

2022

Great Lakes

BEACH CONFERENCE

Muskegon, MI | October 31-November 2

Student Poster Presentations

Presentation Title, Author, and Abstract

1 The Utilization of the ArcGIS Survey123 App for Sanitary Surveys among Muskegon County, MI Beaches in 2021-2022

Author: Tyler Chlystek, GVSU, Annis Water Resources Institute

The ArcGIS Survey123 mobile app was used by the 2021-2022 Annis Water Resources Institute (AWRI) beach monitoring team to complete sanitary surveys at Lake Michigan and inland beaches in Muskegon County, MI. The app was used on an electronic tablet which allowed surveyors to complete and upload the survey in a timely fashion. It can be used offline which provides inclusivity among beaches regardless of internet service availability. Surveys can be transferred from the tablet and uploaded to the ArcGIS Survey123 website once internet connection is available. The tablet also offers users the option to capture images. This technological advantage provided technicians with the opportunity to provide visual evidence of potential harmful algal blooms (HABs) or other conditions at beach locations that may be significant. Photos were taken of algae, cyanobacteria, and other concerns (e.g. foam) in various Muskegon locations. All 2021-2022 Sanitary Surveys were prepared from data recorded on the Survey123 app. ArcGIS Survey123 data can be used to provide the community with information on beach conditions and data can be extracted and used to evaluate outcomes based on historic trends using the Environmental Protection Agency's "Virtual Beach" regression model. We will present highlights of using the Survey123 app during the 2021 and 2022 beach seasons and discuss ways to improve implementation.

2 A Regional Approach to Marine Debris Removal in Northern Lake Michigan

Author: Katie Peterson, University of Wisconsin Oshkosh/Michigan Tech University

Marine debris has been a significant issue select marine environments for some time. However, the problem has grown in the breadth of area impacted over the years and now is impacting locations like the Great Lakes. While macro debris is a major issue for aesthetics, it also contributes to the overall loading of microplastics in water and beach sand throughout the Great Lakes. This presentation will explore a regional approach to removal of marine debris via boat collection using an Elastec Omni Cat marine debris boat, a Pixiedrone autonomous trash collection drone, SeaBins installed at marinas, as well as the BeBot remote controlled beach cleaning system. These technologies were deployed on a rotating schedule in northern Lake Michigan in communities such as Green Bay, Sturgeon Bay, and Manitowoc. The technologies used will be evaluated for their usefulness in single locations versus a rotating regional approach. A characterization of the marine debris recovered will be presented as well as microplastic data from both water and beach locations in Door County, WI. Understanding the marine debris present will help inform educational programming moving forward. Further, understanding how marine debris contributes to microplastic debris in the water and beaches will be critical in developing education and mitigation strategies.

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3 Survey of Microcystin concentrations at select Wisconsin inland and Great Lake swimming locations

Author: Jake McDowell, UW Oshkosh/MTU

This project surveyed the concentration of microcystin, a cyanobacterial toxin, throughout the 2021 and 2022 Wisconsin swimming season. Cyanobacterial toxins have become increasingly concerning as a health and safety hazard in public waters. This study aims to identify toxin trends in local waters which are frequently in use throughout the summer season. Toxin levels will be determined on northern and northeastern Wisconsin inland lake and northern Lake Michigan sampling sites. In 2022 temperature, turbidity, pH, nitrogen and phosphorous levels were determined at select sites which were found to have elevated microcystin concentrations in 2021. Additionally, microcystin concentrations determined in the laboratory will be compared to rapid, in-situ measurements of phycocyanin, a cyanobacterial pigment as measured by a personally deployed sonde. The goal of this comparison is to determine any distinct relationship between the concentrations of phycocyanin and microcystin toxin which could allow for early warnings to beachgoers.

4 Economic Value of Re-engineering Great Lake Beaches: Door County

Author: Sara Pabich, UW Madison

Wisconsin's Beach Monitoring Program has helped Door County residents and visitors better plan their beach vacation by monitoring water quality and notifying the public if health hazards exist. Poor water quality due to stormwater runoff, algae blooms, and closures from elevated levels of E.coli decreases the appeal for individuals to go to the beach. Beach re-engineering can mitigate and improve water quality to reduce the number of closures yearly. Beach re-engineering can increase water quality as well as increase the aesthetic appeal of the beach. While these re-engineering projects can often be expensive, early study results demonstrate that Door County beaches are worth investing in.

To determine the cost-benefit analysis of re-engineering beaches in Door County, beach users were randomly asked if they would take the time to complete a survey that would investigate the economic impact of the beach usage and willingness to pay for various beach improvements. The survey began with basic questions, such as asking about the frequency an individual attends the beach, leading to a conjoint choice analysis where individuals gave scenarios and asked which beach they would mind. By providing scenarios, the study could identify the most important features for beach users. Knowing essential beach features, such as good water quality, one can estimate the willingness to pay for high-demand features at beaches. Early results have shown that doing what is environmentally friendly in terms of water quality improvement is also economically beneficial.

Through sustainable re-engineering of beaches, our study suggests there will be an increase in beach use, which reduces the healthcare cost associated with closures and increases expenditure at local beaches and the surrounding area. By demonstrating that the investment in the environmental health of public beaches is cost-effective, we hope to encourage communities to support investments in public beaches.

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5 Environmental Factors Associated with Enterococci Bacteria in Chicago's Beach Water

Author: Ella Remund Wigier, University of Illinois

The University of Illinois Chicago School of Public Health (UIC SPH) has partnered with the Chicago Park District to use a rapid quantitative polymerase chain reaction (qPCR) method to monitor enterococci bacteria in Chicago's beach water. The UIC SPH Water Microbiology Research Laboratory collects two 1L water samples each from multiple Chicago beaches daily from Memorial Day until Labor Day. The samples are then tested using the qPCR method to determine the level of enterococci bacteria at each beach. The results are reported to the Chicago Park District by 12:00 PM daily.

This is a unique project given the number of beaches and the frequency of testing. To our knowledge, there is not another data set that exists with this number of observations. Because daily monitoring of beaches for enterococci bacteria with qPCR method is both expensive and labor intensive, we are investigating whether there is a statistical association between environmental factors and enterococci bacteria level. If a strong association is found between actual beach value exceedances and predicted exceedances (based on weather and lake conditions), it would suggest that communities without beach water qPCR monitoring may be able to use readily available environmental data to predict whether the enterococci levels exceed Beach Action Values. However, it is also possible that our findings will be location-specific.

In order to perform our data analysis, we are using the qPCR results dataset and weather sensor datasets from three Chicago beaches. We are using multivariate regression analysis to determine the strength of statistically significant associations and, if possible, to develop a useful predictive model. In this presentation we will describe the data, as well as any associations found, and the extent to which these findings may be applicable in other settings. Limitations of this research will also be discussed.

6 Characterizing Current Flow in the Straits of Mackinac Using Observations and Hydrodynamic Modeling

Author: Rachel Falls, MTU

The confluence of Lakes Michigan and Huron in the Straits of Mackinac has unique and frequently changing currents that are influenced by many factors. A better understanding of the spatial and temporal variability of these currents is important for predicting flow magnitude and direction, assessing the potential for hydrokinetic power generation, and tracking the movement of oil and other pollutants in the Straits of Mackinac. In this project, current velocities within the Straits of Mackinac were simulated using a 3-D hydrodynamic model for a period of 274 days (April 2 - December 31, 2016). Additionally, tilt current meters (TCMs) were placed at the bottom of the lake in five locations chosen to coincide with ancient river channels and to compare with model results at a variety of water depths. Acoustic doppler current profiler (ADCP) data are also available from a surface buoy deployed west of the Mackinac Bridge, along with high-frequency (HF) radar to provide 2-D maps of surface currents. Each of these data sources are used to validate the model and provide additional characterization of the Straits current velocities. In agreement with previous studies, our preliminary results show that flow in the Straits is highly variable, often alternating between east/west currents in the center of the Straits and north/south flow in the ancient river channel between St. Ignace and Mackinac Island. Flow magnitudes from the TCMs average between 10 - 20 cm/s, with outliers as high as 120 cm/s. Additional data analysis is performed to assess the spatial variability of current velocities, as well as time series analysis to identify cyclicities in the observed and simulated flow patterns. Ongoing and future work is focused on utilizing the results to assess the potential for hydrokinetic power generation within the Straits of Mackinac.

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7 Etiological Creek Studies of Elevated E. coli on Billings Lake, Manton, Wexford County, Michigan

Author: Kyle Latta, Ferris State University Shimadzu Core Lab

Idiosyncratic E. coli elevations of unknown etiology occur in Billings Lake (Manton, Wexford County, Michigan) causing closures of the “Kiddie” Beach. The Ferris State University Shimadzu Core Lab has investigated these increases since 2016. Summer 2020 demonstrated elevated E. coli levels occurred first in upstream Manton Creek after rain events greater than one inch. Summer 2021 studies concentrated on the creek after large rain events. Seven sites on Manton Creek, two on Billings Lake, and one on the spring-fed spur to Billings Lake were sampled for five days after five rain events, greater than one inch. Additionally, for each site on each day, a sanitary survey and usually a surfactant assay were performed. Afterwards, samples were analyzed using EPA Draft Method C. Results showed E. coli concentrations consistently higher than other sites at the sampling site furthest upstream, suggesting this may be the source of the E. coli. A water impoundment site intermediate between the lake and upstream site also showed relatively high levels. Surfactant levels were usually modestly elevated after large rain events. Sanitary surveys showed nothing helpful other than a pile of dog feces, likely dumped from a 5-gallon pail, at the Manton Creek entrance to the lake. But as E. coli levels were often more elevated upstream of the dog feces, this too was not a probable E. coli source. Microbial source tracking (MST) efforts using digital droplet PCR were stymied by contamination issues but are scheduled for completion summer 2022. Summer 2022 studies will likewise focus on starting sample collection during rain events as the possibility remains that starting after rain events did not catch relevant E. coli elevations.

8 Factors influencing Beach Water Quality in Chippewa County Michigan Inland Lakes

Author: Caitlyn Maas, Lake Superior State University

Inland lakes are an important water resource and contribute substantially to Northern Michigan’s tourism economy and quality of life. Inland Lakes are subject to a variety of natural and anthropogenic influences that may negatively affect water quality and lead to elevated exposure to various pathogens and contaminants. Factors influencing beach water quality were examined at four inland lake public beaches within the Lake Huron and Superior watersheds with contrasting water chemistry, use patterns, and potential anthropogenic influences (i.e., storm water, septic, etc.). Lakes were monitored weekly during the summer 2022 field season using a combination of field data collection (temperature, conductivity, dissolved oxygen, chlorophyll, etc.), microbiological methods (culture based, qPCR, and microscopic examination), and chemical analysis (ion chromatography, colorimetric analysis, and mass spectrometry). Significant differences in chemical and biological parameters between lakes were found, and evidence of both anthropogenic influences and natural variability will be discussed. A comparison of fecal indicator results from qPCR and culture based methodologies (colilert-18) will be examined, as well as results from qPCR based microbial source tracking. The implications of these results for public health and water quality management for rural bathing beaches will be discussed.

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9 Distal Origins of Elevated E. coli in Billings Lake in Wexford County, Michigan

Author: Bailey Copeland, Ferris State University Shimadzu Core Lab

The Ferris State University Shimadzu Core Lab has been investigating idiosyncratic elevated E. coli increases in Billings Lake (Manton, Wexford County, Michigan), which close the Kiddie Beach on Billings Lake. Investigations showed, in summer 2020, elevated E. coli levels originate in upstream Manton Creek after rain events greater than one (1) inch. In summer 2021, the E. coli geographic source was indicated to potentially be associated with the most distal Manton Creek sampling site. However, although E. coli were continuously present at this site, E. coli rarely were at levels of concern. Theoretically, the possibility remained that sampling after rain events missed large effluxes of E. coli at this or other points on Manton Creek. Accordingly, in summer 2022, sampling started during large rain events rather than afterwards. Sampling continued for five (5) days and assays for E. coli concentrations were performed using qPCR-based U.S. EPA Draft Method C. Additionally, sanitary surveys and surfactant assays were performed. Results to present show during the rain event, all sampling sites along Manton Creek had significantly elevated E. coli concentrations, that the most elevated levels were at the most upstream sampling site from Billings Lake, and that E. coli levels at this site were most persistent over the next five days. Additionally, preliminary digital droplet PCR-based MST data indicate E. coli is not of human origin, consistent with Billings Lake MST data in 2018. Sanitary survey points of interest show a beaver pond upstream of this most distal Manton Creek site. Surfactant assays have shown little of interest. Sampling and assaying using Method C and MST continue to confirm the geographic origin and animal origin of the elevated E. coli in Billings Lake.

10 Improving Recreational Water Quality Monitoring Through Microbial Source Tracking Normalization

Author: Megan Jamison, Oakland University

Microbial source tracking relies on detecting target DNA sequences of host-associated microorganisms, typically bacteroides. Since they are strict anaerobes, their presence in a water sample indicates recent fecal contamination, whereas the presence of FIB (fecal indicator bacteria) does not necessarily indicate recent contamination. E. coli naturalized in the sediments or on vegetation can be a bacterial sink where they reproduce before being subject to resuspension and transport from high currents or wave action. This project implemented a non-host-specific target, AllBac, to improve the interpretation of FIB levels. There is still a knowledge gap in interpreting MST results; in this project, AllBac and the standard curves for the host-specific targets were used to create a model to help fill this gap. The hypothesis was AllBac concentration would increase with increasing E. coli levels. This is based on the idea that high E. coli levels caused by recent fecal contamination would be accompanied by the anaerobic bacteroides (AllBac) found in the intestinal tract of warm-blooded animals. Through a partnership with the Macomb County Health Department, five public beaches were monitored for FIB twice a week from the middle of April to the end of September. From the days monitored, sixty-five samples were selected for MST analysis, choosing samples that were representative of the beaches throughout the season and any days that exceeded the BAV (beach action value). There was a strong positive correlation between Colilert-18 and AllBac, 0.73, and a moderate positive correlation between Method C and AllBac, 0.53.

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11 Effects of Rainfall Events on Microbial Contamination at South Linwood Public Beach

Author: Carson Moen, Saginaw Valley State University

Over the past several years our lab at Saginaw Valley State University has tested public beaches in Bay County, MI for fecal contamination. A trend has been seen relating a high level of contamination after a rainfall event. This poster will encompass a beach's level of contamination in response to rainfall events in the summers of 2019, 2020, 2021, 2022. South Linwood Beach is connected to a series of drains that collect runoff from farmers' fields and border several dense housing areas. Two separate methods were used to quantify the levels of fecal indicator bacteria, specifically *Escherichia coli*, which is associated with the lower intestine of warm-blooded organisms. The first was the historical standard Colilert, a culture-based method that requires overnight incubation, resulting in slow-turnaround for beach closing determinations. The second test, digital drop PCR (ddPCR), was used to measure *E. coli* DNA within a few hours of sampling. ddPCR methods can also be used to determine the sources of contamination, known as microbial source tracking (MST) by exploiting genetic differences in *Bacteroides* and other enteric microbes originating from humans, ruminants, avians, etc., each of which were detected at the South Linwood Beach and its nearby inlets. Based on comparison of rainfall and *E. coli* levels, there was indeed a trend of high levels of fecal contamination following precipitation events, with the sources of this microbial contamination appearing to be a majority of gull and bovine markers. More beach sites should be studied in relation to contamination due to rainfall events.

12 The effect of nutrients on the survival of *E. coli* in freshwater beach sand

Author: Sophia Ward, University of Wisconsin Madison School of Freshwater Sciences

Freshwater beach sand is a reservoir for *E. coli* strains that are often not associated with fecal contamination events, indicating that the sand has a unique population of *E. coli*. Although these *E. coli* are not pathogenic to humans; they are exchanged with surface water through wave action and impede beach monitoring efforts that rely on *E. coli* enumeration. In this study, laboratory microcosms were used to replicate beach conditions and better understand how the nutrients Carbon and Nitrogen present in the sand may influence *E. coli* survival. Microcosms seeded with both Carbon and Nitrogen treatments that are two times the baseline levels show significantly higher survival than either treatment alone or no treatment. The results of this study aid in beach monitoring efforts by providing the framework for further research on how pollution sources that contain Carbon and Nitrogen may promote *E. coli* survival.

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13 Tracking High E.coli Levels at Thornapple Lake

Authors: Ashley Thompson, Grand Valley State University, Cell and Molecular Biology Department

Grand Valley State University, in partnership with Barry-Eaton County Health Department, monitored four beaches over the 2022 Swim Season: Gun Lake Main Beach, Gun Lake Campground, Fox Memorial Park, and Charlton Park. Testing for *E.coli* and coliforms was done weekly using Colilert-18 tests.

Anticipating contamination from agricultural entities upstream and inadequate septic systems from homes surrounding Charlton Park on Thornapple Lake, additional water samples from the beach were filtered via membrane water filtration and stored to be able to run Microbial Source Tracking (MST) at a future date. Since mid-July, Charlton Park *E. coli* counts were over the acceptable compliance level of 300 *E.coli* per 100 ml sample. High levels continued, and required shutting the beach down from July 14-29 and August 4-24. In an attempt to pinpoint the location of contamination in Thornapple Lake, 28 additional samples were tested from various locations across the lake with Colilert. Samples that tested over the threshold were filtered and stored to run MST testing with markers for human, cow, and goose fecal contamination. Preparation is currently underway to determine both the source and location of contamination in Thornapple Lake so that proper corrective action may be taken to ensure the lake is a safe swim location.