fecal pollution in the outfall, but that pollution subsequently contaminates the stormwater system, presumably associated with rainfall. This study illustrates the complexity of factors that contribute to high bacteria levels in stormwater and natural streams, and the need for continued long term monitoring in order to develop best management practices for stormwater systems.

HANSON, ERIN[1], RICHMOND, NICOLE[2], BAUMGART, PAUL[3], and BLAKE, LAURA[4], [1]Wisconsin Department of Natural Resources, 2984 Shawano Ave, Green Bay WI 54313; [2]Wisconsin Department of Natural Resources, Madison; [3]University of Wisconsin Green Bay; [4]The Cadmus Group, Inc.

Development of a Total Maximum Daily Load for the Lower Green Bay and Fox River Area of Concern using the SWAT Model to Estimate Phosphorus and Sediment Loads

The Lower Green Bay and Fox River Area of Concern is impaired by excessive phosphorus and sediment loads that contribute to nuisance algae growth, oxygen depletion, changes in benthic and plankton populations, and reduced water clarity which hinders underwater plant growth. The Wisconsin Department of Natural Resources is in the process of completing a total maximum daily load (TMDL) analysis of phosphorus and sediment for the Lower Fox Watershed (638 mi^2 in northeastern Wisconsin). Preliminary estimates of reductions needed to meet water quality goals in lower Green Bay are approximately 52% for total phosphorus and 56% for total suspended solids, if a 40% reduction is achieved from upstream sources at the outlet of Lake Winnebago.

A modified version of the U.S. Department of Agriculture Soil and Water Assessment Tool (SWAT) is being used to quantify major sources of phosphorus and suspended sediment loads within the Lower Fox watershed for the TMDL. Preliminary estimates of current phosphorus loads in the Lower Fox (approximately 239,000 kg/year) are almost equally distributed between agriculture (44%) and point sources (38%) with additional contributions from urban runoff (9%), barnyards, construction sites, and other nonpoint sources (each at 3%). Furthermore, approximately half of the phosphorus load is in the dissolved form, which has implications for selecting effective farm management practices to reduce phosphorus loading to streams. For total suspended solids, preliminary estimates of current loads in the Lower Fox (approximately 58,000 mt/year) are dominated by agriculture (63%), followed by urban runoff (19%), construction sites (10%), point sources (5%), and other nonpoint sources (3%). The SWAT model will also be used to predict the outcome of optimal combinations of phosphorus and suspended sediment control strategies for TMDL implementation planning.

HANSON, NICHOLAS B. and DOREVITCH, SAMUEL, Department of Epidemiology and Biostatistics, University of Illinois at Chicago, School of Public Health, 2121 W Taylor St, Chicago, IL. 60612.

CHEERS: Chicago Health, Environmental Exposure, and Recreation Study. A Spatial Overview and Analysis of Preliminary Data Using GIS.

Recreational use of the Chicago Area Waterways System (CAWS) and Lake Michigan is popular, but little is known about how pollutant sources and other variables relate to health risk. The University of Illinois at Chicago is conducting an epidemiologic study of health risk of limited contact water recreation on Lake Michigan and local inland water. By utilizing a geographic information system (GIS) we have been able to better understand our water quality and participant data. Water quality, and recreational activity vary significantly by location. By mapping our data we have been able to spatially investigate microbial measures of water quality. GIS is helping us further explore our data and provide possible reasons for these findings. Distance of water sampling and recreation locations to water reclamation plants and combined sewer overflows (CSO) along the CAWs could be significant. It is likely that land use is another contributing factor to water quality, which is why we are using GIS to identify all possible sources of contamination. Spatial mapping of where study participants live provides information about socioeconomic status, an important variable to consider in studies of health outcomes. Not only do we hope to identify possible contributing factors with GIS but also utilize its statistical functions. GIS will allow us to perform spatial regression techniques and account for geographic features and spatial autocorrelation.

HUBBARTT, ANNA[1], BUSSE, KIM[2], ABLER, R.[1], HEIN, R.[1], MCDERMOTT, C.[2], and KLEINHEINZ, G.[2], [1]UW-Manitowoc; [2]UW-Oshkosh.

Relationship Between *E. coli* Concentrations and Beach Physical Parameters in Manitowoc County, WI (Lake Michigan)

Lake Michigan is a vital recreational and economic resource for communities along its shore. Manitowoc County beaches are monitored for microbial contamination using *E. coli* as a microbial indicator. There are 7 monitored Great Lakes beaches in Manitowoc County, WI and the number of beach days with advisories or closure has historically been higher than in similar, surrounding Lake Michigan counties. Little research has been done in Manitowoc County to determine sources of microbial contamination or physical factors that may influence concentrations of *E. coli* present in daily beach samples. This study will investigate physical factors such as wave height, avian counts, wind speed, wind direction, or algal presence and their relationship to daily *E. coli* concentrations (2008 and 2009). These relationships will be important in understanding daily *E. coli* concentrations as well being useful in developing predictive models in the future.

KOSLOW, MELINDA, Regional Campaign Manager, National Wildlife Federation, 213 West Liberty St, Ste 200, Ann Arbor, MI, 48014-1398.

Unequivocal Climate Change: How do we Communicate, Plan, and Make Decisions Regarding Adaptation of Lake Michigan?

The current atmospheric CO2 concentration is such that surface air temperatures will continue to warm by 1.6ºF or 0.9ºC globally by 2100 even without a reduction of emissions (*IPCC* 2007). Impacts of this warming on the Great Lakes region will include changes in precipitation patterns and lake levels, food web disruptions, water quality issues, and damage to shoreline infrastructure. Integrated decision making between stakeholders throughout the Great Lakes is needed to address these complex regional issues in an effective manner, and to prevent unnecessary costs. The action of climate change adaptation is to design initiatives and measures that reduce the vulnerability of natural and human systems against actual or expected climate change effects. This process of Great Lakes adaptation will include mechanisms that facilitate the involvement of individuals, groups and organizations related to climate change planning and decision making in the region. Additionally, the process will include the tools for communication, whether verbal or visual, in order to pursue further collaboration that will help spur effective policy.

MACCOUX, MATT J.[1], SCHMITT MARQUEZ, HEIDI S.[1], DOLAN, DAVID M.[2], MCGUNAGLE, KEVIN P.[3], QUALLS, THERESA M.[4], and ESLINGER, LAWRENCE D.[1], [1]University of Wisconsin-Green Bay, Environmental Science and Policy Program, 2420 Nicolet Dr., Green Bay, WI, 54311, [2]University of Wisconsin-Green Bay, Natural and Applied Sciences; [3]Farmington, MI; [4]University of Wisconsin-Green Bay, UW Sea Grant Institute.

Point Source Loadings of Phosphorus to Lake Michigan: 1993 – 2008

Monitoring and controlling phosphorus inputs to the Great Lakes became a priority after the Great Lakes Water Quality Agreement was signed in 1972. Since then, concentrated efforts have taken place to determine whether industrial and municipal point sources are contributing to phosphorus loads in excess of the targets. Tracking of these sources was a priority up to the early 1990s and must now be updated in order to allow continued monitoring of the Great Lakes ecosystem. The current project, updating point source phosphorus loads through the present, is just one part of a larger grant from EPA-GLNPO to update nutrient loadings to all of the Great Lakes. Data are provided on a monthly basis when available as reported by each facility that discharges to the lakes or their tributaries by each state in the basin. The data are obtained from the Environmental Protection Agency's Permit Compliance System (PCS) and the Integrated Compliance Information System (ICIS) and converted into text (alpha) files, which are then analyzed for errors and missing or redundant data using a SAS QA/QC program developed at EPA in the 1980s. While Lake Michigan is the subject of this poster, the same procedures will be followed to update all Lakes' point source loading data. The largest contributors of phosphorus have been identified and compared with one another over the 15-year period of the study to identify trends in loading and to determine what fraction of the total lake load is due to point sources.

MANCHIRALA, SREENIVAS, Yerram, S., Kleinheinz, G., Pillsbury, R., and McDermott, C., UW-Oshkosh.

Production of Mathematical Models to Predict *E. coli* Concentrations Based on Physical Parameters at Door County, WI Beaches

The traditional methods to quantitatively determine *Escherichia coli* concentrations in beach water are the membrane filtration and defined substrate methods. These methods take 18-24 hours for enumeration of *E. coli* concentrations. This may result in improper beach closures and openings, as authorities base their decisions on previous day *E. coli* concentrations. To overcome these problems, mathematical models were developed using the data collected from Door County beaches in the 2007 & 2008 swimming season, to predict the *E. coli* concentrations using various explanatory variables. Mathematical models were developed using the USEPA "Virtual Beach" software, an application that uses the multiple linear regressions. Explanatory variables that were included in the predictive models were unique for each beach and often for each year. Overall, it was concluded that predictive models should be beach specific and that combination of years of data does not necessarily result in more robust mathematical models, due to annual changes in swim season physical parameters.

MCNINCH, RACHEL M. and DREELIN, ERIN A., Michigan State University Center for Water Sciences, 1405 S Harrison Rd, Ste 301, Manly Miles Building, East Lansing MI, 48824.

Comparing Land Use Surrounding 64 Michigan Beaches of Interest at Different Watershed

In conjunction with the Michigan Department of Environmental Quality (DEQ), the Center for Water Sciences (CWS) at Michigan State University has been working to analyze trends in the State's *Escherichia coli* (*E. coli*) database compiled from recreational beach monitoring. 64 beaches have each been assigned an Annapolis Protocol (AP) class (5 class levels ranging from A being 'good' to E being 'poor'; WHO 1999) based on previous statistical analysis conducted by the CWS. These 64 beach sites were analyzed using ArcGIS software to determine the percent of different land cover classes within the surrounding watershed at three scales: 1) entire watershed (HUC12), 2) 1km contributing area upstream of site, and 3) 5 km contributing area upstream of site. Land use was analyzed at each scale for the entire watershed/contributing area as well as for 50 and 125 meter buffered sections around rivers and streams within each area. A difference in the land use is noticeable between AP classes. The 1km contributing area indicates that 'good' beach sites have a high percentage of wetlands and 'poor' beach sites have a high percentage of urban land use. This trend, however, is not noticeable at the watershed scale, making it evident that scale is an important factor when conducting land use analysis in regard to beach sites. Not all 64 beaches lie within areas contained within the hydrology data layer, thus preventing a thorough analysis of the contributing surface water areas. As 61 of these beaches are located on one of the Great Lakes, it is likely the driving factor of *E. coli* concentrations is not only contributing surface waters but wind and water currents as well. In our continued analysis, we are looking into buffer options that may more accurately depict the scale most relevant for investigating pollution sources at beach sites.

MORRISON, SANDRA S.[1], CORSI, STEVEN R.[2], FRANCY, DONNA S.[3], HAACK, SHERIDAN K.[4], WHITMAN, RICHARD L.[5], MORRIS, JAMES R.[3], and GRANNEMANN, NORMAN G.[4], [1]USGS Great Lakes Science Center, 1451 Green Rd, Ann Arbor, MI 48105; [2]USGS Wisconsin Water Science Center; [3]USGS Ohio Water Science Center; [4]USGS Michigan Water Science Center; [5]USGS Great Lakes Science Center, Lake Michigan Ecological Research Station.

USGS Beach Health Research Progress: Ocean Research Priorities Plan (ORPP) Project

USGS received ORPP funding in 2008 and 2009 (potentially through 2012) to address a number of high priority recreational water quality issues in the Great Lakes. Research is focusing on data analysis/interpretation, real-time assessments, pathogens at beaches, and coastal processes. Scientists from the USGS Michigan, Ohio, and Wisconsin Water Science Centers and the Great Lakes Science Center have developed a strategy for the project that integrates their unique capabilities, builds on extensive knowledge and experience, and expands collaborative efforts with partners to apply the best possible science to meet the research needs of beach managers and other stakeholders. This poster presentation highlights key accomplishments, how this research will benefit beach managers and the public, and goals for the future.

PANAS, ALICIA, LEMBCKE, ANNA, KACHUR, REYNEE, GORMAN, WENDY, MCDERMOTT, C., and KLEINHEINZ, G., UW-Oshkosh and Northland College.

Beach Monitoring for *E.coli* along Wisconsin's Lake Superior Shoreline

Lake Superior is one of the largest sources of fresh water in the world and a vital recreational resource for those communities along its shore. Funding provided by the BEACH Act allows the United States Environmental Protection Agency (USEPA) to monitor the quality of water at beaches located on Lake Superior. There are 39 beaches that are monitored in Ashland, Bayfield, Douglas, and Iron Counties, Wisconsin. Thirty-four are sampled once a week and five are sampled twice a week due to a greater number of beach users. Generally, water quality is excellent at Lake Superior beaches. Historically, however, rain events and particular period of the swimming season have resulted in beach closures. Further investigation has revealed some possible sources of contamination, while the source of many elevated *E. coli* events remains a mystery. This study continues to look at *E. coli* concentrations from Lake Superior beaches for the 2009 season and to investigate sources of microbial contamination of beach water through measurement of physical beach and weather parameters.

QUALLS, THERESA[1], HARRIS, VICTORIA[1], and HARRIS, H.J[2], [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 Lower Green Bay: An Environmental Report Card on the Status and Trends of Environmental Indicators

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 beneficial uses. 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.

The Green Bay Metropolitan Sewerage District (GBMSD) initiated a long term water quality monitoring program with stations along the trophic gradient in lower Green Bay and the Fox River. This data set was analyzed to determine the status and trends for several trophic state indicators including total phosphorus, chlorophyll *a*, total suspended solids and Secchi depth. The Lower Green Bay and Fox River AOC still does not meet any of the targets set for these indicators in the 1993 lower Green Bay and Fox River Remedial Action Plan.

Biological indicators include aquatic invasive species, benthic macroinvertebrates, coastal wetlands, fish populations, and colonial nesting birds. The status and trend assessments for the biological indicators are variable. Several fish species in lower Green Bay received a "good" status assessment, whereas aquatic invasive species received a "poor" status assessment. Other indicators analyzed in the report include recreational use indicators, such as the number of fishing licenses and boating registrations sold in coastal counties, and the number of beach closings.

Based on the status and long-term trend assessments, the state of Lower Green Bay is mixed. Water quality in the AOC has not improved over time, but 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 response to remedial actions.

REYNOLDS, SCOTT D., Tetra Tech, 1921 E Miller Rd, Ste A, Lansing , MI 48911.

The Dog Days of Summer – The Use of Scent Trained Canines for Illicit Discharge Detection in Municipal Storm Sewer Systems

In December of 2006 Tetra Tech began developing the idea to train a dog to locate illicit connections to municipal storm sewer systems. Based on the most common illicit discharges, it was decided that raw human sewage and detergents (surfactants) would be the focus of the dog's training. To our knowledge this has never been attempted.

Training began in early April of 2007. Sable, a 15 month old male German Shepherd mix, was selected as a candidate for the training and purchased from a no-kill shelter in Michigan. Over the next 3 months Sable underwent extensive training with target scent and scent discrimination exercises in various terrain and environments. He was taught to alert by barking when a target scent was located.

Sable hit the ground running in late July and began live field trials in a county in eastern Michigan. Tetra Tech IDEP field crews were conducting investigations on the counties storm sewer systems. Sable was taken to various locations over a three week period where know illicit connections existed and had been verified by laboratory analysis.

He is now taken in the field during IDEP investigations and taken to outfalls, manholes, and catch basins where the status of an illicit connection is not known. When dry weather flow is located Sable inspects the outfall or structure. Based on his alert (or lack of) various information is recorded and water samples taken. When laboratory analysis is completed the results are compared to his previous alert.

Data analysis of the 2007-2008 field seasons showed that Sable gave the correct response 83% of the time when compared to traditional lab tests for *E. coli*, ammonia, and surfactants. Microbial source tracking is in the works and soon Sable's responses will be compared to the presence or absence of human source bacteria.

ROCKWELL, DAVID C.[1], SCHWAB, DAVID J.[2] and JOSEPH, SONIA[3], [1]Center of Excellence for Great Lakes and Human Health (CEGLHH), Cooperative Institute for Limnology and Ecosystems Research U. of Michigan, 755 Raintree Dr, Naperville, Il, 60540-6311; [2]NOAA's Great Lakes Environmental Research Laboratory, 4840 S State Rd, Ann Arbor, MI 48108; [3]Michigan Sea Grant Outreach Coordinator, Center of Excellence for Great Lakes and Human Health (CEGLHH), NOAA Great Lakes Environmental Research Laboratory, 4840 S State Rd, Ann Arbor, MI 48108.

Beach Water Quality Forecasting in the Great Lakes
Using Ocean Observing Systems to Predict Public Health Issues

The best current methods for assessing recreational water quality are based on nowcast models using the concentration of *E. coli* a measurement involving incubation over at least 18 hours. These models reduce occurrences where people unintentionally swim in contaminated water as well as lost revenues from unnecessary swimming restrictions. Contamination by bacteria, viruses and protozoa in recreational waters is a health risk and having timely accurate forecasts of water quality is critical to protect human health against adverse exposure situations. NOAA's Center of Excellence for Great Lakes and Human Health is developing and testing new models incorporating 48-hour forecasts into beach nowcast models. Recent developments in operational Ocean Observing Systems in the Great Lakes allow parameters such as rainfall, wind direction, wind velocity and lake currents to be used to predict *E. coli* levels at the beach. These models link the parameters that impact water-borne pathogens and provide swimming safety probabilities so individuals are better informed about contaminated water risk factors. The goal of the 48-hour forecast model is to provide the public with the likelihood for swimming at modeled beaches. This service will be relevant because the swimming public can plan where to recreate several days in advance.

SILVA, MARCIA, VANDEWALLE, JESSICA, BOOTSMA, MELINDA, and MCLELLAN, SANDRA, Great Lakes WATER Institute, University of Wisconsin-Milwaukee- 600 E Greenfield Ave, Milwaukee, WI 53204-2944.

Impact of Heavy Rains and Combined Sewer Overflows at Bradford Beach and Atwater Beach, Milwaukee, WI

Bradford Beach and Atwater Beach are two popular beaches in Milwaukee. E*scherichia coli* and *Enterococci* distribution were assessed following heavy rains and combined sewer overflow (CSO) events, including an 8-day period following 22.9 cm of rainfall in 2008 and a 2-day period following 9.6 cm of rainfall in 2009. *E. coli* and *Enterococci* levels at the two beaches following SSO and CSO events reached 10^4 CFU/100 ml in the first two days of the event, reducing to less than 320 CFU/ml after the third day. These bacteria densities were similar to days when there were heavy rain events, and were significantly higher than levels following light rainfall. It was observed that turbidity increased with storm events and usually followed same trend of bacteria levels. However, turbidity was not found to be directly proportional to bacteria levels. There are other factors impacting turbidity, such as presence of cladophora and resuspension events.

Human sources of fecal pollution were evaluated using the human *Bacteroidales* marker. From 41 beach water samples collected at Atwater Beach, none was positive during CSO events, and only one was found positive during a heavy rainfall event, which may correspond to discharges from two stormwater outfalls upstream of the beach that are consistently positive for human specific *Bacteroidales*, which is evidence that the stormwater is contaminated with sewage. For the 56 beach water samples collected at Bradford Beach and tested for *Bacteroidales,* 13 were found positive, all of them during CSO events. At the same time, some stormwater outfalls at the beach were found positive for this sewage indicator. Therefore, it is unclear if the source was from CSO delivery nearshore or from stormwater outfalls contaminated with sewage. These results demonstrate that sewage contamination of beaches is a serious concern with and without recognized CSO events.

SULLIVAN, JERRY, GIS Project Manager, Wisconsin Department of Natural Resources, Bureau of Science Services, 101 S Webster St, SS/7, Madison, WI 53707-7921.

Integrating Web Mapping Services and Local Geospatial Data for Watershed Planning

Watershed Planning requires integration of diverse geospatial data that rarely lies within a single jurisdiction. This poster offers a framework for integrating **web mapping services** and **local geospatial data** applicable to watershed planning. It reviews the state of Arc Internet Map Server, ArcGIS Server, MapGuide, MapServer, and Open Geospatial Consortium (OGC) Web Mapping Services (WMS) and Web Feature Services (WFS) to support local watershed planning in the Lake Michigan Basin. Reviewed sites include local, county, regional planning commission, state agency (WI, MI, IL, IN), federal agency (USGS, EPA, NOAA, USFWS, NRCS, FSA), university, and nonprofit sources.

Sites are characterized as publically accessible via a browser (Internet Explorer, Firefox), a free desktop application (ESRI ArcGIS Explorer suite), an open source client (Quantum GIS), or a professional desktop (ArcGIS). If internet mapping or web services are "streamable", it is important to determine if their map projection / datum / coordinate system information is also provided.

An analysis is made of which themes needed for watershed planning are accessible, and whether these themes are selectable, query-able, or extractable. These themes include: watershed boundaries (at any scale); soils polygons, labels, attributes, and thematic views; wetlands; land cover and/or land use; environmental corridors; elevation, slope, (aspect, hillshade); water quality data; monitoring stations; gauging stations; and so forth. Weather, bathymetry, impairments, and hazards are also examined.