ABSTRACTS

State of Lake Ontario Conference

Presented by IAGLR
Virtual | March 9–11, 2021

IAGLR

International Association for Great Lakes Research

ABSTRACTS

2021 State of Lake Ontario Conference

Presented by IAGLR

Virtual | March 9-11, 2021

International Association for Great Lakes Research
4840 South State Road
Ann Arbor, Michigan 48108
iaglr.org

CONTENTS

ABSTRACTS

An alphabetical listing of abstracts presented at the 2021 State of Lake Ontario Conference, organized by first author. Presenters are underlined.

A

ALIPOUR PARVIZIAN, B., ZHOU, C., FERNANDO, S., CRIMMINS, B., HOPKE, P., HOLSEN, T., Clarkson University. **Concentration and Temporal trend (1978-2016) of Hexaboromocyclododecane (HBCDD) in fish tissues from the Great Lakes**.

Hexaboromocyclododecane (HBCDD) is a brominated flame retardant (BFR) that is commonly used as part of building insulation and in many common household items. The global production volume of this BFR reported to be 600,000 tons per year in 2001. Due to the toxic and persistent nature of this compound multiple regulatory agencies have started to monitor there levels in the environment and food. Therefore, as a part of Great Lakes Fish Monitoring and Surveillance Program (GLFMSP), total HBCDD (∑HBCDD) concentrations and temporal trends in homogenized whole fish samples from the Great Lakes region (1978 to 2016) were determined. Both increasing and decreasing trends were observed for the region, indicating the impact of atmosphere transport both globally and locally, food web change, and climate change in trend of this compound.

ANDERSON, A., MEYER, J., MUGALINGHAM, S., MIDLANE-JONES, S., Lower Trent Conservation. **Implementing the Proposed Long Term Phosphorus Management Strategy for the Bay of Quinte Area of Concern**.

A Phosphorus Management Strategy, as identified in the 2020 Draft Canada-Ontario Agreement, is being developed for the Bay of Quinte Area of Concern to continue to address harmful and nuisance algae. An important element of the proposed strategy is to reduce by at least 20%, the rural non-point phosphorus loads generated within focus areas in the watershed that have been identified through a watershed- based phosphorus loads model called SPARROW, as well as more refined sub-watershed based SWAT model. Field scale modelling has been completed in identified sub-watersheds to identify areas in the field that are prone to erosion. As the majority of the land is privately owned voluntary landowner stewardship is the best approach to achieve the reduced phosphorus loads. Voluntary landowner stewardship through education, public engagement, and cost sharing incentives help to foster a shared responsibility of environmental protection. Through the Bay of Quinte Remedial Action Plan, several programs are promoted to area residents. Programs include education and outreach on proper on-site sewage maintenance; collection of soil samples to assess soil nutrients; incentive funding to implement best management practices such as, planting cover crops and riparian buffers. Participants in the soil sampling program in the focus areas receive a large field scale map of the field showing among others: soil nutrient results, slopes, gullies modeled using DEM acquired through technologies such as LiDAR and/or point cloud cover associated with Ortho Photos; as well as estimated field erosion over a certain time span, again using above mentioned technology based DEMs acquired at two different times. This paper will illustrate the above-mentioned tools implemented in the rural land uses within focus areas for phosphorus reduction in the Bay of Quinte.

ARHONDITSIS, G., University of Toronto. **A probabilistic assessment of the status of Areas of Concern in the Laurentian Great lakes: How far are we from delisting the Hamilton Harbour, Lake Ontario, Canada?**

Environmental policy analysis aims to identify the important drivers of degradation, elucidate sources of controversy, and put the necessary risk assessment tools in place to prepare for the unexpected. In this context, we reappraise the idea of probabilistic water quality criteria as a pragmatic way to accommodate the frequently experienced situation when the prevailing conditions may not always be favourable, even if the central tendency of the system is on par with what is defined as an acceptable ecosystem state. Our case study is the Hamilton Harbour, a large embayment located at the western end of Lake Ontario, with a long history of environmental pollution problems. Based on a probabilistic framework, our basic objective is to provide a comprehensive assessment of the current state of eutrophication and fish contamination in the system. Notwithstanding the significant improvements brought about by the remedial measures in the area, our analysis shows that the system continues to experience excessively high exceedance frequencies of the water quality goals as well as the consumption advisory PCB benchmarks of eight sport fish species examined. These results clearly suggest that the Hamilton Harbour is still a long way off from being delisted as an Area of Concern. While our modelling analysis does not negate -in principle- the optimism that the goal of restoring environmental health of the system is achievable, it cautions that there are many "ecological unknowns" that may determine the degree and timing of restoration. The present framework encapsulates one of the founding concepts of the Hamilton Harbour remediation, whereby management strategies and quality goals heavily rely on continuous research and monitoring and dynamically adapt to the contemporary changes of the ecological conditions.

AWONAIKE, B., LEI, Y.D., PARAJULEE, A., MITCHELL, C., FRANK WANIA, F., University of Toronto, Scarborough. **Polycyclic Aromatic Hydrocarbons and Quinone Substituted Congeners in Urban and Rural Stormwater Run-off: Effects of Land Use and Storm Characteristics**.

We explored the significance of stormwater as a source of polycyclic aromatic hydrocarbons (PAHs) and oxygenated PAHs (OPAHs) to two creeks draining contrasting urbanized landscapes in Southern Ontario, Canada. Changes in stream water concentrations of PAHs and OPAHs over the course of a major rainfall event were used to assess how land use and emission sources influence contaminant fate and behaviour in a watershed. By comparing three rainfall events during different seasons, we further explored the influence of seasonal variability, rainfall/runoff amount and antecedent dry period on PAH behaviour. The analysis of concentration-discharge (C-Q) relationships revealed that during a warm-weather precipitation event, OPAHs behaved similarly to their unsubstituted PAH counterparts. Nearly identical C-Q patterns at all sites indicated a common source of both contaminant groups. The bulk of PAH and OPAH transport during the rain event occurred via suspended sediments. Higher concentrations at the more urbanized watershed indicate that land use and emission intensity were major determinants of PAH and OPAH concentration and fate during the precipitation event. During cold weather events, PAH loads were up to two times higher than during summer, but only at the more urbanized watershed. PAH loads also increased with increasing runoff ratio and longer antecedent dry period, suggesting that the flushing of surfaces accumulating PAHs from the atmosphere was an important process delivering PAHs to the streams. At the less urbanized watershed, variation in PAH behaviour between events was minor, evidenced by similar C-Q patterns and small differences in PAH loads.

B

BEERS, D.[1], BEERS, M.[1], BLEIER, T.[1], SCHULTZ, R.[1], CHISLOCK, M.[1], UNGHIRE, J.[2], WILCOX, D.[1], LAWRENCE, G.[1], [1]SUNY Brockport; [2]U.S. Army Corps of Engineers. **Evaluating effects of Braddock Bay barrier beach restoration on water quality and trophic state**.

In 2016, U.S. Army Corps of Engineers completed restoration of the historic barrier beach at Braddock Bay, an embayment located on the southern coast of Lake Ontario approximately 11 miles northwest of Rochester, NY. Water quality of Braddock Bay has been monitored since 2015 to determine if the trophic state has been affected by restoration activities. Water quality samples were collected within Braddock Bay, its tributaries, and Lake Ontario immediately outside the bay to assess pre-, during, and after construction conditions. Two major tributaries (Buttonwood Creek, Salmon Creek) serve as major sources of nutrients (i.e., phosphorus). As a result, water quality for Braddock Bay sites and tributaries remains poor, characterized by eutrophic-to-hypereutrophic conditions. We have observed significantly lower post-restoration phytoplankton biomass and increased water clarity in segments of the bay protected by the barrier beach. In contrast, similar trends have not been observed in segments of the bay not protected by the barrier. Total phosphorus concentrations for sites appear consistent over the monitoring period. In contrast, levels of soluble nitrogen have been lower at Braddock Bay sites post-restoration. As Lake Ontario is rich in NOx, relative to bay sites, completion of the barrier beach appears to have enhanced nitrogen limitation of phytoplankton, leading to improved water quality for protected sites in Braddock Bay. Given the currently impaired water quality conditions in Braddock Bay and continued external loading of phosphorus via tributaries, upstream management strategies should be encouraged to improve water quality further. Algal blooms, especially those dominated by filamentous cyanobacterial species (e.g., Lyngbya, oscillatoria), may pose a long-term risk to Braddock Bay, especially when stable, low water conditions are combined with severe nitrogen limitation and low nitrogen-to-phosphorus ratios. Continued monitoring in future years is necessary to assess the risk associated with potential algal blooms.

BELLISARIO, K., LENZI, J., SALAZAR, K., WALKER, D., PIJANOWSKI, B., Purdue University. **Engaging Great Lakes Communities in Soundscapes and Land Use Planning**.

Noise occurs in urban areas and is generally composed of low frequency sounds like traffic that may prevent the ability of animals to communicate with other members of their species. As noise can negatively affect the health and behavior of humans and other animals, it is considered to be a form of pollution. Historically, noise has been treated differently than other types of pollutants like airborne chemicals and can be measured with precise instruments, however, these measurements become more meaningful when related to human perception. The Soundscapes Planning team held a workshop in June 2017 with city planners, town managers, program/education coordinators, and directors of parks in northern Indiana (n=14) to develop the principles of planning and soundscapes. Prior to the workshop, the team collected 30-second soundscape recordings, wind speed, temperature, relative humidity, and decibels (dBA) along highway and industrial areas. The collection points (n=280) were overlayed on existing land use, and using an interpolation algorithm, a noise gradient (range 32.7-107.6 dBA) was produced, mapped, and shared with participants. Participants were asked to define their community, reflect on how to collect information on sound in their community, to develop a list of organizations that could support this effort, and to estimate the interest to collect specific recordings. From this workshop, the team identified three principles of planning and soundscapes as 1) the need to reduce noise at unhealthy noise levels, 2) protect natural sounds in quiet places and parks, and 3) identify and preserve community sounds that are unique. Additionally, the team is integrating a soundscape community planning tool in the Tipping Point Planner decision support system, as part of the Tipping Point Planner facilitated planning program.

BENOIT, N., HOWELL, T., Ontario Ministry of the Environment Conservation and Parks. **Measuring drivers of water quality along the Mississauga - Toronto waterfront of Lake Ontario**.

The "Golden Horseshoe" of Lake Ontario, encompassing the cities of Mississauga and Toronto potentially exerts significant influence on the nearshore through loading of nutrients, major ions and suspended solids from urban rivers, wastewater treatment plants and stormwater. Previous studies have described water quality variability in this region; however, conditions have been difficult to quantify in an integrated and holistic manner appropriate for addressing water quality at a regional scale. In 2018, the Ministry of the Environment Conservation and Parks conducted a series of surveys spanning 60 km of the shoreline of Mississauga and Toronto, from the Credit River in the south-west to the Rouge River in the north-east. A combination of field-based sensors and seasonally deployed instruments, surrogate water chemistry variables, UV-A fluorescence and conductivity were used to compile spatially-weighted estimates over blocks of shoreline stratified by distance offshore. UV-A fluorescence correlated with nutrients, major ions and suspended solids showing recurrent but temporally unique water quality patterns that aligned with shoreline loading points. The open coastline SW of Toronto Harbour was more impacted from land-based inputs compared to the more lake-like conditions found NE of Ashridges Bay to the Rouge River. Toronto Harbour water quality was strongly influenced by weather-related loadings from the Don River. Area-wide chloride and conductivity were linked to heightened river discharge in late spring and declined seasonally. Lake circulation and water column stratification contributed strongly to water quality variability. Strong along-shore mixing, and frequent reversals resulted in highly changing conditions near loading points, while the water column shifted between fully mixed to strongly layered. Despite challenges posed by diverse sources of variability to water quality, field studies can inform on nearshore conditions at a scale that captures the causative elements of the variability to support management of water quality at the edges of the Great Lakes.

BOWEN, K.[1], CURRIE, W.[1], JOHNSON, T.[2], [1]Fisheries and Oceans Canada; [2]Ontario Ministry of Natural Resources and Forestry. **East vs. West - Comparison of Lake Ontario zooplankton at three Canadian index stations**.

Forces driving lower food web productivity of Lake Ontario have undergone many changes in the last 40 years, including phosphorus control, fluctuations in planktivores (Alewife), and invasion by dreissenid mussels and predatory cladocerans. Index stations sampled frequently throughout the year are key to understanding long term changes in top-down and bottom-up drivers influencing the lower food web. This is because phytoplankton, zooplankton and the microbial loop have short generation times and populations can change rapidly throughout the growing season. Observations of declining productivity in the lower food web prompted Fisheries and Oceans Canada (DFO) and Ontario Ministry of Natural Resources and Forestry to resume sampling at long-term index Station 81 in the Kingston Basin starting in 2007. This 35 m deep station was part a long-term monitoring program from 1981 to 1995. DFO also began sampling two western Lake Ontario index stations in the nearshore (BUR) and offshore (LO2) starting in 2013. In this presentation we will compare zooplankton population metrics between the eastern and western stations, including community composition, biomass and production of dominant groups. For example, May to October mean biomass ranged between 19 and 61 mg/m3 at shallow BUR, and only 9 to 30 mg/m3 at the deeper offshore stations between 2013 and 2019. We will also examine relationships between herbivorous zooplankton populations and predators, including Alewife and the invasive cladocerans Cercopagis and Bythotrephes, and how these top-down influences vary annually and spatially in Lake Ontario.

BROWN, T.[1], SETHI, S.[1], RUDSTAM, L.[1], CONNERTON, M.[2], HOLDEN, J.[3], HOYLE, J.[3], CHALUPNICKI, M.[4], GORSKY, D.[5], KARBOSKI, C.[5], EVANS, T.[6], SARD, N.[7], COSTA, J.[8], PRINDLE, S.[9], SANDERSON, M.[9], KLINDT, R.[9], TODD, M.[9], ROSEMAN, E.[6], LAU, A.[6], COOPER, A.[6], REINHART, D.[6], DAVIS, C.[6], LANTRY, B.[6], WEIDEL, B.[6], [1]Cornell University; [2]New York State Department of Environmental Conservation; [3]Ontario Ministry of Natural Resources of Forestry; [4]Tunisian Laboratory of Aquatic Science, [5]Lower Great Lakes Fish and Wildlife Conservation Office, [6]Lake Ontario Biological Station, [7]SUNY Oswego, [8]Fisheries and Oceans Canada, [9]New York State Department of Environmental Conservation. **Contemporary spatial extent and environmental drivers of larval coregonine distributions across Lake Ontario**.

Coregonine fishes (Coregonus spp.) are important components of native Great Lakes food webs and fisheries and are central to basin-wide conservation and management initiatives. In Lake Ontario, binational management objectives include conserving and restoring spawning stocks of cisco (C. artedi) and lake whitefish (C. clupeaformis), but the spatial extent of contemporary coregonine spawning habitat and which environmental factors are currently most important for regulating early life success lake-wide are not well characterized. In Spring 2018, we conducted a binational ichthyoplankton assessment to describe the contemporary spatial extent of coregonine spawning habitat across Lake Ontario. Further, we characterized a suite of physical, climatic, and biological variables hypothesized to influence coregonine early life stage success and regressed them against observed species-specific catches using GAMMs and multimodel inference to quantify the relative importance of potential biophysical drivers. Between 10 April – 14 May, we collected 1,092 ichthyoplankton tows and captured over 2,350 coregonine larvae, including in historical spawning habitats. However, over 95% of observed production was restricted to the eastern basin and was dominated by cisco, with lake whitefish representing less than 6% of captured coregonines. Our statistical analysis results highlight the importance of climatic drivers operating at large spatial scales and of local environmental habitat characteristics that may interact to regulate species-specific coregonine early life success by operating on egg and larval stages. While we found that observed catches of both species across sampling areas were strongly and similarly explained by ice cover duration, the importance of site-specific characteristics differed between the two species, suggesting differential ecological responses to microhabitat scale drivers between cisco and lake whitefish. Together, our updated spatial distribution of spawning habitat lake-wide and quantitative evaluation of environmental drivers provides insight into contemporary coregonine ecology, critical for designing monitoring programs and prioritizing ongoing management actions across Lake Ontario.

BRUNNER, S., BHADBHADE, S., SIRVIENTE, A., KEARNS, K., Great Lakes Observing System. **The Future of the Great Lakes Observing System**.

The Great Lakes Observing System, or GLOS, is revamping the way we ingest observational data and serve it out to our end users. Historically, GLOS has been known for primarily serving real-time data from moorings and sondes at stations that usually approach GLOS or have been long-time partners of GLOS. Other information, such as delayed mode data (e.g. grab samples) and model outputs, is served on through GLOS, but is less accessible and user-friendly. Over the past year, GLOS has started to reinvent its data portal, from the ingestion of data to provision of data products. This new portal will make every step more intuitive and simple for data providers and end users: metadata collection, alerts about data quality flags or thresholds, finding observing platforms nearby, and more. GLOS also has additional staff capacity to aid in identifying additional observing sources of all types, bringing those sources onto our platform, and understanding gaps around the various basins. For example, Lake Ontario has traditionally been a data sparse lake on the GLOS buoy platform. We hope to change that by engaging more with the Lake Ontario observing community to learn where the observations are happening, what the driving factors are, and how GLOS can help bring the data to more users, as well as potentially fill gaps that exist.

BUCCI, K.[1], BIKKER, J.[1], BAYOUMI, M.[1], STEVACK, K.[2], WATSON-LEUNG, T.[2], ROCHMAN, C.,[1] [1]University of Toronto; [2]Ministry of the Environment, Conservation and Parks.
Microplastics from Lake Ontario impact fathead minnow development and reproduction.

Microplastics are a complex suite of contaminants varying in size, shape, polymer, and associated chemicals, and can be referred to as a multiple stressor. Still, many studies testing the effects of microplastics use commercially bought microplastics of a uniform size, shape, and type. In this study, we investigated the effects of pre-consumer polyethylene (PE), pre-consumer polypropylene (PP), and a mixture of PE and PP collected from the shoreline of Lake Ontario, where they likely sorbed a complex cocktail of contaminants. Two experiments were conducted, the first comparing the effects of these three plastics to larval development and the second comparing the chronic effects of pre-consumer PE and environmental PE on development, reproduction, and offspring quantity and quality. In the first experiment, we determined that the effects of microplastics differ between polymer types, and with and without sorbed environmental contaminants. Exposure to Lake Ontario microplastics caused an increase in length and weight, and almost 6x more deformities than either of the pre-consumer microplastics. We also determined that the mechanism of impact (i.e. physical or chemical stress) is context dependent. In the second experiment, we determined that both pre-consumer PE and PE from Lake Ontario have limited chronic effects on the parental generation, but the Lake Ontario microplastics affect the viability of F1 eggs and offspring development. This study provides further support for treating microplastics as a multiple stressor and begs further research on the effects of environmentally relevant exposures of microplastics on the long-term growth, survival, and reproductive output of aquatic organisms.

BUCKTOOTH, S., **Invasive species management and Mohawk cultural use of plants**.

The SRMT Land Resources Program, through various invasive species management efforts and the establishment of a native plant nursery, are working toward the re-establishment of native plants, with particular focus on culturally significant species, in Akwesasne. Our efforts have focused primarily on wetland and riparian areas that have been more prone to the effects of invasive species so that ecosystem function can be returned to these areas in a way that is also beneficial to the Mohawk community. This presentation will include a few slides of the scientific work, and then discuss the cultural use values of select plants for medicinal and traditional food uses for community members and how it relates to restoration priorities.

BURANT, C.[1], FILIPSKI, M.[2], NATALIE GREEN, N.[3], [1]Niagara Parks Commission, [2]New York State Department of Environmental Conservation, [3]Niagara Peninsula Conservation Authority.
Working together to restore our Niagara River: Collaborative Habitat Restoration Projects.

The Niagara River is identified as one of five bi-national Great Lakes' Areas of Concern (AOCs) due to historical water quality problems and habitat loss which are being addressed through separate, yet complementary, Remedial Action Plan (RAP) efforts. The Loss of Fish and Wildlife Habitat is one of the most common issues within AOCs (including the Niagara River) and is typically associated with the loss of riparian (shoreline) vegetation, coastal wetlands, or underwater fish habitat due to shoreline hardening or infilling, destruction or draining of wetlands, removal of shoreline vegetation or dredging of deep-water shoals, etc. Over the past few years, RAP partners on both sides of the border have taken similar approaches to restore and improve fish and wildlife habitat in the Upper Niagara River. Efforts have focused especially on restoration of coastal wetland, which is considered the most significant loss to the Niagara River due to AOC-related causes. Adding shoreline protection (low-profile berms) to dissipate wave energy and prevent ice damage has been successful in promoting the reestablishment of wetland areas. In New York, federal and state partners have focused especially on re-establishing wetland and upland habitat and mitigating the effects of erosion at the Strawberry Island-Motor Island Shallows—a critical wintering area for waterfowl and one of the most important fish spawning areas in the upper Niagara River. In Ontario, the Niagara Parks Commission, with support from the provincial and federal governments, is restoring coastal wetland and riparian habitat at key locations along the upper Niagara River where tributaries intersect the river (to maximize the capture of sediment and biotic drift). The collaborative approach, as well as the restoration techniques employed, may provide valuable examples for habitat improvement in other locations.

BURLAKOVA, L.[1], KARATAYEV, A.[1], HRYCIK, A.[1], DANIEL, S.[1], MEHLER, K.[1], RUDSTAM, L.[2], WATKINS, J.[2], DERMOTT, R.[3], SCHAROLD, J.[4], ELGIN, A.[5], NALEPA, T.[6], [1]SUNY Buffalo, [2]Cornell University, [3]Fisheries and Oceans Canada (alumnus), [4]U.S. EPA Great Lakes Toxicology and Ecology Division, [5]NOAA Great Lakes Environmental Research Laboratory, [6]University of Michigan. **Six decades of Lake Ontario ecological history according to benthos**.

The Laurentian Great Lakes have experienced multiple anthropogenic changes in the past century, including cultural eutrophication, phosphorus abatement initiatives, and the introduction of invasive species. Lake Ontario, the most downstream lake in the system, is considered to be among the most impaired. The benthos of Lake Ontario has been studied intensively in the last six decades and can provide insights into the impact of environmental changes over time. We used multivariate community analyses to examine temporal changes in community composition over the last 54 years, and to assess the major drivers of long-term changes in benthos. The benthic community of Lake Ontario underwent significant transformations that correspond with three major periods. The first period, termed the pre/early Dreissena period (1964-1990), was characterized by high densities of Diporeia, Sphaeriidae, and Tubificidae. During the next period defined by zebra mussel dominance (the 1990s) the same groups were still prevalent, but at altered densities. In the most recent period (2000s to present), which is characterized by the dominance and proliferation of quagga mussels deeper into the lake, the community has changed dramatically: Diporeia almost completely disappeared, Sphaeriidae have greatly declined, and densities of quagga mussels, Oligochaeta and Chironomidae have increased. The introduction of invasive dreissenids has changed the Lake Ontario benthic community, historically dominated by Diporeia, Oligochaeta and Sphaeriidae, to a community dominated by quagga mussels and Oligochaeta. Dreissenids, especially the quagga mussel, were the major drivers of these changes over the last half century.

BURROWS, M.[1], DEPINTO, J.[2], HECKY, R.[3], [1]International Joint Commission; [2]LimnoTech; [3]University of Minnesota, Duluth. **Understanding Declining Offshore Productivity – Findings, Recommendations and Research Implications**.

The International Joint Commission's Science Advisory Board completed its report on declining offshore productivity in June 2020. The goal of the study was to confirm and improve understanding of the phenomenon of declining offshore productivity while the Great Lakes are at the same time experiencing symptoms of nearshore nutrient enrichment. This report is a unique compilation of all available information about the very significant issue of declining offshore productivity. The report identifies the need for Great Lakes water quality managers to partner with fishery managers to break down information silos and adopt an adaptive management framework that considers both the upper and lower food webs. Targets set for nutrient reductions under the Great Lakes Water Quality Agreement (GLWQA) require an ecosystem-level analysis to consider potential impacts on offshore waters and strike a balance between ecosystem services. The report recommends that the Great Lakes Executive Committee (GLEC) explore and implement opportunities and capacities for cooperative application of ecosystem forecasting science addressing nutrient and fisheries management in the Great Lakes. Further, it states that when addressing this recommendation, GLEC should engage and partner with state and provincial fisheries and environmental agencies as well as other national and binational agencies involved with monitoring and managing Great Lakes aquatic resources. The report includes a finding that the process of setting nutrient targets for Lake Ontario under Annex 4 of the GLWQA will be an important test case for current ecosystem modeling capabilities. The report also describes how invasive mussels are implicated in sequestering nutrients in the nearshore. Complex factors that contribute to the observed decline in fish populations are presented. There is not yet a complete explanation for the relationship between the declines in nutrients and offshore fish populations and the report identifies knowledge gaps that need to be filled to solve this puzzle.

C

CARTWRIGHT, L.[1], PORTISS, R.[1], BARNES, K.[1], MIDWOOD, J.[2], BOSTON, C.[2], GRANADOS, M.[3], SCISCIONE, T.[1], [1]Toronto and Region Conservation Authority, [2]Fisheries and Oceans Canada, [3]Prereview.org. **Fish community response to embayment habitat restoration at Tommy Thompson Park, Toronto**.

Tommy Thompson Park is an artificial landform on the Toronto waterfront that has been naturalized due to extensive terrestrial and aquatic habitat restoration. The park contains multiple embayments and cells that have been restored using techniques such as log tangles, shoreline shoals, wetland berms, exclusion barriers, shoreline vegetation zones, and complex shoreline profile improvements. We monitored fish communities at six sites within three restored embayments for up to 30 years using standardized boat electrofishing transects. Electrofishing data were used to examine changes in fish community composition, thermal regime, an index of biotic integrity and piscivore, forage and native species CPUE over time. Fish community response to restoration was variable among sites although there were some consistent patterns. All sites were dominated almost exclusively by coolwater and warmwater fish including Pumpkinseed, Yellow Perch, Rock Bass, Bluntnose Minnow, Gizzard Shad and Emerald Shiner. Even though these species dominated most sites, there were declines in Pumpkinseed, Bluntnose Minnow and Spottail Shiner at several sites while Yellow Perch and Gizzard Shad increased. Index of biotic integrity scores remained similar pre- and post-restoration although were quite low in the most recent years which may or may not be related to restoration. Changes in fish community composition were evident at three of six sites, all located within Embayment C. Pre-restoration communities tended to have a higher CPUE of Bluntnose Minnow, Spottail Shiner and Threespine Stickleback while post-restoration communities had more Gizzard Shad and Largemouth Bass although there was some variability among sites in pre- and post-restoration communities. These results suggest that there have been temporal changes in fish communities at restored sites in Tommy Thompson Park which can be used to gauge restoration success and inform future aquatic habitat restoration.

CASIMIRRI, G., Green Venture. **Depaving Paradise and a Raingarden for Every Yard: Community Engagement for Green Stormwater Infrastructure in Hamilton, ON**.

Green Venture is a community-based, non-profit organization which empowers Hamiltonians to implement greener practices in their homes and communities to make Hamilton a climate champion. We directly engage and support residents of all ages to take action to reduce climate vulnerability and impacts in our community by supporting the implementation of lot-level green infrastructure which filters water and reduces runoff. This presentation will review Green Venture's 15 year experience of community engagement for green stormwater infrastructure and highlight lessons learned from our Depave Paradise community projects with 9 schools, churches and BIAs which absorb 880,000L of stormwater annually and our Catch the RAIN project which is currently creating community green infrastructure demonstration projects and trying to find innovative ways to support residents to reduce runoff on their properties and install rain gardens and other green infrastructure retrofits.

CHOMIAK, K., BANGKONG, C., DIAZ, R., DAILY, J., CHADO, M., EDDINGSAAS, N., HOFFMAN, M., HUDSON, A., TYLER, C., Rochester Institute of Technology. **Differential toxicity of microplastics over time in two freshwater bodies**.

A growing body of literature illustrates the magnitude of plastic pollution in the water and sediment of Lake Ontario and its watershed. Because the benthos is the ultimate depositional site for many microplastics, understanding the impact on benthic ecosystems is important. However, "plastic" is a catchall term for numerous polymers used for different purposes, with unique physical and chemical properties. This variety complicates our ability to draw comprehensive conclusions about fate and impact. With environmental exposure, the physical and chemical characteristics may change, leading to lower or higher density, adsorption or leaching of toxins, and accumulation of surface biofilms that further influence the physical and chemical properties. How these changes vary among water bodies and thereby shift fate and impact, is currently understudied. Over time, benthic invertebrates may be exposed to and consume plastics and plastic-associated toxins, and how these impacts vary across polymer type and with environmental exposure is also largely unknown. We used traditional chronic and acute toxicity assays to evaluate the toxicity of six common consumer plastics on Lumbriculus variegatus in their pristine state and after incubation in the water column and sediment of Lake Ontario and a stormwater pond in Henrietta, NY for 1 and 4 months. Preliminary results suggest differential impacts by polymer, site, and area of incubation. These findings help to identify polymers that may generate the greatest ecological risk and create a more complete picture of how toxicity changes across the plastic life cycle in different freshwater environments.

CONNOLLY, J., WATKINS, J. RUDSTAM, L., Cornell University. **Lake Ontario meiobenthic harpacticoid copepod community influenced by nonindigenous species**.

Harpacticoid copepods are an understudied component of the meiofaunal community that serve an important ecological role as detritivores and include a diversity of indigenous and nonindigenous species in the Laurentian Great Lakes. We characterize this community through a quantitative assessment of the harpacticoid assemblage of Lake Ontario conducted from August to September 2018 as part of the Cooperative Science and Monitoring Initiative offshore benthic survey. Benthic dwelling harpacticoid copepods were collected primarily by ponar grabs from a range of depths and substrate types. This study, the first lake wide study of the harpacticoid community, documents a community highly influenced by exotic species and includes the first detections of nonindigenous Schizopera borutzkyi (Monchenko, 1967) and Heteropsyllus nunni (Coull, 1975) from Lake Ontario. S. borutzkyi a species previously introduced to the Great Lakes

from the palearctic region was found to be a successful invasive species, accounting for 65% of the sampled population in terms of density. In contrast, the most common native species Canthocamptus robertcokeri (Wilson, 1958), Bryocamptus nivalis (Willey, 1925), and Moraria cristata (Chappuis, 1929) comprised only 9%, 6%, and 4% of the sampled population respectively. Species considered nonindigenous accounted for 72% of the lake wide population. Relative abundance of nonindigenous species decreased with depth from 79% in <20m, to 55% from 20-40m, to only 24% at depths >40m, suggesting a deep-water refuge for indigenous species. The dominance of these previously undetected nonindigenous species in Lake Ontario benthos underscores the value of biological monitoring of often overlooked meiobenthic communities.

COVEART, C., GM BluePlan Engineering, Ltd. **King Street E. Coli Investigation**.

GM BluePlan Engineering Ltd. (GMBP) was retained by the Town of Niagara-on-the-Lake to complete an investigation of the King Street storm sewer outlet which discharges to the Niagara River. The outlet was flagged by the Niagara River Remedial Action Plan for elevated levels of Escherichia Coli (E. coli) since beach closures occur when E. coli levels exceed 200 CFU/100mL. Without action, there was concern for the future of this key recreational area and the long-term deleterious impacts on the Niagara River. The expectation was for GMBP to identify the source of contamination which is typically cross-connections; the inadvertent flow from one system (sanitary) to another (storm) through improper connections or leaks from poor-condition components of the systems. GMBP developed a systematic study approach which included review of flow monitoring data, implementation of a water quality sampling plan and subsequent DNA analysis to identify the source of E. coli (human or otherwise), and numerous field investigation such as smoke and dye testing, CCTV of private sanitary laterals and municipal sewers, and condition assessments. This thorough analysis discovered a multitude of system issues including improper and cross-connections, poor condition municipal and private property assets that effectively leaked sanitary flow to the storm system, and abandoned wastewater infrastructure continuing to serve as conduits for cross-flow between active infrastructure. With these findings, GMBP developed a prioritized action plan to address the immediate issues. Sewer systems are critical infrastructure and regular inspection and maintenance of these assets will detect issues, improve operational efficiencies, and enable improvements to be planned before defects result in system failure. As the climate changes with increased likelihood of more frequent and intense rain events, it is imperative that infrastructure is managed effectively. These suggested practices are an investment in system resiliency through inherent improvement of system knowledge, operation, and condition.

CREVECOEUR, S., Environment and Climate Change Canada. **Characterisation of Lake Ontario microbial and algal communities with high throughput sequencing**.

Lake Ontario is rather oligotrophic and considered healthy based on water quality standard. However, Lake Ontario microbial and algal communities are highly impacted by anthropogenic stressors such as eutrophication, toxic pollution, invasive species (dreissenid mussels) and climate change. Therefore, a better understanding of the microbial and algal communities structure, which are at the base of the food web, are crucial to better assess Lake Ontario ecosystem health. Here we used high throughput sequencing of the 16S and 18S rRNA gene to characterize the microbial and algal communities composition in several Lake Ontario profiles taken during the summer of 2018. Results indicated that the microbial and algal communities varied greatly depending on the sample location, reflecting the influence of local environmental conditions. Regardless of the sampling depth, Actinobacteria and Cyanobacteria dominated the microbial community, and *Synechococcus* was the most abundant genus within the Cyanobacterial phylum. Further investigations are needed to better understand the impact of Lake Ontario ecosystem changes on microbial and algal communities and food web transfer in order to better understand how to manage Lake Ontario's health.

CURRIE, W.[1], BOWEN, K.[1], WATKINS, J.[2], RUDSTAM, L.[2], [1]Fisheries and Oceans Canada, [2]Cornell University. **Fate of productivity in Lake Ontario: the role of veligers of Dreissena**.

The offshore waters of Lake Ontario are now significantly more oligotrophic, a result of nutrient reductions subsequently affecting algal productivity. This was exacerbated by the introduction of filter feeding Dreissena polymorpha (zebra mussel) introduced in 1989 and its replacement by D. bugensis (quagga mussel) by the mid-1990s. The food web role of the planktonic veliger larvae of Dreissena however had not been well examined due to inadequate counts by programs and underestimates of biomass. Veligers of D. bugensis now account for a significant portion of the total zooplankton biomass within Lake Ontario. Coordinated sampling by agencies including DFO, US EPA, USGS, NY DEC, MNRF during the Cooperative Sampling and Monitoring Initiative in 2013 and 2018 allowed the first lake-wide estimates of veliger distributions. The use of stratified 64 μm nets and focus on density and biomass measures now permits an estimate of grazing potential for veligers relative to herbivorous crustacean zooplankton. We will discuss the spatial and temporal distribution of veligers, estimates of grazing rates and preliminary studies on fate of veliger production.

D

DAILY, J., HOFFMAN, M., Rochester Institute of Technology. **Modeling the 3D distribution and mass estimate of microplastic in Lake Ontario**.

Mass estimates of plastic pollution in the world's oceans based on surface samples differ by several orders of magnitude from what is predicted by production and input rates. It has been theorized that plastic accumulates in the sediment, or on beaches and nearshore water. This uncertainty indicates the importance of accounting for additional mechanisms driving movement, beyond surface transport, for improved mass estimates. Additionally, as plastic moves away from the surface, it is likely accumulating at lower depths or in the benthos, dictating which organisms are exposed, yet the vertical distribution remains not well understood. Here we present the first known three-dimensional modeling effort for Lake Ontario. This work allows for a first pass three-dimensional mass estimate and sediment deposition rate for Lake Ontario.

DANIEL, S.[1], BURLAKOVA, L.[1], KARATAYEV, A.[1], HEBERT, P.[2], PFRENDER, M.[3], LODGE, D.[4], TREBITZ, A.[5], [1]SUNY Buffalo, [2]University of Guelph, [3]University of Notre Dame, [4]Cornell University, [5]U.S. EPA Office of Research and Development. **Great Lakes DNA Barcode Reference Library: Mollusca, Annelida, and Minor Phyla**.

DNA-based tools have been improved greatly in recent years and can increase the scope of diversity surveys and detection of aquatic invasive species compared with traditional approaches. The development of complete species-specific libraries of DNA signatures is an essential step to enable taxonomically rich and spatially extensive species surveillance and monitoring. The Great Lakes Center at SUNY Buffalo State aims to expand the taxonomic coverage of The Barcode of Life Database (BOLD) DNA library and has assembled a collaborative team including leading barcoding and taxonomic experts for targeted taxa. By preliminary estimations, 70% Annelida, 34% Bivalvia, and 56% Gastropoda, and 70% minor phyla known from the Great Lakes lack barcodes. Collaborators have identified nearly 1000 specimens that have been plated and sent in for genetic barcoding. This presentation will focus on identifying possible cryptic species, and describing shortcomings and difficulties in genetic barcoding. Additionally, we will discuss progress made by our partners from Cornell and Notre Dame Universities, and recommendations for further research.

DITTRICH, M.[1], BLUKACZ-RICHARDS, A.[2], MARKOVIC, S.[1], [1]University of Toronto, Scarborough; [2]Environment and Climate Change Canada. **Speciation and bioavailability of particulate phosphorus in forested karst watersheds of southern Ontario during rain events**.

Understanding riverine phosphorus (P) dynamics, its transport, and transformation mechanisms from sources in the watersheds to receiving water bodies are essential for the development of effective strategies to decrease excess P loading and reduce eutrophication. Karst watersheds are thought to be especially vulnerable to P pollution due to their geomorphological features. In this study, we investigated the dynamics of particulate P (PP) chemical phases in two karst watersheds from a Great Lakes Area of Concern in southern Ontario (Bay of Quinte, Canada). Suspended solids were collected during different hydrological regimes representing storm events with low and high discharge, and particulate P binding forms were measured using extraction techniques. Our results show that in these karst watersheds, particulate P is dominated by chemical species that are likely to be highly bioavailable and contribute 6275% to total PP. Concentrations of these bioavailable P binding forms in suspended solids increase two- to three-fold on dry mass basis during periods of high river flow. Electron microprobe and energy dispersive X-ray spectroscopy suggest that the primary carriers of particulate P are aggregates of Fe oxyhydroxides and Al-silicates. Our results underscore the influence of particulate P sources on the ongoing eutrophication in the Bay of Quinte Area of Concern.

DOKOSKA, K.[1], DELANEY, F.[2], [1]Ontario Climate Consortium, [2]Environment and Climate Change Canada. **State of Climate Modeling in the Great Lakes Basin**.

In 2019, the Ontario Climate Consortium (OCC), in partnership with Environment and Climate Change Canada (ECCC) published a report summarizing the state of climate modeling in the Great Lakes Basin (GLB) through a review of existing Great Lakes regional climate modeling efforts and a binational experts workshop. The report assesses model strengths and limitations, knowledge gaps, the application of climate modeling in the GLB, and highlights key recommendations for climate modelers, users, and translators. The presentation will first showcase the results and recommendations of the state of climate modeling report and then share some of OCC's latest experiences in providing updated climate projections for municipalities and conservation authorities in and around Lake Ontario, including Durham Region, Toronto and Region Conservation Authority, and Ganaraska Region Conservation Authority. Building on insights from the report, these examples provide a consistent approach that can be applied to other localities within the GLB to study changes in regional climate. Climate modeling remains an important tool for understanding how the climate will change in the future, where and by how much, as well as future uncertainties to help inform planning and resilience-building efforts. Over the last few decades, climate modeling in the GLB has improved significantly. Most climatological studies in the GLB now use Regional Climate Models, which offer higher resolution outputs than Global Climate Models. While there have been significant strides in climate projections for the GLB, gaps still exist such as data collection, model development, and general understanding of the Great Lakes and their interactions with outside influences. By enhancing the way we examine current conditions, project future climate in the GLB, and communicate this information, we can equip decision-makers and resource managers with the necessary information to help reduce the negative impacts of climate change on GLB communities and residents and enhance resilience.

E

EDGE, T.[1], THOMAS, J.[2], [1]McMaster University and Environment and Climate Change Canada; [2]Ontario Ministry of the Environment, Conservation and Parks. **Microbial source tracking: 100 years of advances in fecal pollution source attribution in Lake Ontario**.

In 1913, an International Joint Commission (IJC) study involving 17 microbiology labs in Canada and the United States collaborated to identify sewage contamination hotspots and the health risks of untreated sewage releases in Lake Ontario and other Great Lakes. Since that time, the scale and challenges of different fecal pollution sources and human health risks have changed. There have also been advances in DNA technologies and microbial source tracking to better assess the sources of fecal pollution and associated health risks from diverse human and animal fecal sources. We summarize Lake Ontario studies in Niagara and Toronto Areas of Concern where water and stormwater samples were analyzed for E. coli and microbial source tracking DNA markers using a digital PCR technique. The HF183 DNA marker for human sewage was the most frequently detected DNA marker, occurring in 100% of samples from some sites in the Don River and some CSO and stormwater outfalls. Use of a human mitochondrial DNA marker and chemical markers like caffeine has provided additional evidence of sewage contamination. A gull DNA marker has also been widely detected, particularly at some beaches. Human DNA markers have been detected in many stormwater systems, including on dry weather sampling days, indicative of sewage cross-connections. The cumulative impact of many cross-connected stormwater outfalls is an under-recognized source of sewage contaminates such as pathogens, antimicrobial resistance, pharmaceuticals, and nutrients. Considering environmental changes over the past 100 years in the Great Lakes, and technology advances since 1913, the IJC is investigating the opportunity to conduct a new Centennial Study. This study could apply new microbial source tracking techniques to identify current fecal pollution hotspots and their sources, better assess health risks, and provide guidance for targeting remedial actions to reduce fecal pollution in Lake Ontario and other Great Lakes.

ELGIN, A.[1], GLYSHAW, P.[1], WEIDEL, B.[2], [1]NOAA Great Lakes Environmental Research Laboratory, [2]U.S. Geological Survey Great Lakes Science Center. **Depth-specific differences in quagga mussel growth and body condition in Lake Ontario**.

Long-term monitoring of invasive dreissenid mussels in Lake Ontario has revealed depth-specific population changes, with some density declines in shallow and mid-depth regions but gradual increases in deeper, offshore areas. Meanwhile, mussel biomass has increased lake-wide. To help elucidate the population trends observed in Lakes Ontario, Michigan, and Huron, we conducted a series of year-long field experiments to estimate quagga mussel growth. The Lake Ontario study was initiated in June 2018 near Oswego, NY in collaboration with the USGS Lake Ontario Biological Station. Mussels were deployed in cages on instrumented moorings at depths of 15m, 45m and 90m and retrieved in May 2019. We discovered that the highest growth rates occurred at 15m, followed by 45m. Further, quagga mussels at 45m and 15m in Lake Ontario had substantially higher growth and mortality rates compared to mussels in Lakes Michigan and Huron at similar depths. The low growth observed at 90m in Lake Ontario was similar across all three Lakes. In addition to this experiment, we also collected quagga mussel length-weight data from 12 sites across Lake Ontario during the CSMI Whole Lake Benthic Survey on board the EPA R/V Lake Guardian. We will present depth and regional trends in mussel body condition (relative tissue mass for a given length). Improving our ability to describe quagga mussel population dynamics is important for anticipating current and future changes caused by this highly impactful species.

EVANS, T.[1], FEINER, Z.[2], RUDSTAM, L.[3], MASON, D.[4], WATKINS, J.[3], REAVIE, E.[5], SCOFIELD, A.[6], BURLAKOVA, L.[7], KARATAYEV, A.[7], SPRULES, W.G.[8], [1]St. Mary's College of Maryland; [2]Wisconsin Department of Natural Resources; [3]Cornell University; [4]NOAA Great Lakes Environmental Research Laboratory; [5]University of Minnesota, Duluth; [6]Purdue University; [7]SUNY Buffalo; [8]University of Toronto, Mississauga. **Size spectra analysis in Lake Ontario detects food web changes and provides insight into energy transfer efficiency**.

Size spectra analysis (SSA) is an attractive approach for detecting changes in food webs because it simplifies complex community structures and predicts organism concentration at different body sizes. We applied SSA to phytoplankton and macrozooplankton (wet weight 2^-43 to 2^-2 g) data from 2006-2015 in the spring and summer in all the Great Lakes. We investigated how consistent the slope and height of the abundance-versus-weight size spectra were over the decade and between seasons. Slopes of the pelagic size spectra in summer were generally near the theoretical slope of -1.0, but spring slopes were steeper, reflecting larger differences in mass between small and large organisms. Lake Ontario slopes were the most consistent across the Great Lakes. The height (predicted number of organisms at the midpoint of the size spectra) was variable across the lakes, but stable in Lake Ontario over the decade examined; heights were higher during summer than spring in all lakes. Slopes became shallower when benthic data (wet weight 2^-21 to 2^3 g) collected in the summers of 2012-2015 were combined with pelagic data in Lake Ontario, suggesting benthic organisms may increase food web efficiency. Benthic data are not routinely included in SSA, but our results suggest they can have a strong impact on slopes and therefore on predictions of fish production; thus, inclusion of benthic data may be important in systems where benthic organisms contribute significantly to fish diets.

F

FANG, J., Toronto and Region Conservation Authority. **Assessing the condition of Toronto Harbour's benthic macroinvertebrate community**.

Benthic macroinvertebrate community was assessed from 13 stations covering nearshore areas in the Toronto Harbour in 2007, 2010 and 2018 as part of the Toronto and Region Conservation Authority's sediment monitoring program. The presence or absence of some species in the benthic macroinvertebrate community reflected the quality of the environment. For the purpose of this assessment, we focused on two indicators of biotic integrity: 1) the presences of invasive species (quagga mussel, zebra mussel, and New Zealand mudsnail), and 2) an oligochaete trophic index, which is based on the relative abundance of oligochaetes species. Quagga mussel remains the most abundant and widespread invasive species in the Toronto Harbour. New Zealand mudsnail has established as the dominant species at one station near the Toronto shoreline. A total of 24 species of oligochaetes were identified from our monitoring stations. The abundance and distribution of oligochaetes species varied with depth and location. Overall, Limnodrilus hoffmeisteri, an indicator of eutrophication, was the most abundant oligochaete species in this study.

FIGARY, S., HOLECK, K., WATKINS, J., RUDSTAM, L., Cornell University. **Comparing Lake Ontario's nearshore and offshore zooplankton communities using long term monitoring datasets**.

Long-term monitoring by GLNPO-EPA of the offshore zooplankton community composition in Lake Ontario found that between 1997 and 2016 the zooplankton community shifted from being dominated by cyclopoids to now calanoids, including Limnocalanus. However,

Lake Ontario also includes nearshore habitat that may be ecologically distinct from the offshore and may have a different zooplankton community composition and abundance due to increased human impacts, earlier spring warming and thermal stratification, and a mixed thermal layer that can include the benthic zone and therefore potentially higher dreissenid mussel effects. Nearshore habitats are also the most important habitat for many larval fish species. Monitoring of nearshore zooplankton and understanding of drivers of nearshore zooplankton is therefore important for fisheries management in Lake Ontario. This project is investigating the differences in the nearshore and offshore zooplankton community compositions over time using three existing long-term monitoring datasets to determine if the changes observed in the offshore habitat are also occurring in the nearshore zooplankton community. The New York DEC/USGS/USFWS/Cornell Biological Monitoring Program (BMP) includes monitoring of zooplankton, chlorophyll, secchi depth, and total phosphorus at seven nearshore sites biweekly from May to October since 1995. Here, we compare the zooplankton community observed at these nearshore sites with offshore samples collected by the BMP and GLNPO EPA. Additionally, the Cooperative Science and Monitoring Initiative monitors the same parameters as GLNPO in nearshore and offshore sites every five years. Using data from these three existing datasets, this project will determine if the community shifts observed offshore also has occurred in the nearshore habitat, if the nearshore zooplankton community is more variable than the offshore community, and if that increased variability is linked to other parameters, such as distance from shore, distance from major tributary, or timing of onset of stratification between years.

FITZPATRICK, M., MUNAWAR, M., NIBLOCK, H., Fisheries & Oceans Canada. **Exploring Microbial Food Web Changes in Lake Ontario, 1990 - 2018**.

Fisheries & Oceans Canada began studies of the microbial food web of Lake Ontario in 1990 under the LOTT (Lake Ontario Trophic Transfer) banner and showed that a variety of organisms including bacteria, picoplankton, heterotrophic nanoflagellates (HNF) and ciliates in addition to phytoplankton and zooplankton were important to the dynamics of the Lake Ontario food web. Over time, the relative importance of autotrophic and heterotrophic organisms to the microbial-planktonic food web has varied considerably. During the summer of 1990, autotrophs represented about 95% of the organic carbon pool whereas the 2003 survey found that 60% of the organic carbon was heterotrophic. Further surveys were conducted during 2008, 2013 and 2018 as part of the LOLA (Lake Ontario Lower Food Web Assessment) and CSMI (Coordinated Science and Monitoring Initiative) research efforts. The current paper will compare and contrast the results from these various surveys and present a long-term perspective on the state of microbial and planktonic communities in Lake Ontario.

FLAHERTY, T., MIDWOOD, J., SIMMONS, D., SHAHMOHAMADLOO, R., Ontario Tech University. **Determining the effects of harmful algae blooms and on fish from both environment and laboratory-based studies through the use of proteomics**.

The effects of harmful algae blooms (HABs) on wild, freshwater, large-bodied fish physiological processes has been underexamined. HABs are composed of cyanobacteria which produces toxic peptides called microcystins. Microcystins are known to cause liver hemorrhage and neurotoxicity in fish species. Collection of samples from wild fish in Hamilton Harbor and Lake Erie took place for the purpose of measuring toxic effects of HABs on a molecular level using plasma proteomics approaches. Plasma is useful for examining wild fish health because it contains proteins from the entire body which provides information on biological processes from different organ systems. In our design, we are also including fish exposed to harmful algae in a controlled laboratory environment to determine the effects on the plasma proteome as a positive reference for comparison to the wild fish. Our wild target species from Hamilton Harbor were Goldfish (Carassius auratus) and gizzard shad (*Dorosoma cepedianumi*), sampled before HABs formed in the spring, during peak HAB formation in late summer, and after the HABs started senescing in the fall. In the laboratory, Rainbow trout (*Oncorhynchus mykiss*) were exposed to microcystis aeruginosa in a 14-day uptake and depuration study. The blood plasma from both field and lab samples will be analyzed using liquid chromatography with tandem mass spectrometry (LC-MS/MS) in order to identify changes in the protein profile of fish before, during and after exposure to toxins. The purpose of this research is to identify biomarkers that can determine whether a fish has been exposed to cyanotoxins, and to understand how HABs affect fish biological processes.

FLOOD, B.[1], WELLS, M.[2], MIDWOOD, J.[2], BROOKS, J.[3], KUAI, Y.[1], [1]University of Toronto, Scarborough; [2]Department of Fisheries and Oceans Canada; [3]Carleton University. **Basin morphometry and wind direction structure the internal swash zone in Hamilton Harbour, Lake Ontario**.

Wind blowing over a lake drags the surface water downwind while deeper water flows upwind, resulting in a tilting of the thermocline. When the wind forcing stops, the water masses and thermocline oscillate back and forth around their equilibrium position producing basin-scale internal waves, or internal seiches, over timescales of hours to days. The area along the lakebed over which the thermocline washes, known as the internal swash zone, is thus repeatedly exposed to both the epilimnetic and hypolimnetic waters. Distinct water-quality parameters in the epilimnion (warm, well-oxygenated) and hypolimnion (cold, often poorly oxygenated) result in a dynamic internal swash zone with high temperature and dissolved oxygen variability. Repeat exposure to the often poorly oxygenated hypolimnion has the potential to impact habitat suitability for hypoxia-intolerant species, while fluctuating levels of turbulence and stratification can impact biogeochemical fluxes at the sediment-water interface suggesting physical processes in the internal swash zone can affect water quality and habitat availability at the basin-scale. While others have investigated the variability of temperature, water currents, and turbulence in the internal swash zone, the spatial variability of the internal swash zone, and how it is influenced by basin morphometry and wind direction, is poorly understood. I will present findings from field observations and modelling results where we investigated how basin geometry, bathymetry, and wind direction influenced the size and shape of the internal swash zone in Hamilton Harbour, Lake Ontario. A key finding of this work was that, in natural basins, the size and shape of the internal swash zone cannot be predicted from simplified upwelling parameters such as the Wedderburn number. High spatial and temporal resolution field observations or numerical modelling, or a combination of both, are required to fully map the internal swash zone in complex natural basins.

FRANCELLA, V.[1], GREEN, N.[2], O'CONNOR, K.[3], VANDEN BYLLAARDT, J.[3], [1]Toronto and Region Conservation Authority, [2]Niagara Peninsula Conservation Authority, [3]Hamilton Harbour RAP. **Eat Safe Fish: A Collaborative Engagement with the Mississaugas of the Credit First Nation**.

In 2019, the Mississaugas of the Credit First Nation Department of Consultation & Accommodation (DOCA) in collaboration with the Niagara River, Hamilton Harbour and Toronto & Region Remedial Action Plans developed a project to engage the Mississaugas of the Credit First Nation community on the topic of safe consumption of local fish. The intention of the collaboration was to collect information on which fish local anglers were catching and eating within the Niagara River, Hamilton Harbour and Toronto Area of Concerns (AOCs), while also disseminating information on which fish could be safely consumed within each AOC, in efforts to better address

the Restrictions on Fish Consumption Beneficial Use Impairment shared by all 3 AOCs. This is a presentation on the collaborative process employed and of its outcomes.

FRANK, H., GREEN, N., Niagara Peninsula Conservation Authority. **Whatcha Eatin'? A Robust Approach for Determining Niagara River Fish Consumption**.

The Niagara River is a channel in the Great Lakes basin that connects Lake Erie to Lake Ontario over a span of 58 kilometers. In 1987, the Niagara River was designated as an Area of Concern (AOC) due to ecosystem health and water quality issues, which included restrictions on the consumption of fish. A world class fishery and fishing destination, the river offers anglers a wide variety of species and scenic landscapes. Being able to eat fish from the Niagara River is considered a beneficial use; however, legacy pollutants in the AOC result in restrictions on the amount of fish people can eat, depending on species and size. In order to address fish consumption issues and to better inform monitoring and outreach needs, the Canadian Niagara River Remedial Action Plan (RAP) team designed and implemented a robust approach to surveying local anglers. Our approach includes in-person and online survey methods, passive methods at targeted locations, visually-appealing outreach materials, social media marketing, and other tailored engagements approaches (e.g., fish fry and survey with a local Indigenous community). To date, this fish consumption survey approach has been highly effective in encouraging participation from various anglers (i.e., boat and shore fishers) at different locations, provided an opportunity for sharing educational information about eating safe fish, and has engaged anglers from various parts of the community and from non-English speaking backgrounds. The data collected from this multifaceted approach will support the Canadian Niagara River RAP team in future assessments and decision-making related to the 'Restriction on Fish Consumption' beneficial use impairment. Since fish consumption is a common impaired beneficial use at various AOCs, other RAP agencies in the U.S. and Canada will be interested to learn about the approach, which could be tailored and implemented at their specific AOC.

FURGAL, S.[1], COLLINGSWORTH, P.[2], [1]Cornell University, [2]Illinois Indiana Sea Grant. **Overview of Lake Ontario CSMI activities in 2018**.

The binational Cooperative Science and Monitoring Initiative (CSMI) under Annex 10 (Science Annex) of the Great Lakes Water Quality Agreement coordinates agency science and monitoring in support of management of the Great Lakes ecosystem. The process includes enhanced monitoring and science-based field activities which are conducted in one Great Lake per year, tied to the information needs identified by the Lake Partnerships. The 2018 Lake Ontario CSMI investigations by federal agencies and partners addressed key knowledge gaps among the six broad themes including characterizing nutrient concentrations and loadings, understanding nearshore nutrient issues, evaluating the status of the aquatic food web, understanding fish dynamics, characterizing critical and emergent pollutants and evaluating the status of coastal wetlands. Here, we will provide an overview of the CSMI five-year cycle that involves the development of science priorities, field year planning, intensive field year science and monitoring, analysis and reporting to decision-makers. Highlights from reporting and outreach efforts on other lakes are also discussed.

FUTIA, M.[1], LANTRY, B.[2], LANTRY, J.[3], JOHNSON, J.[4], CONNERTON, M.[3], RINCHARD, J.[5], [1]University of Vermont, [2]U.S. Geological Survey Lake Ontario Biological Station, [3]New York State Department of Environmental Conservation, [4]Ontario Ministry of Natural Resources, [5]SUNY Brockport. **Thiamine deficiency monitoring in Lake Ontario lake trout during the 2013 and 2018 CSMI**.

Thiamine Deficiency Complex (TDC) is a nutritional health issue that likely causes an early life-stage bottleneck for lake trout populations in the Great Lakes region. TDC is associated with a diet rich in alewife and is most frequently characterized by low thiamine (vitamin B1) concentrations in eggs due to poor maternal transfer. As a result, offspring mortality is often elevated between the yolk-sac and swim-up stages. To determine the prevalence and severity of TDC in lake trout from Lake Ontario, we monitored egg thiamine concentrations during the Cooperative Science and Monitoring Initiative conducted in 2013 and 2018. Average thiamine concentrations in lake trout eggs were 11.5 ± 7.5 and 9.9 ± 5.0 nmol/g in 2013 and 2018, respectively. While the average concentrations were above the recommended management threshold of 4 nmol/g, multiple females produced eggs below this recommended level. In addition, secondary effects associated with low thiamine concentrations (e.g., reduced predator avoidance) may occur at concentrations greater than 4 nmol/g and likely further increase offspring mortality under natural conditions. As a result, TDC may still be an impediment to lake trout recruitment in Lake Ontario. During the presentation, we will explore spatial and temporal differences in egg thiamine concentrations.

G

GEORGE, S.[1], BALDIGO, B.[1], COLLINS, S.[2], CLARKE, D.[3], WINTERHALTER, D.[1], [1]U.S. Geological Survey, [2]Niagara County Soil and Water Conservation District, [3]New York State Department of Environmental Conservation. **Status of resident fish communities in the Eighteenmile Creek Area of Concern, New York**.

The lower 3.5 km of Eighteenmile Creek, a tributary to Lake Ontario in New York, was designated as an Area of Concern (AOC) in 1985 under the Great Lakes Water Quality Agreement due to extensive contamination of bed sediments by polychlorinated biphenyls (PCBs) and other toxicants. Five beneficial use impairments (BUIs) have been identified in this AOC, including degraded fish and wildlife populations. We used boat electrofishing to characterize fish communities in five subreaches of the Eighteenmile Creek AOC and in a comparable section of a nearby reference stream (Oak Orchard Creek) during June 2019 to infer whether legacy contaminants are currently impairing fish communities in the AOC to an extent that they differ from the regional reference condition. Estimates of community abundance, biomass, diversity, and fish condition (relative weight of several common species) from each system were compared using a noninferiority testing framework. This statistical approach puts the burden of proof on demonstrating equivalence, rather than difference, and is appropriate when the goal of management action is to restore the condition of an impacted area to that of the surrounding area. Biomass, diversity, and fish condition in the Eighteenmile Creek AOC were similar or superior to that in Oak Orchard Creek, while total abundance was 20% lower in the AOC. These findings and those of a 2007 sampling effort suggest that fish communities in the Eighteenmile Creek AOC are not impaired despite recent studies indicating that PCBs are bioaccumulating in fish tissues at 1-2 orders of magnitude above background levels. Our findings will be integrated with data on the condition of benthic macroinvertebrate communities and the potential toxicity of local contaminants to piscivorous wildlife in order to fully address the remaining aspects of the fish and wildlife populations beneficial use impairment.

GILES, R.[1], ROCHMAN, C.[1], RUPPERT, J.[2], WALLACE, A.[2], [1]University of Toronto, [2]Toronto and Region Conservation Authority. **Plastic Pollution in a Lake Ontario Tributary: Impacts of rubber microplastics on benthic macroinvertebrate communities**.

Globally, urbanization continues to increase and produce elevated levels of contaminants (e.g., metals, pesticides) in the air, soil, and water within and around urban centers. In particular, heavily trafficked roads are a source of rubber microplastics and other anthropogenic contaminants including polycyclic aromatic hydrocarbons (PAHs), heavy metals, and road salt to Lake Ontario, entering the lake through rivers and streams. This contaminant mixture represents one of the largest contributors of diffuse-source toxicants in urban areas, and yet is seldom studied as a contaminant mixture. Here we investigate how microplastics and other contaminants impact ecosystem structure and function in the Humber River, a Lake Ontario Tributary. Specifically, we (1) investigate microplastic and other contaminant fluctuations over a five-month period, and (2) assess community-level invertebrate responses to these contaminant loads in urban streams. Preliminary results demonstrate that microplastics in urban sites are greater than rural sites, and tire dust is found in greater proportions in urban areas compared to rural areas. We detected differences in community composition of benthic macroinvertebrates between rural and urban sites. This study builds on our understanding of how microplastics and other anthropogenic contaminants impact stream communities, and has the potential to help inform future policy and urban development decisions.

GRIMM, A.[1], SHUCHMAN, R.[1], SAYERS, M.[1], PENNUTO, C.[2], [1]Michigan Tech University, [2]SUNY Buffalo. **Long-term and Lake-Scale Satellite Monitoring of Lake Ontario Cladophora**.

The problem of nuisance Cladophora growth in Lake Ontario has varied both spatially and temporally. Using Landsat-8 OLI imagery and a semi-automated water column correction method, we generated an updated ca. 2018 classified map of the extent of Cladophora and other submerged aquatic vegetation (SAV) in the nearshore zone across the lake. The results were compared with a baseline ca. 2010 map generated using Landsat TM imagery. The maximum mapping depth for the updated map varied with water clarity, with a lake-wide mean of 8.2 m and standard deviation of 3.9 m. We were able to classify 970 km2 of lake bottom using this approach compared to the 790 km2 of Lake Ontario mapped in 2010. Approximately half (109 km2) of this increase reflects an increase in the map extent to include more of the St. Lawrence River connecting waterway, while the other half represents an approx. 9% increase in the maximum mapping depth due to the combined effects of an improved satellite sensor and increasing lake clarity. The 2018 map shows that approximately 440 km2 or 45% of the satellite-visible bottom of Lake Ontario is colonized by SAV, compared to 40% in 2010. The map was validated using field observations collected by both American and Canadian partners. The archive of Landsat imagery dating back to 1973 was also utilized to document longer-term changes in SAV extent and water clarity for two sentinel locations near Ajax, Ontario and Olcott, New York, showing a decrease in SAV extent after the addition of phosphorus goals to the Great Lakes Water Quality Agreement followed by a resurgence after the introduction of invasive mussels. These updated map resources will support Cladophora management efforts and help to prioritize areas for nutrient abatement programs.

GURDAK, D., SULLIVAN, C., U.S. EPA. **Improving information sharing through participatory CSMI database efforts**.

Samples and data collected during the CSMI field year are traditionally analyzed and brought together into databases for analysis and report writing. This talk use the participatory 2018 Lake Ontario CSMI effort to discuss opportunities and propose procedures to improve data sharing amongst researchers and the public. These procedures will enhance CSMI analyses and reports while facilitating the development of an actionable research agenda to maximize the science in CSMI activities.

GUTIERREZ, R., DEBRECENI, S., ROCHMAN, C., RISKIN, S., University of Toronto Trash Team. **Creating a waste free tomorrow: Assessing waste literacy and behaviour change in grade 5 students**.

In response to a growing necessity to implement awareness raising campaigns to inform behaviour change toward more sustainable consumption and use of plastic products, the University of Toronto Trash Team has developed a school program to improve scientific and waste literacy among elementary students. Our team of undergraduate and graduate students, postdocs, staff and researchers are working towards a common goal to increase waste literacy in our community while reducing plastic pollution in our ecosystems. Designed for grade 5 curriculum, our goal is to foster a sense of curiosity about the natural world and human impacts on the planet through the lens of plastic pollution and aquatic ecosystems. Four lessons were co-created by our team that explore our relationship with plastics: 1. Plastics Cycle 2. Watersheds and their Relationship to Litter 3. Impacts of Plastic on our Ecosystems 4. Solutions to Plastic Pollution. These include direct connections to research by our team, all early-career scientists with a predominant focus on the Great Lakes. Developed with a peer-to-peer framework, lessons are facilitated in the elementary classroom by our team, who become mentors to these elementary students, opening their eyes to career options available in STEM. In order to assess the effectiveness of these lesson plans and the impact of program, we are studying how the lessons impact knowledge, attitudes, and self-reported behaviours in participating children toward aquatic litter and plastic pollution. To address this, we will use short paper questionnaires pre- and post- participation. The baseline survey will be administered as part of the classroom activities associated with the lesson plan and the same survey will be administered with the help of teachers several weeks following the lesson. Results will enable us to discuss effective strategies to engage children in the topic of plastic pollution in lakes, rivers and oceans.

H

HEER, T., WELLS, M., MANDRAK, N., University of Toronto, Scarborough. **Asian carp spawning success: Predictions from a 3-D hydrodynamic model for Toronto's Don River**.

Asian carps are threatening to establish in the Great Lakes basin and the examination of factors leading to spawning success is vital for preventive efforts. Hydrodynamic modelling can determine if successful hatching of carp eggs can occur in a tributary, by predicting egg movement during a spawning event to see if hatching can occur before eggs settle. A 3-D hydrodynamic model, coupled with a Lagrangian particle tracker, was used to assess hatching rates of three Asian carp species (bighead, grass, and silver carps) in different temperature and flow scenarios in the east Don River, a potential spawning tributary to Lake Ontario. In-river hatching rates were highest in scenarios with warmer summer water temperatures (23–25 °C) and flow magnitudes of 15–35 m3/s, which occur at least once every year. Using a 3-D hydrodynamic model allowed the inclusion of low-velocity zones where eggs become trapped in lower flow scenarios, thereby reducing modelled hatching success. In-river hatching rates were significantly reduced when the spawning location was moved close to the mouth of the river, with no modelled hatching if spawning occurred in the lower 8 km of the Don River, indicating that preventing Asian carp movement upstream would viably reduce the chances of successfully spawning occurring in this tributary. The magnitude of reduction in spawning success caused by limiting Asian carp passage upstream can guide preventative strategies and the method of using a 3-D hydrodynamic model as a predictive tool could be applied in similar tributaries across the Great Lakes basin.

HEINEMANN, K., U.S. EPA. **Lake Ontario Annex 4 Nutrients Objectives and Targets Task Team – 2020 /2021 Charge and Status**.

As described in Annex 4 of the 2012 Great Lakes Water Quality Agreement (GLWQA), Canada and the United States manage nutrient issues in the Great Lakes by establishing phosphorus concentration and loading targets required to meet Lake Ecosystem Objectives for each of the Great Lakes. In Spring 2020 the binational GLWQA Annex 4 Subcommittee established and charged a new Task Team to assess the state of the science and to determine whether or not to recommend a revision of the GLWQA interim targets for P concentration of 10ug/L and a load of 7000 Metric Tonnes Total P Per Year. The Task Team held several meetings beginning in October 2020 and will continue its work through early summer 2021. Canadian and US Task Team co-chairs will report out on progress and process to date as well as the outlook for completion of the Task Team's work to address all aspects of the Annex 4 Subcommittee Charge.

HEISEY, A.[1], LANTRY, B.[2], CONNERTON, M.[3], RINCHARD, J.[1], [1]SUNY Brockport, [2]U.S. Geological Survey, [3]New York State Department of Envionmental Conservation. **Spatial variability of thiamine concentration and fatty acid signatures in lake trout**.

In Lake Ontario, thiamine deficiency is considered a recruitment bottleneck for lake trout posing a challenge to the recruitment of wild fish. Diminished reserves of thiamine in adult fish result in reduced transfer to the eggs during spawning, leading to neurological impairments and overall mortality in the offspring. Since thiamine cannot be synthesized de novo, the forage base is the primary driver of thiamine deficiency. Throughout the Great Lakes, the consumption of an alewife rich diet is the primary cause of thiamine deficiency. Recently, wild recruitment has been observed in the western basin of the lake. Furthermore, the forage composition of the lake trout has undergone a recent shift, with the round goby becoming increasingly central. In this study, we use fatty acid signature analysis to infer diet selection in lake trout across an east-west spatial scale in Lake Ontario from 2019. In addition, the analysis of egg thiamine concentration seeks to link changes in forage composition to the observed wild recruitment observed in the western basin. The results underscore the need for continued monitoring of thiamine concentrations in the face of changing prey composition.

HELLQUIST, E.[1], WALSH, M.[2], WEIDEL, B.[3], BENJOU, L.[1], EARL, E.[1], BAILINE, R.[1], KUHN, D.[1], RAYMOND, C.[1], [1]SUNY Oswego, [2]U.S. Fish and Wildlife Service, [3]U.S. Geological Survey. **Plastic abundance across habitats and biota of Lake Ontario: Shoreline wrack, prey fish, and introduced salmon**.

The benthic, limnetic, littoral, and shoreline habitats of Lake Ontario contain plastics that have the potential to alter habitat quality and enter biota. We sampled shoreline macroplastics in southeastern Lake Ontario. We also measured microplastics in prey fish throughout the basin as well as Chinook and Coho salmon from the Salmon River watershed. Across four shoreline locations, the greatest concentration of surface plastics averaged 20.5 g/m2. Flat plastic shards were the most abundant surface plastics followed by bottle caps, fragments, straws, shot gun wadding, styrofoam, and personal hygiene products. To assess how plastics may be incorporated into biota, we sampled round goby (n=153), deepwater sculpin (n=14), slimy sculpin (n=18), and alewife (n=145) from 18 locations throughout Lake Ontario (depth 6-130 m). Plastics were found in 97% of the fish sampled. Fibers were recovered from 89%, fragments from 47%, and beads from 5% of the fish. Across all species, we recovered 0-17 fibers, 0-7 fragments, and 0-8 beads per fish. Slimy sculpin had the greatest mean particulate count per fish (7.7), followed by round goby (4.7), alewife (4.4), and deepwater sculpin (2.3). For salmon, 92% of Chinook contained plastics (n=40) and all Coho contained plastics (n=33). Chinook averaged 4.0 fibers (range 0-19) and 0.1 fragments (range 0-1) per fish whereas Coho had 3.7 fibers (range 1-8) and 0.72 (range 0-5) fragments per fish. Fourier Transform Infrared Spectroscopy (n=3) indicated fiber samples were PETE plastics used in food packaging and plastic textiles. Our results demonstrate the ubiquity of plastics in Lake Ontario and illustrate the need for integrative field and experimental studies to better understand the impacts of these xenobiotics.

HELM, P., KLEYWEGT, S., RABY, M., MCGILL, S., Ontario Ministry of the Environment, Conservation and Parks. **Changes in PFAS concentrations in Lake Ontario surface waters following restrictions on production and use**.

Per- and polyfluoroalkyl substances (PFAS) are contaminants occurring widely throughout the Great Lakes environment. Several PFAS substances have been the focus of regulatory efforts due to their persistence, bioaccumulation potential and toxicity concerns, with phase-outs and regulatory actions undertaken since the early 2000's. For example, regulations restricting the use of perfluorooctane sulfonate (PFOS) were introduced in Canada in 2008, and regulations on perfluorooctanoic acid (PFOA) and long-chain perfluorocarboxylic acids were introduced more recently in 2016 in Canada. Surveys of Great Lakes surface waters were undertaken in 2005-2007 and again in 2018-2019 to assess occurrence of PFAS compounds and determine whether concentrations had changed in response to regulatory and market changes. Surface water grab samples were collected from sites of the Great Lakes Nearshore Index and Reference Station network in Lakes Ontario, Erie and Superior as part of the Great Lakes Nearshore Monitoring and Assessment Program. Concentrations of ΣPFAS10, the sum of 10 PFAS compounds measured in both time periods, declined significantly from a mean of 10.4 ng/L (8.96-11.9, 95% confidence interval (CI)) to a mean of 7.30 ng/L (6.73-7.88 ng/L, 95% CI). In Lake Ontario, mean PFOS concentrations declined from 6.7 ng/L in 2006 to 2.5 ng/L in 2018. Short-chained PFAS compounds were not measured in 2005-2007, but concentrations in Great Lakes waters in 2018-2019 averaged 0.33 to 2.86 ng/L for individual compounds (e.g. perfluorobutane sulfonate and perfluorobutanoic, -pentanoic, and -hexanoic acids). Lake Ontario and Great Lakes water concentrations are responding to regulatory measures and market changes in the use of PFAS compounds.

HILL, B., Environment and Climate Change Canada. **The Ins and Outs of Environment and Climate Change Canada Water Quality Monitoring Upstream and Downstream of Lake Ontario**.

Environment and Climate Change Canada (ECCC) has been monitoring Niagara River water quality in support of the Great Lakes Water Quality Agreement since first establishing a fixed sampling site at Niagara-on-the-Lake in 1975. Over the following decade, additional sites were added at the head of the river in Fort Erie, at the entrance to the St. Lawrence River at Wolfe Island, and at Point Edward and Port Lambton in the St. Clair River. These "connecting channels" sites are used to identify exceedances of water quality guidelines, to assess current water quality conditions, and to evaluate trends and have become key component of the Niagara River Toxics Management Plan, the St. Clair River Remedial Action Plan, and the St. Lawrence River Action Plan. For Lake Ontario, ECCC's monitoring on the Niagara River provides and assessment of the current status and long-term trends of nutrients, major ions, trace metals, and organic contaminants entering from upstream sources in the Great Lakes and similar samples collected at Wolfe Island provide the means to assess the timing and magnitude of the deposition and transfer of these water quality compounds within the lake itself. Data generated from ECCC's monitoring are used to identify exceedances of water quality guidelines, to assess current water quality conditions, and to evaluate trends. This presentation assesses water quality conditions and guideline exceedances for organic contaminants, trace metals, nutrients, and major ions in water and solids over the past decade.

HLEVCA, B.[1], WELLS, M.[2], [1]Ontario Ministry of Environment, Conservation and Parks; [2]University of Toronto. **Small oscillations in Toronto Harbour and their effect on flushing shallow embayments**.

Water circulation in Toronto Harbour plays a key role in determining water quality and water temperatures, thus implicitly influencing its fish habitat. Previous studies have noted the role of upwelling events and wind driven flows in determining the water exchange of the deep Inner and Outer Harbours. However, the role of frequent water level oscillations on flushing the many shallow embayments of Toronto Harbour, has been overlooked. These shallow regions form a large portion of the harbour's fish habitat and are important components of the "Status of Wildlife Habitat Loss" and "Degraded Wildlife Populations" BUIs of the Toronto Harbour Remedial Action Plan. In this study we quantify the dominant water level oscillations within the two large basins of the Inner and Outer Harbour, and then determine the role these high frequency modes have in flushing the adjacent shallow embayments around the harbour. Field observations find two dominant modes with periods of ½ and 1 hour, in agreement with theory and numerical modelling. These modes have amplitudes of up to 10 cm, and as the water rises and falls, periodic currents of up to 0.4 m s^{-1} flow in and out of the shallow embayments. Given that many shallow embayments of the harbour are less than 2 m deep, these strong flows have the potential to exchange a large fraction of the water every few days. We used numerical models to help interpret our findings for flushing timescales and discuss their potential impact upon the temperature regime of the shallow embayments.

HOLDA, T.[1], RUDSTAM, L.[1], WATKINS, J.[1], POTHOVEN, S.[2], WARNER, D.[3], O'BRIEN, T.[3], BOWEN, K.[4], CURRIE, W.[4], O'MALLEY, B.[3], BOYNTON, P.[1], JUDE, D.[5], [1]Cornell Biological Field Station, [2]NOAA Great Lakes Environmental Laboratory, [3]U.S. Geological Survey Great Lakes Science Center, [4]DFO Great Lakes Laboratory for Fisheries and Aquatic Sciences, [5]University of Michigan. **Comparing mysid abundance and trends across the five Great Lakes**.

Mysis diluviana is a small offshore crustacean native to the Great Lakes where it is an important prey for fishes and a consumer of zooplankton and phytoplankton. In the past 50 years, major ecosystem changes have occurred in several of the Great Lakes (e.g., offshore oligotrophication, loss of Diporeia, multiple invasive species). Understanding concurrent patterns in Mysis abundance in each of the Great Lakes will help us better understand the Mysis population in Lake Ontario. Using the available EPA GLNPO Mysis data, Jude et al. (2018) found that Lake Ontario had the highest pelagic Mysis densities during 2006-2016, followed by lakes Superior, Michigan, Huron, and then Erie. In addition, Jude et al. detected no significant changes in Mysis abundance in 2006-2016 in lakes Michigan, Huron, and Ontario (although they found a significant increase in Lake Superior). However, 10 years of data is limited for detecting trends, and the time period prior to 2006 may have been particularly important, especially in Lake Huron where large ecological changes occurred in 2003-2004. We expanded on previous analyses by adding: 1) recent (2017-2019) Mysis catches in the GLNPO sampling program; 2) Mysis catches in GLNPO deep nighttime zooplankton nets from 1997-2019; and 3) Mysis catches in annual monitoring programs run by NOAA GLERL (L. Michigan), USGS GLSC (L. Michigan and L. Huron), and DFO

GLLFAS (L. Ontario) within the timeframe of 1997-2019. We found: 1) Lake Ontario had highest abundance of all lakes during 1997-2019; 2) Lake Ontario Mysis abundance has been very stable since 1997 – in contrast with historic (mid-2000s) and recent (past decade) declines in lakes Michigan and Huron and with increasing abundance in Lake Superior (1997-2019). Although the results from Michigan and Huron suggest an effect of oligotrophication, the results from Lake Ontario indicate a stable mysid population.

HOLLENHORST, T.[1], MCKINNEY, P.[1], MELENDEZ, W.[2], PAUER, J.[1], [1]U.S. EPA Great Lakes Toxicology and Ecology Division, [2]General Dynamics Information Technology. **Can Autonomous Glider Results be Used to Ground Truth a Hydrodynamics Model? An Example from Lake Ontario CSMI 2018**.

During the spring and summer of 2018, we guided an autonomous underwater glider along the south shore of Lake Ontario over two different periods (May 23- June 12 and July 27 – August 14). We programed the glider to surface every two hours at which time it would collect GPS waypoints, and connect to the base station via iridium satellite communications. At that time, we could download decimated data from the glider to check sensor functionality and data inspection while also providing new waypoints or instructions as necessary. Underwater the glider navigates via blind reckoning using information from its last surfacing waypoints and the direction to its next waypoint. Once it surfaces again it checks its location against the intended waypoint and then calculates depth averaged current velocity and direction to help it navigate to the next waypoint. The depth averaged current values are also stored as part of the gliders mission data files and are available during and after each mission for inspection and analysis. The two Lake Ontario missions in 2018 resulted in 241 (May-June) and 237 (July-Aug.) surfacing's for which depth averaged current values were calculated. We compared these depth-averaged current values to hydrodynamics model outputs of current velocity and direction coincident with each surfacing's day and time. The glider transects were between the Niagara River and Rochester, NY parallel to the southern shore in less than 40 meters of water and flew out perpendicular to shore about every 20 kilometers. This allowed us to compare alongshore and offshore gradients of temperature, turbidity and conductivity as well as current velocity and direction from both the glider data and from the EFDC model outputs. Direct comparisons of glider current velocity and direction data to EFDC model outputs will be discussed as well as alongshore and offshore differences.

HOWELL, T., BENOIT, N., Ontario Ministry of the Environment, Conservation and Parks. **Nutrient Footprint on the Toronto-Mississauga Waterfront of Lake Ontario**.

The extent of nutrient enrichment over the urbanized shoreline of western Lake Ontario bordering the Cities of Toronto and Mississauga was investigated in 2018. Concentrations of total phosphorus were higher and more wide-ranging compared with nearshore reference areas in eastern Lake Ontario. Area-weighted chlorophyll a was higher from the mouth of the Credit River to Humber Bay west of Toronto Harbour compared to the east from the Toronto Beaches to the Rouge River, a pattern seen broadly in concentrations of phosphorus fractions and nitrates. Concentrations of phosphate measured by mass spectrometry, and using an internal standard to minimize sampling losses, were higher in Toronto Inner Harbour, near waste water outfalls, river mouths, and to varying extent over the mixing areas of these discharges. Chlorophyll a suggested broadly oligotrophic to oligo-mesotrophic conditions despite areas with nutrient fractions suggestive of more productive conditions. Toronto Inner Harbour was mesotrophic, with wide-ranging levels of phosphorus fractions strongly influenced by the variable loading from the Don River into the harbour. Blooms or scums of planktonic algae were not observed. Elevated concentrations of phosphate were found at shallow depths suitable for growth of the green algae Cladophora. As these urban areas continue to grow, it is advisable to monitor the effects of additional nutrient loading that may exacerbate growth of algae, given that present conditions indicate variable but pervasive nutrient enrichment.

HRYCIK, A., MEHLER,K., BURLAKOVA, L., KARATAYEV, A., SUNY Buffalo. **Lake Ontario Dreissena dynamics as revealed by video analysis**.

We conducted a lake-wide survey of Dreissena mussels in Lake Ontario as part of 2018 CMSI efforts. Video imaging on Ponar grabs (59 sites) and benthic sled transects (57 sites) enabled us to calculate estimates of Dreissena coverage across Lake Ontario. Dreissena density and biomass were highest at mid-depth sites (30-100m), with smaller mussels dominating at shallower depths. We found non-linear relationships between Dreissena coverage from video analysis versus biomass and density from Ponar grabs due to larger average Dreissena sizes in areas of high coverage. Nonetheless, results corresponded well between methods. Furthermore, image processing coverage calculations were similar between researchers, suggesting high repeatability of our methods. Our results demonstrate that image analysis can be a powerful tool for monitoring benthic communities in concert with traditional sample collection.

J

JIANG, G., VRIENS, B., BENTLEY, C., PINTER, J., Queen's University. **"Top-down" analysis of trace metal transport through the Great Lakes**.

The number and quantities of trace metals used in the energy and communication sectors, (pharmaco)chemical industry, and high-tech consumer products are rapidly increasing. Examples include silver used in textile antimicrobials, gadolinium in medical contrast agents, and an increasing number of other platinum group elements and rare earths. Unfortunately, conclusive data on the environmental concentrations of these elements is still very scarce: trace metals are typically not part of governmental surveillance programs as quantification at (ultra-)trace levels in natural samples remains challenging. The waste streams, environmental emissions and impacts of trace metals therefore remain poorly quantified to date. We are working to examine the environmental footprints of human trace metal use in the Great Lakes basin. We use a top-down approach: decades of aggregated hydrometrics and federal water quality surveillance data are supplemented by new ultra-trace level measurements of metals in freshwater and wastewater effluent samples to produce 'black-box' mass-balances and loading estimates through the Great Lakes. Using calibrated water budgets and existing surveillance data, we determined the fluxes of various heavy metals (Pb, Cd, Zn, Cu, Hg) and select emerging trace metals (Ag, Gd). Preliminary results reveal that the biogeochemical processes controlling the distribution of the investigated trace metals (e.g., bioaccumulation, sedimentation) vary as expected based on their aqueous geochemistry. Anthropogenic forcing on large-scale metal budgets (e.g., through wastewater effluent and industrial discharge) could be identified for select trace metals. Our current efforts focus on adding additional trace metals to our mass balance models and on geospatially tracking input anomalies to geogenic trace metal sources and/or specific human applications.

JOCK, J., Saint Regis Mohawk Tribe. **Integrating Indigenous Traditional Ecological Knowledge and Scientific Ecological Knowledge for restoration in an AOC**.

Case study of how Saint Regis Mohawk Tribe's Environment Division applied reciprocal learning amongst Mohawk experts (i.e Kanien'keha language, ceremony and traditions, knowledge holders for plant medicines, etc.) and professionals (i.e. Archeologist, Botanist, etc) of varying backgrounds for a comprehensive interdisciplinary learning environment of both sciences and cultural teachings for understanding Grasse River Indian Meadows significance to Mohawks past, present, and future. Collective learning experience guided plant restoration decision making in the Grasse River Indian Meadows, as part of the Superfund Site and St. Lawrence River Area of Concern (AOC).

JOHANNSSON, O., DERMOTT, R., MILLARD, S., Fisheries and Oceans Canada. **The DFO Bioindex Program: its History and Value to Lake Ontario Monitoring**.

The Lake Ontario Bioindex Program was conceived to provide information on the health of Lake Ontario and to monitor the response of the lake to management actions, such as phosphorus control. A holistic approach was adopted to ecosystem monitoring, emphasizing lower trophic level composition and productivity. This approach necessitated frequent (weekly) sampling throughout the ice-free season and inclusion of a suite of physical and chemical environmental measures. The value of the program was quickly recognized and led to lasting partnerships with fisheries management agencies both provincially and bi-nationally. The Bioindex Program has provided vital information on within system relationships, changes over time and inter-annual variability. The Bioindex data have been used to evaluate the response of the lower trophic level community (and thus the lake ecosystem) to decreasing phosphorus levels and changes in the fish community. The holistic approach to monitoring also enabled the evaluation of other environmental problems, such as invasive species and climate change, on the ecosystem. Now the information from the Bioindex Program provides a strong base against which later ecosystem changes have been and will continue to be assessed.

JOHNSON, A., **Indigenous perspective of lake sturgeon, muskrat, and beaver**.

Lake sturgeon, muskrat, and beaver are considered culturally significant species for Haudenosaunee people. They have historically been significant food sources for Indigenous peoples, as well as impacted by legacy organochlorine contaminants such as PCBs around the lake. This talk will provide an overview of knowledge, cultural stories, and community adaptations specific to these impacted species as considered important from a Mohawk sturgeon fisherman and subsistence trapper perspective.

JOHNSON, T.[1], KLINARD, N.[2], FISK, A.[2], [1]Ontario Ministry of Natural Resources and Forestry, [2]University of Windsor. **Using acoustic telemetry to assess potential for bloater restoration in Lake Ontario**.

Canadian and U.S. agencies are committed to restoring a self-sustaining population of bloater (Coregonus hoyi) in Lake Ontario within the next 15 years. Fish culture have developed captive rearing and brood stock programs to rear bloater for re-introduction but what is the fate of these bloater once stocked. We used acoustic telemetry to investigate behaviour, habitat use and survival of stocked bloater (21-400g) between 2015-19. Tagged bloater rapidly descended to the lake bottom but short-term mortality was high (58% in the first 2 weeks) with predation being the primary mechanism (~40% in the first 2 weeks, average time to death 5.5 d). Compression trauma may have contributed to the remaining mortality and is being investigated; this mechanism could also have important implications for other stocked fishes. Of the bloater that survived, they quickly dispersed from the stocking location showing a preference for deep water (>40m) with little evidence of schooling. Bloater exhibited extensive diel vertical migration, moving to near surface depths in the isothermal water column during the night (stocking occurred in November and April) and returning to near bottom depth during the day. Such behaviour is energetically costly and increases vulnerability to visual predators. Successful restoration of bloater in Lake Ontario will require increasing post-release survival possibly through altered stocking practices (e.g. time, location or method of stocking, or pre-conditioning bloater to better respond to the lake environment).

K

KARATAYEV, A.[1], BURLAKOVA, L.[1], MEHLER, K.[1], ELGIN, A.[2], RUDSTAM, L.[3], WATKINS, J.[3], WICK, M.[4], [1]SUNY Buffalo, [2]NOAA Great Lakes Environmental Research Laboratory, [3]Cornell University, [4]ORISE. **Dreissena in Lake Ontario 30 years after the invasion**.

We examined three decades of changes in density and biomass of dreissenids in Lake Ontario for effects of density-dependent processes and predation by round goby (*Neogobius melanostomus*). Dreissenids (almost exclusively quagga mussels (*Dreissena rostriformis bugensis*) peaked in 2003 13 years after arrival and then declined in depth zones <90 m but continued to increase in >90 m through 2018. Lake-wide density also increased from 2008 to 2018 along with average mussel lengths and lake-wide biomass that reached an all-time high in 2018. Round goby were assessed with videography in the 10 to 35 m depth range with average density 4 fish m-2. This is sufficiently high densities to impact mussel population given feeding rates in the literature. Although the abundance of 0 - 5 mm mussel appear to be high in all three years with measured length distribution (2008, 2013, 2018), abundance of 5 to 10 mm, the size range most commonly consumed by round goby, was low expect at >90 m depths. This size gap was more pronounced in 2013 and 2018 than in 2008. Note that goby density peaked in 2006 and although variable, has stayed abundant since that time. However, we did not find the expected decline in dreissenids density in the nearshore and mid-depth ranges were goby have been abundant for at least two decades, due to the high number of 0-5 mm mussels at those depths.

KIRKPATRICK, S., SCHULTZ, R., CHISLOCK, M., SUNY Brockport. **Evaluating restoration techniques for a coastal fen on Lake Ontario degraded by Typha × glauca and shrub encroachment**.

Peatlands along the coast of the Great Lakes are undergoing ecosystem change including colonization by invasive plant species and shrub encroachment. The development of restoration techniques is necessary to protect this rare wetland class. Hybrid cattail (Typha× glauca) is a clonal dominant species that is highly competitive and significantly reduces native vegetation diversity and abundance by decreasing light availability and altering nutrient availability. Woody shrub encroachment also changes peatlands by lowering plant diversity and limiting peatland-specific vegetation through the alteration of hydrology, nutrient availability, and light availability. Our objective is to test the efficacy of techniques to restore native vegetation at a 23 hectare coastal poor fen on the southern shore of Lake Ontario that is degraded by both T.× glauca and shrub encroachment. We are testing combinations of cutting, herbicide, and litter removal in both intermediately invaded and less invaded areas. Vegetation and porewater will be sampled to evaluate changes in nutrient availability and vegetation communities in response to the treatments. Our pre-treatment sampling indicated that nitrate/ nitrite concentrations were significantly higher in T.× glauca invaded plots compared to the reference wetland. There was also a significant positive correlation between relative T.× glauca cover and orthophosphate concentration. If below 60% cover, relative shrub cover was found to be positively correlated to floristic quality metrics, richness, and diversity. The effectiveness of the treatments will be assessed next growing season.

KUAI, Y.[1], WELLS, M.[1], JOHNSON, T.[2], FISK, A.[3], KLINARD, N.[3], WEBBER, D.[4], SMEDBOL, S.[4], [1]University of Toronto, Scarborough; [2]Ontario Ministry of Natural Resources; [3]University of Windsor; [4]VEMCO. **The influence of strong thermal stratification on reduced detection efficiency of acoustic transmitters in eastern Lake Ontario**.

The successful use of acoustic telemetry to detect fish hinges on understanding the factors that control the acoustic range. The speed-of-sound in lakes is primarily a function of water temperature, and the seasonal thermal stratification in the Great Lakes represent the strongest speed-of-sound gradients in any aquatic system. Such speed-of-sound gradients can act the refract sound waves leading to greater divergence of acoustic signal, and hence more rapid attenuation. The changes in sound attenuation change the detection range of telemetry array and hence influence the ability to monitor fish. We use three months of data from a sentinel array of Vemco fish tags, and a record of temperature profile to determine how changes in stratification influences acoustic range in eastern Lake Ontario. We interpret data to show that changes in acoustic detection range correlate strongly with changes in sound speed gradients due to thermal stratification. The strongest temperature gradients occurred in late summer, when the sound speed difference between the top and bottom of the water column was greater than 60 m/s. V9 tags transmitting across the thermocline could have their acoustic range reduced from >650 m to 350 m, while the more powerful V16 tags had their range reduced from >650 m to 450 m. In contrast we found that when the acoustic source and receiver were both transmitting below thermocline there was no change in range, even as the strength of sound speed gradient varied. Changes in thermal stratification occur routinely in the Great Lakes, on timescales between months and days. If the target fish species is located across a thermocline from an acoustic telemetry receiver, then the acoustic range can be reduced by 50% compared to unstratified conditions. We recommend that researchers try and situate receivers at the same depths where fish are expected to inhabit.

L

LABIB, M., GUIASU, R., Glendon College, York University. **The uncertain concept of native range as applied to the invasive rusty crayfish in Ontario and the rest of the Great Lakes region**.

The difficult to define native range concept is applied to the distribution of the rusty crayfish in Ontario and the rest of the Great Lakes region. We reviewed all the relevant literature, from 1852 to 2018, and all the relevant Ontario museum specimens, and found that the non-native status of this crayfish species in Ontario is based on very scarce and incomplete records, speculation about the means of dispersal, and contradictory information in the specialized literature. The "invasive" label applied to this species can lead to bias in interpreting the ecological role of this crayfish, which would likely not be the target of control programs if it wouldn't be regarded as non-native in this area. The rusty crayfish is considered by many as native to several states bordering the Great Lakes and Ontario, such as Michigan and Ohio, as well as possibly native to Lake Erie. This resourceful species is also able to survive in a variety of freshwater habitats and is capable of dispersing itself quite well without human assistance through the vast interconnected Great Lakes system. Despite the fact that the rusty crayfish seems perfectly capable of reaching Lake Ontario on its own, and may well do so in the future, once the "invasive" label is attached to this species, its actions, impact, and even its very presence at various locations in this region tend to be viewed in a negative light. This can lead to control and even attempted eradication campaigns against this crayfish in areas where it is suspected of being introduced. Given the uncertainties about the extent and history of the native range of this species, as well as the controversies about its impact, it may be difficult to justify the current approach to the management of this species in Ontario.

LAROCQUE, S.[1], JOHNSON, T.[2], MIDWOOD, J.[3], GORSKI, D.[4], CONNERTON, M.[5], FISK, A.[1], [1]University of Windsor, [2]Ontario Ministry of Natural Resources, [3]Fisheries and Oceans Canada, [4]US Fish and Wildlife, [5]New York State Department of Environmental Conservation. **Combining movement and feeding ecology to assess niche overlap of salmonids in Lake Ontario**.

In Lake Ontario, six salmonids are the backbone of an economically important recreational fishery, with the two native species undergoing restoration efforts. Understanding both spatial habitat use and diet among species can identify potential competitive bottlenecks impacting native species restoration and overall fishery sustainability. By combining two different analyses we can better determine the realized niches and potential overlap between species and whether they are partitioning habitat and resources. We used acoustic telemetry data from 2016-2019 (n = 148) and stable isotopes collected in 2018 (n = 425) to assess the spatial habitat use and dietary overlap of the salmonid community in Lake Ontario. Most salmonids were highly mobile and occupied large areas of Lake Ontario, while Lake Trout (*Salvelinus namaycush*) and Brown Trout (*Salmo trutta*) showed more residency. Atlantic salmon (*Salmo salar*), Chinook salmon (Oncorhynchus tshawytscha) and Coho salmon (*Oncorhynchus kisutch*) had high dietary overlap, while Rainbow Trout (*Oncorhynchus mykiss*), Brown Trout, and Lake Trout were more distinct. The complementary acoustic telemetry and stable isotope data revealed that Atlantic salmon, Chinook salmon, and Coho salmon have a very similar overall niche which may have negative repercussions for Atlantic salmon restoration in Lake Ontario. The combined analyses allowed us to further our understanding of salmonid ecology in Lake Ontario and will assist in sustainable fisheries management.

LAUFMAN, K., GREEN, N., RUCK, B., Niagara Peninsula Conservation Authority. **Water quality improvements at a Niagara River beach resulting from green infrastructure and remedial actions**.

Queen's Royal Beach (QRB) is a popular recreational area located within Old Town Niagara-on-the-Lake, along the shores of the Niagara River near Lake Ontario, impacted by water quality issues due to high levels of bacteria. In the interest of continuing to safeguard the safety of residents and tourists that utilize the beach and as part of its commitment toward the Niagara River Remedial Action Plan (NRRAP), the Town of Niagara-on-the-Lake led local monitoring and remediation efforts to address issues at the beach. Beach water quality is one of 14 potential indicators of the overall health of the Niagara River. Since QRB is the only public swimming beach along the Canadian side of the Niagara River Area of Concern there was a need to identify and address the water quality issues associated with bacterial contamination at the beach in order to meet the RAP's specific water quality goals. Accordingly, from 2018 through 2020, several remedial actions were implemented, and the beach was sampled and tested for E. coli during each respective swimming season. Remediation measures included a concurrent investigation of the storm sewer system draining to QRB and subsequent infrastructure improvements (i.e., construction of a bioswale, sewer repairs) by the Town to address water quality issues. Overall, QRB sampling results met NRRAP beach water quality goals each year with over 80% of water samples meeting the appropriate water quality guidelines. This is a case study on how a human and environmental health issue is being tackled through a multi-pronged approach that includes source track-down investigations, objective setting, and planning and implementing remedial actions to meet those objectives. The approach and lessons learned can benefit other communities in their efforts to address local bacterial loading issues.

LAWRENCE, G.[1], WILCOX, D.[1], NORMENT, C.[1], MUDRZYNSKI, B.[1], AMATANGELO, K.[1], CHISLOCK, M.[1], SCHULTZ, R.[1], ALTENRITTER, M.[1], UZARSKI, D.[2], BRADY, V.[3], COOPER, M.[4], [1]SUNY Brockport, [2]Central Michigan University, [3]University of Minnesota, Duluth, [4]Muskegon Community College. **Application of the Great Lakes Coastal Wetland Monitoring Program to Restoration Projects in Lake Ontario Wetlands**.

The Great Lakes Coastal Wetlands Consortium developed a basin-wide monitoring plan in 2008 to determine the condition of coastal wetlands. This plan was implemented in 2011-2015 with funding from the Great Lakes Restoration Initiative via USEPA GLNPO. A second phase of the Great Lakes Coastal Wetland Monitoring was funded for 2016-2020. In each 5-year sampling round, many of the original study sites were revisited. The program has collected data on vegetation, invertebrates, fish, amphibians, birds, and chemical and physical parameters from most of the large coastal wetlands across the basin using standardized protocols. Additional wetlands were sampled to benefit restoration projects. On Lake Ontario, data collection at sites in the Rochester Embayment Area of Concern has provided pre-restoration and post-restoration assessments for EPA/GLRI-funded restorations at Cranberry Pond, Buck Pond, and Buttonwood Creek; U.S. Army Corps of Engineers/GLRI restoration at Braddock Bay; and U.S. Fish and Wild-life Service/GLRI restorations at Salmon Creek, Buck Pond, and Long Pond. Pre-restoration data are often not available when funding for restoration is approved, and post-restoration data collection is usually limited to two years. The Coastal Wetland Monitoring Program thus serves an unmet need because data collection at these sites can potentially continue as needed through the duration of this monitoring program. We will present data trends and analyses from the first ten years of data collection.

LEHNEN, J., FILIPSKI, M., New York State Department of Environmental Conservation. **Collaborative Efforts to Address Contaminated Sediment in the U.S. Niagara River Area of Concern**.

The Niagara River is a bi-national Area of Concern (AOC) under the Great Lakes Water Quality Agreement. A long history of industrial land uses, particularly on the U.S. side, resulted in contamination of water, sediment, and biota with PCBs, PAHs, dioxin, metals, and other substances. The 1994 U.S. Niagara River Remedial Action Plan identified contaminated sediment as a source for four of the River's original seven beneficial use impairments (BUIs), and a potential source for two others. Eventual delisting of the AOC is therefore dependent upon characterization of sediments and an assessment of their contribution to the BUIs, potentially followed by remediation or establishment of institutional controls. Over the past 25 years, a number of projects have addressed contaminated sediment in the Niagara River and its tributaries. In addition, many projects have addressed potential sources of contamination, including point sources and hazardous waste sites. Ongoing monitoring has documented significant improvements in water quality. However, the extent of contamination remaining in sediment, and its ongoing contribution to BUIs, remained largely unknown until recently. Several years ago, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Geological Survey, and the New York State Department of Environmental Conservation began collaborating to identify areas where sediment contamination remains a concern. The size of the AOC and limited resources necessitated the development of a systematic approach to sediment sampling and analysis, and to the determination of impacts of any contamination on the food chain. Although sampling is still needed in several areas, the recent efforts have greatly advanced understanding of the scope of the contaminated sediment problem.

LEHNEN, J.[1], SAAVEDRA, N.[1], LAMBRIX, M.[2], GURDAK, D.[2], [1]New York State Department of Environmental Conservation, [2]U.S.EPA. **Accelerated Progress in NYS Areas of Concern (GLRI and GLLA 2010 – Present)**.

Over the past ten years, Areas of Concern (AOCs) throughout the Great Lakes Basin have experienced significant progress towards restoring beneficial use impairments. One of the primary factors driving recent success is the federal support provided by the Great Lakes Legacy Act (GLLA) and the Great Lakes Restoration Initiative (GLRI). Enacted in 2007 and in 2010 respectively, the GLLA and GLRI represent significant administrative, financial, and institutional commitments to restoration in Great Lakes AOCs. Under the Great Lakes Water Quality Agreement (GLWQA), the process of developing and implementing Remedial Action Plans (RAPs) for each AOC was initially driven by local stakeholder groups. Local Remedial Advisory/Action Committees (RACs) were successful in identifying root problems facing each AOC and in developing plans for addressing those problems in the original Stage I/Stage II RAP documents. However, without a framework of federal support, many of the initiatives proposed in the RAPs weren't realized for nearly two decades. Since their inception, the GLLA and the GLRI have fostered significant progress towards the development and implementation of the RAPs in the five New York State AOCs. Administratively, this included a comprehensive review of the status of each AOCs RAP and the development of distinct delisting strategies. Practically, this has facilitated the successful identification and completion of major management actions throughout New York State AOCs, particularly in the Buffalo River and in the Rochester Embayment. Since the advent of the GLLA and the GLRI, 14 BUIs have been successfully removed in New York State AOCs and multiple AOCs are on the path towards delisting.

LIU, F.[1], EIMERS, C.[1], WATMOUGH, S.[1], SORICHETTI, R.[2], [1]Trent University, [2]Ontario Ministry of the Environment, Conservation and Parks. **Effects of intensive agriculture and tile drainage on nutrient export in southern Ontario**.

Recent agricultural land use change in east-central Ontario including the expansion of intensive agriculture (corn and soybean crops) coupled with installation of tile drainage infrastructure may alter the delivery of both phosphorus (P) and nitrogen (N) to Lake Ontario. Through intensive monitoring of several sub-watersheds that encompassed a range of row crop and tile drainage extents, this study examined differences in P and N concentrations both seasonally and during different flow conditions, to better understand land use/land cover (LULC) relationships with nutrient export. There was no clear relationship between P (total or dissolved) and agricultural LULC, and instead P delivery was highly sensitive to flow events. In contrast, there was a strong positive relationship between nitrate-N (NO3-N) losses in stream water and row crop agriculture, such that NO3-N concentrations and export increased with increased extents of tile-drained row crop area within sub-watersheds. The relationship between intensive agriculture and N losses can be used to extrapolate NO3-N loading within other watersheds, regardless of drainage area. Understanding the response of nutrients to changes in agriculture is an integral part of watershed management as rapid changes in both urban and agricultural LULC continue to put pressure on water quality in the Laurentian Great Lakes.

LOCKETT, B.[1], EIMERS, C.[1], SORICHETTI, R.[2] [1]Trent University, [2]Ontario Ministry of the Environment, Conservation and Parks. **Anthropogenic Land Use Modifications of Stream Flow Regimes in East-Central Ontario**.

Urban sprawl and agricultural intensification including tile drainage can alter the flow regimes of streams. East-central Ontario has undergone substantial urban expansion as well as agricultural change, including shifts from low intensity livestock and pastureland to more intensive tile-drained row crop (corn and soybean) agriculture. In order to evaluate the effects of these changes on stream flow, several streams were instrumented between Oshawa and Cobourg, Ontario to encompass a range of land usages, ranging from almost entirely urban (96%) to highly agricultural, with a large extent of tile drainage (89%). Several stream flashiness metrics were used to quantify differences in flow patterns among watersheds over two years. Flow metrics were correlated against land cover and other physiographic characteristics that may influence flashiness of streams. A significant positive relationship ($p < 0.005$) was observed between flashiness and urban land cover as well as with urban + agricultural land cover across all seasons. In contrast, flashiness was negatively correlated ($p < 0.005$) with natural cover in all seasons. The area of agriculture or tile drainage alone was not significantly associated with any metric of stream flashiness. To better understand how landcover intensification affects stream flashiness at shorter time scales, a heavily tile drained watershed was compared with a proximal urban watershed of similar size. Spring melt caused the tile drained watershed to be flashier than the urban stream, however, tile drainage heavily mitigated stream flashiness during summertime convective thunderstorms. This suggests that heavily tile-drained watersheds may behave like urban watersheds during wet periods, and thereby increase flood risks downstream. Conversely, tile drainage may mitigate flood potential during heavy summer rain events.

LOHMANN, R.[1], MA, Y.[2], HABTEMICHAEL, A.[1], BECANOVA, J.[1], CLASSEN, J.[1], ADELMAN, D.[1], VOJTA, S.[1], MUIR, D.[3], [1]University of Rhode Island, [2]Shanghai Jiao Tong University, [3]Environment and Climate Change Canada. **Spatial Distribution and Air−Water Exchange of Organophosphate Esters in Lakes Ontario and Erie**.

OPEs (Organophosphate esters) have been detected at elevated concentrations in the Great Lakes region, dwarfing other flame retardants, such as polybrominated diphenylethers (PBDEs) as compounds of concern. This prompted us to deploy polyethylene (PE) passive samplers in the lower Great Lake region (Lake Erie and Lake Ontario) to detect gaseous and dissolved OPEs, estimate the air-water gas exchange fluxes, and evaluate their occurrence and spatial distribution. Total dissolved phase concentrations of the nine detected OPEs (Σ9OPEsdis) ranged from 30 - 390 ng L-1 during summertime. The median concentrations of the outdoor and indoor gaseous OPEs (Σ9OPEsgas) were 400 pg m-3 and 1445 pg m-3, indicating indoor air as an important source of OPEs. Gaseous and dissolved concentrations were dominated by chlorinated compounds, in particular (tris(2-chloroethyl) phosphate (TCEP), while tri-n-butyl phosphate (TnBP) was the dominant non-chlorinated OPEs. Decreasing gradients from shoreline/nearshore to offshore sites for both gaseous and aqueous OPEs reflect anthropogenic influence from the adjacent rural and urban regions. For air-lake gas exchange fluxes, almost all OPEs underwent net gas-phase deposition, dominated by TCEP and TCPPs with median fluxes of -3980 ng/m2/day and -1320 ng/m2/day; the exception was TnBP, which underwent volatilization with the median fluxes of 1980 ng/m2/day.

LONG, T., BENOIT, N., RICHMAN, L., HOWELL, T., Ontario Ministry of the Environment, Conservation and Parks. **Spatiotemporal trends of polychlorinated biphenyls (PCBs) in surface and suspended sediments from the Lake Ontario Canadian nearshore between 1994 and 2018**.

Spatiotemporal trends for polychlorinated biphenyls (PCBs) were examined in surface and suspended sediments collected between 1994 and 2018 from over twenty nearshore stations on the Canadian side of Lake Ontario and the St. Lawrence River. Samples were collected as part of the Ontario Ministry of the Environment, Conservation and Park's long-term Great Lakes Nearshore Index and Reference Station Monitoring Program. In 2018, PCB concentrations ranged over an order-of-magnitude in surface sediments (<10 ng/g - 357 ng/g) and in suspended sediments (<10 ng/g – 330 ng/g), illustrating the presence of legacy hotspots as well as diffuse inputs from primarily urban watersheds. PCB concentrations in both surface and suspended sediments were consistently highest in Hamilton Harbour, but were also elevated at other stations around the perimeter of the Niagara basin as well as near Trenton and Kingston, Ontario. Generally, higher PCB concentrations were found in surface sediment relative to paired suspended sediment samples suggesting temporal improvements in nearshore sediment quality. However, many stations demonstrated temporal variability in PCB concentrations, a likely factor in the lack of an overall nearshore declining trend. Implications of the data will be discussed, including potential connections to fish consumption advisories, differences in trends between nearshore and offshore sediments, and potential role of climate change on data trends.

M

MACLELLAN-HURD, R., KARATAYEV, A., SCOFIELD, A., HINCHEY MALLOY, E., BURLAKOVA, L., ORISE at EPA Great Lakes National Program Office. **Dreissenid density effects on sediment nutrient composition and other benthic organisms**.

The proliferation of dreissenid mussels has resulted in changes to Lake Ontario's ecosystem functions, including altered nutrient cycling and increased transfer of nutrients to the benthos through mussel grazing. One-way dreissenid mussels recycle nutrients is through the production of biodeposits (feces and pseudofeces), but there is relatively little known about the effects of biodeposits on sediment nutrient composition and benthic communities. Conventional thought is that biodeposit production should result in higher sediment organic carbon compared to areas not colonized by mussels; however, this may not be the case due to increased biological activity associated with biodeposits. Biodeposits could serve as a food source for both bacterial communities and other benthic invertebrates, leading to lower organic carbon within the sediment due to high mineralization rates. Using data collected during the 2018 Cooperative Science and Monitoring Initiative (CSMI) for Lake Ontario, we compared the sediment organic carbon, total nitrogen, total phosphorus, and oligochaeta abundance between high and low mussel density sites, accounting for sediment grain size differences and depth. The density of mussels at the various sites sampled during this year ranged from 19 mussels m-2 to over 10,000 mussels m-2. We compare these results with trends observed in Lake Michigan (2015 CSMI) and Lake Huron (2017 CSMI) to demonstrate if the pattern in Lake Ontario is similar to other Great Lakes. Analysis of sediment composition and benthic organisms between low and high mussel density areas provides insight into the impact of dreissenids on the benthic food web and nutrient cycling in Lake Ontario.

MADANI, M.[1], KOCK RASMUSSEN, E.[2], DELANEY, P.[1], [1]DHI Water & Environment, Inc, Cambridge, Canada; [2]DHI Water & Environment, A/S, Horsholm, Denmark. **Hydrodynamic and wave modeling for development of Cladophora and dreissenid mussels interaction model in Lake Ontario**.

There has been a resurgence of the benthic algae Cladophora on the shallow lakebed of Lake Ontario since the dreissenid mussels emerged in the 1990s. During the summer months, strands of green Cladophora algae grow quickly and form odorous mats of algae in the shorelines after their death. The presence of algal debris causes problems such as blocking cooling water intakes at power plants and fouling filters in drinking water facilities. The algae typically grow in areas of the hard substrate where dreissenid mussels are abundant and the nutrient-related interactions between the mussels and algae make the process very complex. The main objective of the research is to develop a detailed process description model that will facilitate a better understanding of complex ecosystem dynamics of algae, water chemistry, and dreissenid mussels that are influencing the production of Cladophora along the north shore of Lake Ontario. To address this objective a high-resolution 3D hydrodynamic and wave model is being developed using MIKE 3 modeling framework and integrated with DHI's ECOlab ecological model to link the biomass distribution of benthic algae and Cladophora to growth-limiting variables (light, temperature, and macro-nutrients). The hydrodynamic model is being calibrated and validated using measured currents, water level, and temperature data. Development of the model undergoes two phases wherein the first phase, a simple MIKE 3 hydrodynamic and wave model is developed and verified. This model is used to test and verify the process descriptions of the ecological model. In the next phase, the developed model will be refined to have a higher resolution on the Canadian side near Toronto, Ajax, and Oshawa. A comparison with the observed ADCP currents and temperature profile showed that the simplified hydrodynamic model can reproduce currents and the time-evolution of lake surface temperature, vertical temperature profile, and seasonal stratification reasonably well.

MALLON, E., RUNDLE, K., Conservation Halton. **Hamilton Harbour Water Conservation Fund**.

Since 2015, as part of the Cootes to Escarpment EcoPark System, Conservation Halton has delivered a series of workshops teaching Hamilton and Burlington landowners how to manage stormwater on their property. The goal is to inspire residents and businesses to reduce stormwater runoff in their community and lessen impacts to Hamilton Harbour. These workshops encouraged DIY rain gardens, disconnecting downspouts and the proper use of rain barrels. They also brought attention to technical and specialized green infrastructure (permeable driveways, bioswales etc.) that proved difficult for many landowners to install on their own. This barrier to GI implementation was countered though a cost-share incentive offsetting fees associated with materials, equipment and hiring a contractor to complete large projects. To date, well over 1300 residents have participated in workshops and 16 residents completed LID projects with the grant. Furthermore, this initiative gave way to partnership with Fern Hill School and their creation of an educational rain garden. We also partnered with the City of Burlington to construct two bioswales in their right-of-way in the Brighton Beach Community. As this initiative continues to gain momentum there are plans to expand the incentive to target small businesses and large local corporations to do their part to divert stormwater from city infrastructure creeks, and the Hamilton Harbour.

MARSHALL, C., CONNOLLY, J., BOYNTON, P., SCHAEFER, S., RUDSTAM, L., WATKINS, J., Cornell University. **Importance of micro-zooplankton (rotifers, nauplii, veligers) in Lake Ontario**.

Rotifera are a phylum of animals among the smallest metazoans on earth, but they can still be a large component of freshwater communities. We present data on Lake Ontario's rotifers using samples collected lakewide as part of a bi-national inter-agency effort known as the 2018 Cooperative Science and Monitoring Initiative (CSMI), including data on seasonal trends and spatial patterns of community composition, density, and biomass. Both rotifer density and biomass peaked with surface temperature in August at ~300 individuals/Liter and ~9000 ug/m3, respectively. From April through June, Synchaeta sp. dominated the rotifer community abundance, and then decreased to become the least abundant in late summer and fall. The genus Keratella had the opposite seasonal development, being the least abundant in the spring and most abundant in the fall. We also report trends in copepod nauplii and dreissenid mussel veliger larvae, important non-rotifer components of the Lake Ontario micro-zooplankton community. The density of both nauplii and veligers in the upper 20 m remained low at less than 50 individuals/Liter throughout the year. The biomass of nauplii only slightly exceeded rotifers during a short period in April and May (~1000-2000 ug/m3) and did not reach a value higher than ~5000ug/m3 throughout the rest of the year. In contrast, veligers slightly exceeded rotifer biomass for many months (April, May, July, September) with values reaching no higher than ~7000 ug/m3. In October however, veliger biomass values reached as high as ~18000 ug/m3, while rotifer and nauplii remained at ~3000 ug/m3. The abundance and biomass of these three groups is also related to the abundance and biomass of larger zooplankton copepods and cladocerans, the groups that are typically emphasized in descriptions of Lake Ontario zooplankton biomass and trends. Additionally, the potential effect of predatory cladoceran populations (Bythotrephes & Cercopagis) on the rotifer community is explored.

MARTIN, O., CUREAUX, M., BANGKONG, C., CHADO, M., CHOMIAK, K., DAILY, J., DAY, S., DIAZ, R., HOFFMAN, M., HUDSON, A., SCHNEIDER, N., TYLER, C., WONG, N., EDDINGSAAS, N., Rochester Institute of Technology. **The chemical and physical changes to plastics aged in surface and benthic of freshwater aquatic systems**.

Microplastics are a known contaminant of freshwater ecosystems such as Lake Ontario. What is less known is the effect that microplastics have on ecosystem function, the extent to which impacts may be influenced by size, concentration, and polymer type, and how these factors change over exposure time in different aquatic environments. Other factors, including the additives within the plastics, will also influence potential fate and toxicity. To fully understand the impact of plastics in freshwater systems, the extent to which additives leach from plastics, and how different plastics are physically and chemically changed must first be understood. We deployed eight plastic types in four freshwater systems in the Lake Ontario Basin – a rural pond, Conesus Lake, a stormwater retention pond, and Lake Ontario - at the surface and in the benthos. Samples were retrieved after one and fourth months and will be again after twelve months. We are analyzing the extent of physical aging and biofouling by optical microscopy and SEM, the chemical aging by FTIR, and the extent of additive leaching by GCMS. Preliminary results suggest substantial differences between water column and benthic processes, that differ by ecosystem. The combined data will be used in conjunction with other water and sediment characteristics, microbial community composition, and toxicity of the different aged polymers to obtain a more complete understanding of how plastics age in freshwater systems and the effect that aging has on benthic ecosystem functions and services.

MASSON, C., Trent University. **Global to Local Updates: Canada's 2020 International Freshwater Biodiversity Targets**.

2020 was the United Nations super year for nature and biodiversity. In the wake of the global pandemic, global and national-level post-2020 work schedules will now be finalized after the Fifth session of the UN Environment Assembly (UNEA5), scheduled for February 22-26, 2021, rather than before this keystone meeting as formerly planned. Canada's international and national commitments include conserving 17 per cent of terrestrial areas and inland waters under the UN Convention on Biological Diversity (CBD), Aichi Target 11 (2010) and Canada Target 1 (2015). Efforts to better recognize, manage and expand this accomplishment across the broader landscape are of global conservation significance. In September 2020, Canada committed to protecting 25 per cent of Canada's of lands and waters by 2025, up to 30 per cent by 2030. Considerations include federal, provincial, territorial programs, and a prospective 'other' category for Indigenous traditional territories, watershed authorities, municipal parks and land trusts. This presentation will provide global, regional, national and local updates toward a, 'Global to Local: Canada's 2020 International Freshwater Biodiversity Targets,' workshop at IAGLR21.

MATTSON, M., Swim Drink Fish. **Citizen Science**.

Swim Drink Fish has been supporting community-based water monitoring hubs for 20 years, with the Lake Ontario Waterkeeper (2001) and Fraser Riverkeeper (2004) in Canada being excellent examples of monitoring hubs supported by professionals but driven by citizens. The hubs collect, process, and share water sampling data on Swim Guide, a free website and app that now provides water quality data for 8,000 locations in 11 countries, helping over 6 million users learn about water and find clean places for recreation. Swim Guide now has over 100 community water monitoring hubs, as well as hundreds of local public health agencies, collecting and sharing data on the platform, and thanks to funding from Environment and Climate Change Canada and dozens of other collaborators, Swim Drink Fish has established four new hubs on the Great Lakes and will establish two more by 2022. Swimmable, drinkable, fishable water is a global necessity, but taking action starts locally. Mark Mattson, President of Swim Drink Fish and the Lake Ontario Waterkeeper, will explain the value of citizen science and the first steps in connecting communities to their waters through monitoring hubs and empowering them to collect and share the data they need to restore and protect clean water.

MCCUSKER, M[1]., DOVE, A.[1], DEPEW, D.[1], HOWELL, T. [2], [1]Environment and Climate Change Canada, [2]Ontario Ministry of Environment, Conservation and Parks. **An assessment of the nearshore sentinel sites monitoring dataset along the north shore of Lake Ontario**.

The north shore of Lake Ontario has been the subject of intensive efforts over the past several years (2017-2019). Sentinel sites monitoring of the nearshore has been driven by the need to determine status and trends, and to assess ecological factors driving the growth of Cladophora glomerata, a nuisance benthic alga. Data are collected on Cladophora, dreissenid mussels, nutrients and ions in the water, and other physical parameters, to assess variation across a range of depths (3m to 20m) and shoreline conditions (Oakville, Scarborough, and Cobourg). Our analysis points to several factors influencing Cladophora growth, most notably light, substrate, and dreissenid mussels. This dataset, together with previously collected data, show that higher Cladophora biomass tends to be found in dry years with low tributary inflows. Implications for the management of Cladophora will be discussed.

MCKINNEY, P., HOLLENHORST, T., HOFFMAN, J., U.S. EPA Great Lakes Toxicology amd Ecology Division at ORISE. **Buoyancy glider observations for modeling distinct water quality zones in Lake Ontario**.

Models of Great Lakes physical conditions, food webs and biogeochemical cycles depend on observations of physical and biological parameters for calibration. High resolution observations from autonomous gliders represent a potentially rich dataset for Great Lakes model calibration. Using observations of water quality obtained in autonomous glider deployments in southern Lake Ontario during early and late summer 2018, we evaluate alongshore and cross shore gradients, and compare the glider-based observations to hydrodynamic model output. Glider deployments resulted in over 3,000 vertical profiles covering nearshore (2 km from shore and less than 40m water depth) and offshore (20 km from shore and greater than 100m water depth) regions between the Niagara River and Rochester, NY. In both early and late summer, there was an alongshore increase in conductance as relatively lower conductance Niagara water interacted with higher conductance Lake Ontario receiving waters. The early summer cross-shore temperature gradient was characterized by the transition between stratified conditions nearshore and isothermal conditions offshore, known as the thermal bar. In late summer the lake was fully stratified. In this presentation, we compare the glider-based observations to stratification metrics from available buoy and hydrodynamic model output and discuss the potential for incorporating glider observations into models used for characterizing and monitoring distinct water quality zones in the Great Lakes.

MCNABNEY, D., SIMMONS, D., Ontario Tech University. **Identifying Metabolic Indicators of Microcystis aeruginosa and Comparing the Temporal Changes in Algal Community Composition in Two Lake Ontario Areas of Concern**.

When the surface waters of freshwater lakes are warm, still, and abundant with nutrients, cyanobacterial blooms or harmful algal blooms (HABs) can grow exponentially and negatively impact their environment. Specifically, the cyanobacteria Microcystis aeruginosa produce monocyclic hepatotoxins called microcystins that can impair or kill fish and small mammals. Moreover, when cyanobacteria die off and are decomposed, areas of hypoxia form that are detrimental to local aquatic life. Currently, the changes in algal community composition over the summer is not fully understood in Lake Ontario and such information could be the basis of a new HAB prediction method. Additionally, metabolites produced by M. aeruginosa are thought to be another suitable form of HAB prediction if the changes in their abundance were better understood. Moreover, as the climate continues to change, so will water quality variables like dissolved oxygen and temperature and their effects on the lifecycle of M. aeruginosa in Lake Ontario is not very clear. We think that molecular and community-level information will better predict HABs and associated cyanotoxicity than models based on nutrients alone. The proposed study will consist of several sampling events in 2020 from HABs in two Lake Ontario areas of concern: Hamilton Harbour and the Bay of Quinte. Algae samples will be collected and species composition data will be obtained using visual identification. Metabolomics will be performed on algae samples using liquid chromatography mass spectroscopy to identify changes in metabolites over time and under different temperature and oxygen conditions. We will present our preliminary data from these analyses within the context of community-level interactions between M. aeruginosa and other freshwater algae. Ultimately, we expect the results of this study will expand our ability to predict when cyanobacterial blooms will produce toxins and strengthen the knowledge between key water quality variables and the lifecycle of M. aeruginosa.

MIDWOOD, J.[1], BLAIR, S.[1], BOSTON, C.[1], CROFT-WHITE, M.[1], FRANCELLA, V.[2], GARDNER COSTA, J.[1], LIZNICK, K.[2], MATOS, L.[3], PORTISS, R.[2], SMITH-CARTWRIGHT, L.[2], VAN DER LEE, A.[1], [1]Fisheries and Oceans Canada, [2]Toronto and Region Conservation Authority, [3]Environment and Climate Change Canada. **Assessment of fish populations in the Toronto and Region Area of Concern**.

Loss of habitat combined with degraded water and sediment quality resulted in the coastal area and upstream watersheds of the Toronto Region being listed as an Area of Concern (AOC) in 1987. Documented declines in many nearshore fishes, including Northern Pike, and more riverine species like Walleye and Smallmouth Bass, resulted in the fish population beneficial use impairment (BUI) being listed as impaired for this AOC. Here we present the results of a recent assessment of this BUI. In order to evaluate whether ecosystem conditions within the AOC were supporting native fishes in a diverse and stable community structure (Delisting Criteria FP-1) several lines of evidence were explored including: 1) long-term trends in fish community metrics (e.g., indices of biotic integrity) and comparison of these metrics to regional reference areas based on electrofishing and trap net data; 2) pelagic prey fish density and biomass derived from split-beam hydroacoustic surveys and mid-water trawling; and 3) acoustic telemetry to track movements of a subset of species within the central waterfront to evaluate species-specific residency. To evaluate whether formerly abundant fish populations are rehabilitated where locally depressed or extinct (Delisting Criteria FP-2), long-term trends in presence and abundance of select top predators and non-native fishes were assessed.

Finally, to evaluate whether watershed plans are in place (Delisting Criteria FP-3), the use of the integrated restoration priority (IRP) tool for watershed management was explored. The status of each line of evidence for each criteria was assessed independently. Overall results suggest that this BUI remains impaired and recommendations are outlined for actions that may help improve fish populations within the AOC before the next assessment.

MORYK, J., WALLACE, A., Toronto and Region Conservation Authority. **From Rivers downstream to Lake Ontario: 20 years of aquatic sampling through The Regional Watershed Monitoring and Toronto Waterfront Monitoring Programs**.

The Toronto and Region Conservation Authority (TRCA) has two long-term, science-based monitoring programs: 1) the Regional Watershed Monitoring Program and the 2) the Toronto Waterfront Monitoring Program. Through these monitoring initiatives, TRCA acquires terrestrial and aquatic ecosystem data within its nine watersheds and the coastal shoreline of Lake Ontario. The data gathered from these programs is woven into TRCA's environmental policy, planning, restoration, and reporting mechanisms. This presentation highlights some preliminary analysis of both the watershed and waterfront fish data collected over the past two decades.

MUNAWAR, M., MUNAWAR, I.F., NIBLOCK, H., FITZPATRICK, M., Fisheries and Oceans Canada GLLFAS. **State of Canadian Ecosystem Health research in Lake Ontario: Down Memory Lane-1970-2020**.

Information about the aquatic ecosystem of Lake Ontario can be traced back to 1970. The 1970 cruises, designed by Dr. Richard Vollenweider, assembled pioneering data on major nutrients, chlorophyll a, primary productivity, phytoplankton, zooplankton and benthos and resulted in the development of the famous Vollenweider eutrophication model. This was followed by an ambitious program called International Field Year for the Great Lakes (IFYGL 1972/73), jointly organized by the American and Canadian National Committees for the International Hydrological Decade. IFYGL was a coordinated, multi-disciplinary international study of Lake Ontario and its land basin including physical, chemical, and biological aspects and importantly set a precedent for future efforts. Dr Pius Stadelmann's 1972-73 nearshore/offshore primary productivity research at selected stations was also undertaken at this time. These surveys were followed by Dr. David Lean's Lake Ontario Nutrient Assessment Study (LONAS) in 1982 and the Lake Ontario Trophic Transfer (LOTT) study, a major multi-disciplinary and multi-trophic effort organized by Dr. Gary Sprules. These surveys provided an opportunity to address extensive plankton ecology questions including size spectrum distribution analysis and microbial loop composition and dynamics. The turn of the century saw the launch of Coordinated Science and Monitoring Initiative (CSMI) in 2003, a lake-wide binational program which included a series of biologically integrated lake wide surveys. These surveys have continued every 5 years (2008, 2013 and 2018). In addition, long-term programs have been conducted simultaneously such as Project Quinte (1972-2018), the Bioindex program (1981-1995) and offshore eastern basin at station 81 (2007-2020). The aim of this paper is to take you down memory lane through 50 years of Lake Ontario ecology to remind young and old about the history of Lake Ontario.

MUNNO, K.[1], HELM, P.[2], ROCHMAN, C.[1], GEORGE, T.[2], JACKSON, D.[1], [1]University of Toronto, [2]Ontario Ministry of the Environment, Conservation and Parks. **Nearshore fish in urbanized regions of Lake Ontario are heavily contaminated with microplastics and other anthropogenic particles**.

The ingestion of microplastics and other anthropogenic microparticles was assessed in fish from Lake Ontario. Overall, we found 12,442 anthropogenic microparticles across 212 fishes (eight species) from nearshore Lake Ontario and 943 across 50 fish (one species) from Humber River. Fishes from Lake Ontario had high mean abundance of anthropogenic microparticles in their gastrointestinal tracts (59 particles/fish, (SD 104)), with up to 915 microparticles found in a single fish. This is one of the highest reported abundances of anthropogenic particles in the literature. Fish from Humber River contained 19 particles/fish (SD 14). Across all locations, we found diverse microparticle morphologies, with fibers most frequently observed. Overall, ≥90% of particles analyzed via spectroscopy were confirmed anthropogenic, with 54-59% confirmed as microplastics. Of the microplastics, polyethylene (24%), polyethylene terephthalate (20%), and polypropylene (18%) were the most common. Ingestion of anthropogenic particles was significantly different among species within Lake Ontario ($p < 0.05$), and demersal species tend to have a higher abundance of anthropogenic particles though this trend is not statistically significant ($p > 0.05$). The abundance of anthropogenic particles increased with increasing total fish length in Lake Ontario (ϱ= 0.62). The high occurrence and abundance of anthropogenic particle contamination seen in Great Lakes fishes is likely due to urbanization and its associated sources of particles (e.g., wastewater effluent, industry and roadways). Spatial trends and patterns among species should be taken into consideration when defining conservation priorities. The location of collection and habitat within the lake should also be considered as nearshore, demersal fishes may be relatively more contaminated.

N

NEVERS, M., EVANS, M., U.S. Geological Survey. **Assessing Cladophora Growth Across the Great Lakes and in Lake Ontario**.

Nuisance algae continue to plague parts of the Great Lakes, especially Lake Ontario. Overgrowth of Cladophora has been a sporadic but persistent problem, modifying the food web and creating harmful shoreline conditions. Assessing the scope of Cladophora's impact and the drivers that lead to nuisance conditions is a binational (United States, Canada) priority. In this study, we have conducted two years of broad assessment of Cladophora over the algal growing season (May-September) across the Great Lakes, including three transects along southern Lake Ontario: near Lockport at 18-mile Creek, near Irondequoit at the Genesee River, and near Sacketts Harbor at Stony Island. Annual assessments included measurements of Cladophora and dreissenid mussel biomass, coverage, and tissue nutrient content; water column and sediment nutrients; and benthic habitat assessment at four depths (3m, 6m, 10m, 18m) across each of 10 transects. Instruments were deployed at each 6m site for continuous measurements of water quality, light penetration, and current conditions. Cladophora growth across transects and years was variable. In Lake Ontario, Cladophora generally increased over the course of the season, and biomass measurements for Cladophora and dreissenid mussels were some of the highest measured in the study. Collectively, across the lakes, Cladophora growth appears to be driven to varying degrees by light penetration, substrate availability, and benthic nutrients (e.g., phosphorus), but the degree of impact varies by lake and transect. Future efforts will focus on defining the influence of benthic-dreissenid interactions and light availability on Cladophora growth. Data collected as part of this study are being incorporated into a wide range of studies under the auspices of the binational Great Lakes Water Quality Agreement, seeking solutions for reducing Cladophora growth and restoring Great Lakes ecosystem health.

NIBLOCK, H., MUNAWAR, M., FITZPATRICK, M., Fisheries and Oceans Canada GLLFAS.
Long Term Changes to the Productivity at a Pelagic station in the Kingston basin of Lake Ontario.

Given the recent oligotrophication of offshore Lake Ontario there is concern about the capacity of the lower foodweb to support current fish stocking levels. We use seasonal data from a long term biomonitoring station in eastern Lake Ontario to examine changes in primary productivity, phytoplankton composition and major nutrients. Random partitioning of chl a shows the data breaks into 4 time periods 1970; 1981-1991; 1992-1995; and 2007-2018, which includes periods of pre and post phosphorus abatement and pre and post establishment of dreissinids, Bythotrephes and Cercopagis. Chlorophyll and phytoplankton biomass have decreased over the time period while POC and PON decreased then shown an increase in the latest period. Instantaneous rates of primary productivity indicated mesotrophy in the first 3 periods (~12 mg C m-3 hr-1) and oligotrophy (~5 mg C m-3 hr-1) in the recent time period. Complementary changes observed include increases water clarity (as measured by LiCor and Secchi) and a shift in the depth of June-Oct optimal productivity from 3-6 m (1970-1995), to 6-7m (2007-2017). Additionally, depth of optimal productivity shows some seasonality in the latest time period when it is deeper in May and late October. Seasonality of parameters will be compared over this nearly 50 year period.

O

OAKS, C., Hamilton Conservation Authority. **Rehabilitating Lower Spencer Creek - The challenges and compromise required for success when working on the largest tributary of Hamilton Harbour**.

Spencer Creek is the largest tributary of the Hamilton Harbour Area of Concern. Urbanization and buildup within the Lower Spencer Creek (LSC) subwatershed like in the Harbour have impacted the creek system and degraded its function over time. Channelization (straightening) of the creek in the past has led to channel instability and a reduced capacity to support healthy aquatic environments. Historically, management intervention has been through structural means of erosion stabilization, which have had limited degrees of success. In-stream works including grade control structures, concrete lining and gabion baskets have contributed to fish-migration and sediment flow barriers which affect the overall health and functionality of the creek. LSC is directly connected to Cootes Paradise, one of Lake Ontario's largest coastal wetlands, and therefore has an influence on the health of the Cootes Paradise system and Lake Ontario fishery. As a result, the area of LSC between Thorpe Street and Cootes Drive was identified as an area that would benefit from creek rehabilitation work to improve watercourse function and fish habitat. The design elements that were selected were based on the absence of natural fish habitat available in the channel under existing conditions. Natural refuge areas, including pools, undercut banks, and variability in substrate were generally lacking from the majority of the study area. The channel also lacks suitable substrate and structure required for walleye spawning and provides little variability and habitat essential for other supporting species including foraging species for larger predatory fish. The design focused on maintaining the alignment and erosion potential of the current channel while providing hydraulic conditions to maintain constructed refuge and spawning areas. The detailed design plans were finalized in April 2018 and construction was completed in August and September 2018.

P

PATTERSON, N., **Justice for the Land: Indigenous Tenure and Access**.

Indigenous peoples are launching concerted efforts to recover ancestral homelands lost through historic injustice. In many cases, courts have failed to honor Indigenous rights extending back thousands of years. This presentation discusses how Indigenous Peoples are reclaiming their place as the oldest stewards of land and waters through a variety of legal instruments and partnership approaches.

PAUER, J.[1], MELENDEZ, W.[2], HOLLENHORST, T.[1], WOODRUFF, D.[1], [1]U.S. EPA Office of Research and Development, [2]General Dynamics Information Technology. **Will remediation in Lake Erie improve nearshore phosphorus concentrations in southern Lake Ontario?**

Elevated nutrient concentrations have been observed on the southwestern (New York) side of Lake Ontario. Although the link has not been completely established, phosphorus is regarded as one of the drivers of nearshore Cladophora that has been a persistent problem in this area over many years. The Niagara River, the connecting channel between Lake Erie and Lake Ontario, contributes more than 30% of the overall phosphorus load to Lake Ontario. Due to circulation patterns in the lake, this contribution is especially significant in the nearshore areas west of the Niagara River. Here we apply a mathematical model to provide insight into the relative contribution of the Niagara River, which includes almost all of the Lake Erie interbasin phosphorus load, versus loadings from local rivers on the nearshore phosphorus concentrations in this region. We perform numerical experiments to determine to what extent the Niagara, Genesee and smaller local rivers impact the nearshore phosphorus concentrations. Initial model results suggest that phosphorus concentrations in the nearshore area are dynamic and respond rapidly to changes to riverine phosphorus loadings entering the lake. The nearshore west of the Niagara River is strongly impacted by Lake Erie/Niagara River loads, while areas closer to the Genesee River are equally, if not more strongly influenced by the Genesee River load.

PENNUTO, C., WAGNER, J., SUNY Buffalo. **Finescale spatiotemporal dynamics of nutrients in and around Cladophora beds**.

Cladophora remains a nuisance algae across the Great Lakes region, and predicting how much and where it occurs is critical to understand its potential impacts to lake health and local economies. We investigated Cladophora growth dynamics with fine-scale spatiotemporal resolution, and coupled those findings with satellite data to improve predictive power of a Cladophora growth model (CGM). We found the nearshore zone in western Lake Ontario was a very dynamic zone, with multiple upwelling events, while at the same time the zone of Cladophora growth (out to 9 m depth) was well-mixed and chemically homogeneous. There were large changes in nutrient levels throughout the growing season, but those changes were mostly consistent across all depths. In this particular year and location, Cladophora biomass was not particularly high, even though light, substrate, and nutrient conditions would suggest it should have been. Internal tissue carbon and nitrogen content declined over the growing season, as did chlorophyll a content, but phosphorus levels in tissues remained unchanged. We did not detect an app, reciable mussel or Cladophora effect on microscale nutrient concentrations over the 90-day sampling period. Maximum algal biomass was found at the 3 m transect, but was most consistent at the 6 m contour. Biomass of Cladophora rarely reached nuisance levels (e.g., 50 g/m2) and we did not witness an obvious sloughing event. Neither mussel biomass nor mussel abundance correlated with Cladophora biomass, but mussel metrics did correlate with season.

PIJANOWSKI, B.[1], HYNDMAN, D.[2], BELLISARIO, K.[1], SALAZAR, K.[1], WALKER, D.[1], KENDALL, A.[2], MARTIN, S.[2], HAMLIN, Q.[2], UTLEY, L.[1], RUTHERFORD, E.[3], [1]Purdue University, [2]Michigan State University, [3]NOAA Great Lakes Environmental Research Laboratory. **The Tipping Point Concept for Use in Great Lakes Ecosystem Decision Making**.

A key concept in decision-making and assessments of ecological status is that of thresholds or tipping points. Tipping points are breakpoints between any system states. It is generally considered that some states are good or desirable and others are not. Knowing how far one is away a system state is from a tipping point of a system that might be moving toward a tipping point is useful for decision-making. To avert a tipping point, interventions might be necessary through planning and/or policy. This presentation gives a generalized overview of the tipping point concept by using a conceptual-metaphoric model that shows how any ecological, social or socio-ecological system, might move from one state to another and what thehow the system composition might be change as it transitions through a tipping point, or more precisely, a tipping phase. We then show how synoptic spatial data collected across large spatial scales can be used within a "space for time substitution" to provide researchers with an heuristic? model of tipping points. We have developed models of land use, nutrients, aquatic communities and food webs that can be used withinfor a decision support system that provides the necessary dashboards that summarizes current status, current direction and departure of these systems from a tipping phase. As tipping points are very common in complex systems, we also describe how we classify them according to their "leverage" through interventions.

POINT, A., HOLSEN, T., CRIMMINS, B., FERNANDO, S., Clarkson University. **Blood Protein Diversity as a Potential Driver for Perfluoroalkyl Acid Trophodynamics in Lake Ontario's Aquatic Food Web**.

Studies on perfluoroalkyl acid (PFAA) trophodynamics in aquatic food webs provide inconclusive evidence regarding these chemicals' trophic magnification. Both controlled uptake experiments and peculiarities involving enhanced accumulation of PFAAs in lower trophic level organisms suggest that additional aspects beyond direct trophic transfer govern PFAA trophodynamics in these systems. PFAAs share structural similarities with endogenous fatty acids, and several proteins responsible for fatty acid metabolism also affect PFAA accumulation, distribution, and elimination. Within blood, PFAAs are predominantly protein-bound, mainly due to their relatively high affinity for serum albumin – an abundant circulatory protein responsible for long-chain fatty acid transport. Previous publications describe relatively high diversity among fish species' blood proteins, including the absence of albumin in some species. Work in progress seeks to build on these findings by attempting to identify the protein(s) expressing PFAA affinity within the blood of three Lake Ontario fish species (alewife (Alosa pseudoharengus), deepwater sculpin (Myoxocephalus thompsonii), and lake trout (Salvelinus namaycush)), and discerning whether the strength of PFAA affinity towards these blood proteins might contribute to the observed PFAA trophodynamics of this food web.

POLAP, C., Hamilton Conservation Authority. **Hamilton Conservation Authority Water Quality Program**.

The Hamilton Conservation Authority is involved in several water quality monitoring programs within the Hamilton watershed. We collect water chemistry data via routine surface water grab samples and automated samplers. Our areas of focus are on creeks and tributaries that flow into Cootes Paradise and the Hamilton Harbour. Using this data, we can establish long term trends and baseline water quality references as well as identify areas of potential concern and remediation.

PRIDDLE, C., Halton Region Conservation Authority. **Coordination required for innovative designs: Difficulties getting offshore structures approved**.

One of the greatest challenges currently facing the use of innovative nearshore structures can be getting them approved. While such structures limit risks of flooding and erosion while maintaining natural functions at the nearshore, they remain innovative and require buy-in. Such designs do not "check the boxes" review agencies have relied on over the past few decades. Apprehension to approve such structures exists and there is occasionally a desire to defer decisions until other agencies have provided comment. Appleby College in the Town of Oakville is an example of difficulties that can arise and how they can be overcome when a nearshore structure is proposed. Having nearly 300 metres of shoreline, which includes the mouth of a watercourse, Appleby College has a decades long history of attempting to manage shoreline with designs ranging from structural to bioengineering. Record high water levels in 2017 eroded bluffs to the extent that a more permanent solution was necessary. An inventive design was submitted including cobble nourishment and a large offshore structure. The approach Appleby College submitted avoided the traditional hardened shoreline and had many obvious structural and ecological benefits. However, being an offshore structure meant approvals were required by more than one Provincial Ministry, the Department of Fisheries and Oceans (Federal), the Conservation Authority, First Nations, even the Board of Directors at the College. The biggest hurdle for this project became the approval process, and the communication and coordination required. This presentation reveals the difficulties that can arise when numerous review agencies are involved with approving an innovative design, and the importance of ensuring active communication amongst those agencies. One year after the approval and initial stage of the project was complete Lake Ontario again reached record elevations and confirmed the benefits of such structures.

R

RAMESBOTTOM, A., GIBSON, C., STILLE, J., Toronto and Region Conservation Authority. **RAP Delisting and the Adoption of the Integrated Restoration Prioritization (IRP) Tool: Compiling TRCA data on waterfront and inland restoration planning and projects within the Toronto AOC**.

This presentation will examine the TRCA's restoration program data and will highlight cumulative restoration contributions to the Toronto AOC. It will review specific examples of projects implemented with the use if the Integrated Restoration Prioritization (IRP) tool and will examine how TRCA's restoration program has evolved since its implementation. To assess contributions to delisting targets of ecological restoration throughout the Toronto AOC, information on inland restoration and waterfront planning initiatives and projects were summarized. Compiling this information involved multiple GIS datasets that were merged through automated and manual processes. Data comparisons before and after implementation of the IRP tool demonstrate how project planning has shifted to a reach-based approach that has cumulative benefit, and there is now a greater focus on restoration work in highly impaired catchments. Over time, this approach aims to be more effective at achieving significant demonstrable improvements in habitat quality, connectedness, and water quality. Restoration in priority IRP catchments is meant to address the Beneficial Use Impairment (BUI): Loss of Fish and Wildlife Habitat. Specifically, that biotic corridor linkages are protected, enhanced or rehabilitated across the waterfront and throughout the stream and valley system, and remaining and created wetlands are protected.

RASMUSSEN, E.[1], KOCK MADANI, M.[2], DELANEY, P.[2], [1]DHI Water & Environment, A/S, Horsholm, Denmark, [2]DHI Water & Environment, Inc, Cambridge, Canada. **Lake Ontario ecological model system**.

The presentation is a status of project funded by Ontario MECP ending in summer 2021. The objective of the project is to develop a better understanding of complex ecosystem dynamics between nutrients, plankton algae and dreissenids mussels influencing the production of macrobenthic algae Cladophora along the north shore of Lake Ontario. To facilitate this understanding a combined hydrodynamic- ecological model is developed. This presentation focus on the ecological model. The ecological model (template) is developed in DHI's ECOlab which is interlinked to DHI's 3D hydrodynamic model. In the pelagic the template includes 3 groups of phytoplankton, zooplankton, inorganic nutrients (N, P & Si), dissolved organic C, N and P and oxygen. Pools of C, N, and Si is included in the sediment. The benthic community is described by a benthic macroalgae (Cladophora), and a dreissenid mussel part, which is based on a model by (Gudinov et al. 2015) but with extensions and modifications. The mussels are divided into 7 size classes up to a maximum shell length of 30 mm. Two state variables describe a size class, number of mussels pr. m2 and the soft part of the mussels in g C/m2. Mussels can move from one size class to a higher size class determined by the condition. The clearance rate is used to estimate the removal of particulate matter in the water column and the mussel's faeces and pseudo faeces enter the sediment pools. The interlink between mussels, Cladophora and especially the anthropogenic P load is the mussel's ability to clear the water, enabling more light at the bottom on deeper water and trapping the P nutrient on the bottom which in combination favour a production of Cladophora. Hopefully this understanding will be used to the development of policies and programs designed to minimize Cladophora production.

REN, J.[1], POINT, A.[1], FAKOURI BAYGI, S.[1], FERNANDO, S.[1], HOPKE, P.[1,2], HOLSEN, T.[1], LANTRY, B.[3], WEIDEL, B.[3], CRIMMINS, B.[1,4], [1]Clarkson University, [2]University of Rochester, [3]U.S. Geological Survey Great Lakes Science Center, [4]AEACS, LLC. **Bioaccumulation of Perfluoroalkyl Substances in a Lake Ontario Food Web**.

Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals detected throughout the environment. Although the stability and amphiphilic properties of PFAS has led to a variety of commercial and industrial applications, these inherent properties have been accompanied by toxicity and ecosystem persistence. To better understand the distribution of PFAS in an aquatic system (the Laurentian Great Lakes), stable isotopes of carbon (δ 13C) and nitrogen (δ 15N), fatty acid profiles, and PFAS have been measured in the Lake Ontario food web. Sampled organisms included top predator fish, prey fish, and benthic and pelagic macroinvertebrates. The highest PFAS concentrations were observed in deepwater sculpin, suggesting a significant source of PFAS from the benthic zone. Perfluorooctanesulfonic acid (PFOS) was the dominant PFAS observed. The biomagnification factors (BMF) and trophic magnification factor (TMF) were significantly higher for PFOS and long chain (> C10) perfluoroalkyl carboxylic acids (PFCAs) indicating the significant impact of the octanol-water partition coefficient (Kow) on the bioaccumulation of PFASs in the food web.

RENAGULI, A., FERNANDO, S., HOPKE, P., HOLSEN, T., CRIMMINS, B., Clarkson University. **Comprehensive analysis of halogenated compounds in the Great Lakes fish using two-dimensional gas chromatography with high-resolution mass spectrometry**.

Fish have been used for decades as bioindicators for assessing toxic contaminants in the Great Lakes ecosystem. Routine environmental monitoring programs target predetermined compounds that do not reflect the complete exposure of chemicals to biota and do not provide the complete halogenated fingerprint of the biota. In the current work, a nontargeted screening method was developed using a 2-dimensional gas chromatograph coupled to a high-resolution time-of-flight mass spectrometer (GC×GC-HR-ToF MS) and was applied to edible fish fillets and whole fish from the Great Lakes to characterize a more robust set of halogenated organic compound. Lake Ontario had the largest number of non-legacy halogenated organic components. Unknown chemical profiles were explored using correlation and clustering analyses to provide spatial and temporal information on unknowns and help identify persistent, emerging contaminants. Coupled with targeted chemical monitoring in the Great Lakes region chemical profiling provides a means to protect the region from known and unknown emerging contaminants of concern.

RICHMAN, L., VIEIRA, C., Ontario Ministry of the Environment, Conservation and Parks.
Identifying Contaminant Sources to the Niagara River: Long-term Monitoring Using Caged Mussels and Passive Samplers:1983-2018.

To support biomonitoring for the Niagara River Toxics Management Plan, the Ontario Ministry of the Environment, Conservation and Parks monitored contaminants in caged mussels (*Elliptio complanata*) and sediments on the Canadian and American side of the Niagara River since 1983 to describe the general contamination of the near-shore, identify contaminant sources and document the effectiveness of remedial actions implemented at identified sources along the river. More recently (2012-2018), passive samplers: semi-permeable membrane devices (SPMDs) have been deployed to compliment the mussel dataset and estimate nearshore water concentrations. SPMD and caged mussel tissue data from Canadian sites and from U.S. sites at which remedial actions have been implemented [Bloody Run Creek (Hyde Park Hazardous Waste Site); Gill Creek; Occidental Chemical Company (Buffalo Avenue Plant); 102nd Street Hazardous Waste Site; and Pettit Flume Cove] will be presented, as well as data from sites that remain ongoing sources of organic contaminants to the river. The success of implemented remedial actions in reducing the flow of contaminants to the river ranged between very effective (Gill Creek; PCBs; 102nd Street: chlorinated benzenes (CBs)), to no effect for some contaminants (Bloody Run Creek: PCBs, CBs, dioxins). Remedial actions at the Pettit Flume Cove (e.g., CBs, dioxins/furans) initially appeared to be effective, but recent data showed that the cove remains contaminated with dioxin/furans although concentrations in sediment are lower than reported prior to remediation. The SPMD data have corroborated the long-term caged mussel data and have effectively tracked down sources of PCBs not previously detected using the mussels. Additionally, the SPMDs identified the presence of organochlorinated pesticides in the near-shore on both sides of the river confirming suspected widespread historical use and contamination, however, estimated water concentrations were low. Additional remedial efforts are still required at known sources of contaminants to the river.

RICHTER, W., SKINNER, L., New York State Department of Environmental Conservation.
PBDEs and Dioxins in Fish from New York's Great Lakes and Connecting Waters.

We report on polybrominated diphenyl ether (PBDE) and polychlorinated dibenzo-p-dioxin and dibenzofuran (PCDD/F) concentrations in multiple fish species taken between 2010 and 2017 from New York's portion of Lakes Erie and Ontario, the Niagara and St. Lawrence Rivers, and from selected tributaries. PBDE contamination was ubiquitous, with limited spatial differentiation. Five of the 50 measured PBDE congeners contributed nearly 90% of total PBDEs. PBDE concentrations did not exceed human health consumption criteria. In contrast, a high proportion of sample means exceeded criteria protective of fish or fish consuming wildlife. PBDE concentrations in carp from Cayuga Creek suggest the creek is a primary source of the contaminant to downstream waters. Lake Erie, the upper Niagara River, and major rivers draining New York's Adirondack Mountains generally had lower PCDD/F concentrations than the lower Niagara River, Lake

Ontario, and the main stem St. Lawrence River. Concentrations showed considerable declines relative to the preceding quarter century. Nonetheless, Cayuga Creek, which is the receiving water from Love Canal, continued to have 2,3,7,8-TCDD toxic equivalent (TEQ) concentrations that exceeded New York State advisory criteria for limiting fish consumption. In contrast, Lake Ontario TEQ concentrations dropped below advisory guidelines. All fish species from Cayuga Creek, and a substantial proportion of species from the nearer downstream waters, had TEQ concentrations that exceeded criteria to protect piscivorous wildlife. The proportion of TCDD in the lower Niagara River, Lake Ontario and the upper St. Lawrence River showed a clear signal of the Cayuga Creek discharge with downstream diminution. These findings suggest that PCDD/Fs stemming from Love Canal continue to contaminate downstream sediments and be bioavailable and point to the need to investigate additional remediation.

RINCHARD, J.[1], FUTIA, M.[2], TILLITT, D.[3], KRAFT, C.[4], EDWARDS, K.[5], [1]SUNY Brockport, [2]University of Vermont, [3]U.S. Geological Survey, [4]Cornell University, [5]Binghamton University. **Prevalence of Thiamine Deficiency Complex in salmonines from Lake Ontario**.

Thiamine Deficiency Complex (TDC) is a nutritional health issue affecting salmonine species in the Great Lakes region. It is characterized by low thiamine (vitamin B1) concentrations, often resulting in high offspring mortality due to poor maternal transfer. Although the mechanisms causing TDC are undetermined, TDC has been linked to high consumption of alewife, a major prey fish in Lake Ontario. To determine the prevalence and severity of TDC, thiamine concentrations in liver, muscle, and eggs and activity of thiamine dependent enzymes in brain tissue were determined in lake trout, steelhead trout, coho salmon, and Chinook salmon collected from Lake Ontario in 2016 and 2017. Alewife were also collected in spring and fall of 2016 and 2017(?) in the western and eastern basin for lipid, fatty acid, thiaminase, and thiamine analyses. Prevalence of TDC in Lake Ontario and its impediment to salmonine natural recruitment will be discussed. In addition, we will describe the development and validation of a modified ELISA-format assay to measure thiamine.

ROBERTSON, D., SAAD, D., U.S. Geological Survey, Upper Midwest Water Science Center. **Use of SPARROW ratios with limited tributary monitoring to estimate loading from the entire Great Lakes Basin**.

Because of degradation in water quality of the Great Lakes, efforts are being made throughout their watersheds to reduce nutrient loading. To evaluate the success of these efforts and whether water quality improvements can be expected, it is important to continually estimate total nutrient loading to each of the Great Lakes. However, tributary monitoring to the Great Lakes, like most aquatic systems, consists of monitoring at a limited number of sites. In this study, we developed a technique to extrapolate the monitored loads at selected tributaries to the total loading using SPARROW ratios (ratios of nonpoint loads between monitoring tributaries and nearby unmonitored areas using published SPARROW models), annual point source inputs throughout the basin, and annual (or shorter term) monitored loads from tributaries in consistent ongoing monitoring programs (such as the Great Lakes Restoration Initiative Tributary Monitoring Network). The SPARROW-ratio approach incorporates differences in point and non-point nutrient sources, watershed characteristics (such as soil types, slope, runoff, etc.) and spatial differences in runoff. Nutrient loading from the monitored tributaries are computed using surrogate regression techniques to better describe short-term loads and improve their accuracy. To demonstrate how loading estimates from this SPARROW-ratio approach compare with estimates of the previous approach used to estimate total watershed loading (extrapolation based on unit-area yields from nearby monitored tributaries), total loading from the entire U.S. part of the Lake Erie Basin are compared for water years 2012 and 2013 (last years with phosphorus loads estimated for the entire Lake Erie Basin).

RUDSTAM, L.[1], WATKINS, J.[1], BARIBIERO, R.[2], SCOFIELD, A.[3], FIGARY, S.[1], CONNOLLY, J.[1], MARSHALL, C.[1], WHITMORE, E.[1], DOUD, G.[1], [1]Cornell University, [2]GDIT Consulting, [3]U.S. EPA Great Lakes National Program Office. **Oligotrophication of the Lake Ontario offshore – the zooplankton perspective**.

Zooplankton are a major food source for the main prey fish species supporting the Lake Ontario salmonid sport fishery. Over the last two decades, we have observed changes in the zooplankton species composition of Lake Ontario towards that observed in the upper Great Lakes (Michigan, Huron and Superior). This shift includes increasing numbers of large cold-water calanoid copepods and fewer smaller cyclopoid copepods. Here, we compare temporal trends in the zooplankton communities of these four lakes using data from the Great Lakes National Program Office, a sampling program currently led by Cornell University that collects zooplankton data in April and August across all five Great Lakes. We explore potential (and not mutually exclusive) explanations for the observed trends in zooplankton, including increased water clarity, which promotes the deep chlorophyll layer (DCL) and the large calanoid copepods that feed on DCL phytoplankton, decreased phosphorus concentrations in the offshore, changes in alewife abundance affecting zooplankton size structure, and changes in invertebrate predators like the spiny water flea.

RUTHERFORD, E.[1], MASON, D.[1], ZHANG, H.[2], WEIDEL, B.[3], LANTRY, B.[3], KOOPS, M.[4], HOSSAIN, M.[4], CHU, C.[4], BOSTON, C.[4], ARHONDITSIS, G. [5], RUDSTAM, L.[6], FITZPATRICK, K.[6], WATKINS, J.[6], HOLECK, K.[6], JOHNSON, T.[7], YUILLE, M.[7], BROWN, E.[7], HOLDEN, J.[7], FITZPATRICK, K.[6], BURLAKOVA, L.[8], STEWART, T.[9], HINCHEY, E.[9], PORTISS, R.[10], CARTWRIGHT, L.[10], CONNERTON, M.[11], (NY DEC) [1]NOAA Great Lakes Environmental Research Laboratory; [2]Eureka Aquatic Research, LLC; [3]U.S. Geological Survey Great Lakes Science Center; [4]Fisheries and Oceans Canada; [5]University of Toronto; [6]Cornell University; [7]Ontario Ministry of Natural Resources and Forestry; [8]SUNY Buffalo; [9]U.S. EPA; [10]Toronto and Region Conservation Authority; [11]New York State Department of Environmental Conservation. **Modeling Nutrient and Invasive Species Tipping Points on the Lake Ontario Food Web**.

Lake Ontario (LO) is undergoing rapid changes due to invasive species, climate change, development in watersheds and management actions. To understand how these factors may singularly or interactively affect the LO ecosystem, we used an Ecopath with Ecosim model to evaluate the nutrient (total phosphorus, TP) and invasive species (dreissenid mussels, bigheaded carps) tipping points for the LO food web. Our simulation scenarios were combinations of TP levels, with/without mussels, and with/without bigheaded carps. We simulated a range of TP concentrations from 20% to 540% (LO historic high) of current concentrations. Results suggest biomass of most food web model groups would collapsed with TP at 20% of current levels, but would increase with increases in TP. Scenarios with dreissenid mussels showed decreases in biomass of most model groups compared to scenarios without mussels, except for model groups that are direct or indirect predators of mussels. Projected bigheaded carp biomass also increased with increases in TP, but their biomass was negligible under the scenario of 20% of current TP. Bigheaded carp had negative effects on cladocerans and zooplanktivorous fish, and positive effects on carp predators. TP had much stronger effects on the food web than did dreissenid mussels, while effects of bigheaded carp were much smaller than those of TP and mussels. These results should inform ongoing efforts to set guidelines for managing TP loads from Lake Erie and LO watersheds that affect LO nutrient concentrations.

S

SCHLEA, D.[1], REDDER, T.[1], ATKINSON, J.[2], HUI, Y.[2], [1]LimnoTech, [2]SUNY Buffalo. **Model development for nutrient dynamics in Lake Ontario**.

A whole-lake, linked hydrodynamic-eutrophication model has been developed for Lake Ontario to support future management decisions by providing quantitative evaluation of the relative benefits of potential abatement strategies. The Lake Ontario Ecosystem Model (LOEM) was constructed to provide spatially and temporally resolved cycling of nutrients within the entire lake, including utilization in the nearshore by Cladophora and Dreissenids and exchange between nearshore and offshore waters. The LOEM was calibrated to water quality data primarily from Cooperative Science Monitoring Initiative (CSMI) efforts in 2013 and 2018. Initial model evaluations performed include whole-lake phosphorus mass balance analyses, sensitivity to tributary nutrient loading, and assessing the impacts of Dreissenids on water quality and the lower food web. This presentation will summarize the LOEM development, calibration, and application activities that have occurred over this two-year effort, which was motivated by top priorities for Lake Ontario management, including improving nearshore water quality, dealing with oligotrophic conditions offshore, reducing harmful and nuisance algal blooms, and enhancing coastal resiliency.

SCOFIELD, A.[1], MACLELLAN-HURD, R.[2], BRAMBURGER, A.[3], [1]U.S. EPA, Great Lakes National Program Office; [2]ORISE at U.S. EPA, Great Lakes National Program Office; [3]Environment and Climate Change Canada. **Vertical structure of phytoplankton in Lake Ontario based on fluoroprobe profiles**.

The use of multi-spectral fluorometers for assessment of phytoplankton communities has emerged as a popular method to supplement phytoplankton taxonomy datasets. Instruments such as the fluoroprobe allow for the determination of coarse algal divisions at higher spatial, temporal, and depth resolutions than is practical using traditional microscopy techniques. However, appropriate use and interpretation of these data requires in-lake calibrations for yellow substances and ground-truthing with microscopy data. Using data generated by the EPA Great Lakes National Program Office long-term monitoring program, we present a comparison of fluoroprobe results for Lake Ontario with those from more traditional analyses of chlorophyll-a concentrations and phytoplankton community structure based on microscopy. We then investigate the vertical structure and community composition of deep chlorophyll layers in Lake Ontario based on fluoroprobe profiles generated through the GLNPO long-term monitoring program and Cooperative Science and Monitoring Initiative surveys over the past decade. When paired with traditional sampling techniques, analysis of fluoroprobe data can provide valuable supplementary information on the structure of phytoplankton communities in large lakes.

SCOLES, C.[1], SCHULTZ, R.[1], SILVA, A.[1], WILCOX, D.[1], POLZER, E.[2], UNGHIRE, J. [3] KENNEDY, H.[4], [1]SUNY Brockport; [2]U.S. Army Corps of Engineers, Vicksburg; [3]U.S. Army Corps of Engineers, Buffalo; [4]New York State Department of Environmental Conservation. **Vegetation Response to Wetland Restoration in Braddock Bay of Lake Ontario**.

Following lake-level regulation, invasive cattail expanded into coastal wetlands on Lake Ontario, which resulted in the widespread loss of diverse meadow marsh habitat. Braddock Bay, degraded by cattail invasion and erosion due to the loss of its barrier beach, was targeted for restoration by the Rochester Embayment Area of Concern Remedial Action Committee and the U.S. Environmental Protection Agency through the Great Lakes Restoration Initiative. Restoration goals included increasing plant diversity, particularly of meadow marsh species. Objectives included

reducing coverage by cattails by excavating open water areas and channels, creating and planting spoil mounds to increase meadow marsh species, treating areas of cattail in higher elevations to promote succession of meadow marsh species, and reconstructing a barrier beach to protect against wave action and restore the submerged aquatic vegetation community. We collected vegetation data prior to restoration in 2013 and for five years following the 2016 construction activities. Post-restoration results showed that cattail cover decreased across years in the cattail treatment areas, decreased in lower elevation constructed habitats, and gradually increased in higher elevation habitats. Opening of the cattail canopy resulted in increased floating and submersed species, and constructed mounds hosted meadow marsh species. Site-level weighted mean C, a floristic quality metric, increased following restoration and was greater in the restored versus control plots. While purple loosestrife decreased following biocontrol efforts, other invasive species such as European frogbit have been increasing in cover. Submerged aquatic vegetation dramatically increased in volume following the construction of the barrier beach, and although the coverage was lower under higher water conditions in 2017 and 2019, volume was still greater than prior to restoration. We recommend pre-restoration soil surveys to predict settling of spoils and mound elevation, excavating channels to be wide enough to avoid cattail regrowth, and adaptive management to control emerging invasive species.

SEALOCK, L., Environment and Climate Change Canada. **Chemicals of Mutual Concern in Lake Ontario: Achievements and Ongoing Challenges**.

Chemical contaminants have been a long-standing issue in the Great Lakes since the 1970's; however, implementation of binational and federal actions since the 1980's have led to improved chemical conditions. The Great Lakes Water Quality Agreement (GLWQA) addresses chemical contaminants binationally under Annex 3, Chemicals of Mutual Concern (CMCs). CMCs are chemical substances that Canada and the U.S. have designated as such, in order to take additional cooperative and coordinated measures to reduce their release into the Great Lakes. Despite long-term declines in chemical concentrations (namely mercury, PCBs and PBDEs), federal monitoring and surveillance programs indicate that the overall status for toxic chemicals in Lake Ontario is "fair". Due to its downstream position, high population density, and history of industrial activity, concentrations of certain CMCs (e.g. PBDEs, PCBs, HBCD, PFOS, and PFOA) are highest in Lake Ontario, and PCBs still exceed water quality objectives. Lake Ontario exhibits the poorest sediment quality of all the Great Lakes, and mercury and PBDEs still exceed guidelines. Additionally, concentrations of certain CMCs (e.g. PCBs, PBDEs, and PFOS) in fish are higher than environmental targets. Under Annex 3, Canada and the U.S. have committed to develop and implement binational strategies with risk management actions for CMCs to continue to protect Great lakes water quality and ecosystem health. This presentation will highlight some Canadian actions that are working to address these CMCs and reduce their concentrations in Lake Ontario.

SEMCESEN, P., WELLS, M., University of Toronto, Scarborough. **Biofouling induces sinking of buoyant microplastics in freshwater systems**.

Microplastic pollution has opened a Pandora's box of environmental issues, one of which is microplastic buoyancy change. Microplastic dispersal in the Great Lakes is heavily dependent on the physical properties of microplastic particle density and shape, but these can change due to surface growth of microbial communities (biofilms). Through laboratory experiments, we quantified biofilm-induced changes of sinking rates for irregularly-shaped polypropylene granules ranging from 125-2000 μm in size. Our ex-situ experiments emulated a typical Great Lakes freshwater environment which allowed for natural biofilm development. We observed sooner sinking of our smallest (125-212 μm) microplastics within 18 days of entering our freshwater system relative to our largest (1000-2000 μm) microplastics that began sinking after 50 days. Because of this trend in different settling onset times, we expect the size-fractionation of microplastics as they are deposited in benthic sediments of the Great Lakes where smaller particles are deposited closer to their sources. Our study demonstrates a novel mechanism by which microplastic density changes over time and can lead to the selective sinking of buoyant microplastics from the lake surface.

SHERIDAN, E., New York Natural Heritage Trust/ New York State Department of Environmental Conservation. **Bridging Science, Outreach and K-12 Education to Promote Action in NY's Great Lakes.**

Meaningful outreach and education about complex ecological science to partner organizations, the general public and K-12 students is essential to increase a shared understanding of Great Lakes resources, build support for action, and to encourage future stewardship. Using a place-based and participatory outreach strategy, NYSDEC's Great Lakes Program (GLP) has actively engaged over 1,300 stakeholders from over 60 organizations in addressing shared goals under NY's Great Lakes Action Agenda (GLAA), which include environmental quality, natural resource conservation, and community resilience goals. To engage K-12 educators, and foster the next generation of environmental scientists, we have established a successful education partnership between NYSDEC's GLP and NY Sea Grant - NY's Great Lakes Ecosystem Education Exchange (GLEEE). GLEEE has successfully integrated Great Lakes literacy principles, stewardship actions, curriculum and hands-on educational experiences into K-12 classrooms across NY's Great Lakes watershed. A combination of strategic engagement, professional development and networking opportunities have recruited over 160 educators that will reach an estimated 41,362 students. This presentation will further detail NYSDEC's GLP's outreach and education methods, adaptations to maintain engagement, successes, and lessons learned to meaningfully engage diverse audiences in support of the state's GLAA goals.

SHERLOCK, C., GUTIERREZ, R., DEBRECENI, S., ROCHMAN, C., University of Toronto Trash Team. **Fighting Floatables in the Toronto Harbour: Trapping trash in Lake Ontario using Seabins**.

Researchers have estimated that each year approximately 10,000 tonnes of plastic waste enters our Great Lakes and their surrounding watersheds. As a consequence, recent studies have demonstrated widespread contamination of plastic pollution, specifically microplastics (<5mm in size), in Lake Ontario. Microplastics have been found in surface water, sediment, wildlife and even drinking water pulled from Lake Ontario. In response, trash capture devices such as Seabins have been introduced to remove litter directly from our waterways. Beyond diverting and capturing litter, trash capture devices can be used as a research tool to understand local contamination and inform sources of anthropogenic debris, including plastic. As part of a U of T Trash Team solutions-based research project, we are working with Ports Toronto who has deployed several Seabins in Lake Ontario. To quantify and characterize the anthropogenic debris captured and diverted from the Great Lakes, we have developed two separate protocols to quantify our total impact: 1) a simple daily protocol to estimate the mass of litter; and 2) a more detailed protocol to quantify and characterize the type of anthropogenic debris captured at each location. Thus far, our study has found Seabins to be effective in capturing both large and small anthropogenic debris, with small debris comprising an average 84.5% of the anthropogenic debris collected in each bin. We have also found a significant positive correlation between the total weight of the Seabin catch bag and the total count and weight of large and small anthropogenic debris, suggesting simple daily mass recording is useful to quantify our impact. Here, we will share the results of our Seabin project in the Toronto Harbour, and how our protocols are being used broadly across a network to measure collective impact and inform policymakers of the potential solutions to our plastic problem, both upstream and downstream.

SHORE J.A., Royal Military College of Canada. **Impact of the monthly variability of Trent River flows on flushing and particle transport in the Bay of Quinte**.

We quantified the monthly variation in Trent River discharge for the years 2016–2019 using drifter observations of river speed. We estimated that the Trent River was responsible for up to 95% of the Bay of Quinte flushing in low runoff years. We modelled simulated particle transport from the four major river sources and particle settling destinations under different conditions of the spring runoff. Particles were be trapped along shorelines, which extended residence times, and Trent River source particles with constant settling velocities were not transported beyond Big Bay. The Napanee River were the primary source for Longreach.

SINGH, A., Credit Valley Conservation. **Nearshore Water Quality of Lake Ontario under Credit Valley Conservation's jurisdiction**.

Maintaining good nearshore water quality of Lake Ontario in Credit Valley Conservation's jurisdiction is important due to number of environmental and non-environmental reasons. There are two large drinking water intakes of Region of Peel in Lake Ontario in this area that serve over 2 million residents, therefore, source water quality is important for water treatment plants to meet drinking water standards in the treated product. There also are two Region of Peel wastewater outfalls in this area that require assimilative capacity of the lake to be adequate so that the nearshore ecosystem is not compromised. Nearshore is also a popular area for recreational usage, therefore, users expect water quality to be maintained for aesthetics and recreational objectives. Above all, nearshore water quality is crittical for nearshore aquatic habitats. Credit Valley Conservation conducted water quality characterization studies through water quality and quantity modeling and monitoring to identify and characterize near-shore water quality stresses. Near- shore and onshore monitoring water quality sampling for nutrients, E. coli, Total Suspended Solids, and chloride was conducted in 2011-13 at 15 sites. A coupled watershed-lake model was then calibrated using the monitored data to understand pollutant dynamics as they move from land to lake. This presentation will cover results of the modeling and monitoring studies with the main focus on nutrient transportation as they are delivered from land to lake and the impact of road salt on changes in nutrient delivery dynamics.

SMITH, J., CHRESTON, A., Toronto and Region Conservation Authority. **Winning the war one battle at a time: managing phragmites and DSV at a Toronto waterfront park**.

Tommy Thompson Park (TTP) is located on the Leslie Street Spit, a constructed landform on the Toronto Waterfront within the Toronto AOC. Through natural succession and habitat restoration it has evolved into a globally significant Important Bird Area and Environmentally Significant Area. Dog-strangling Vine (DSV) and phragmites were both first documented at TTP in 2007 and have since presented ecosystem management challenges. DSV distribution at TTP peaked in 2013 with 7 ha terrestrial coverage. Various strategies for DSV management were attempted, and the only effective technique to reduce the density and distribution was chemical control. DSV was reduced by 99% (0.075 ha) by 2020. Phragmites rapidly colonized the created wetlands and enhanced shorelines at TTP. Various best management practices were attempted and the recent TTP Phragmites Management Strategy has been successful. A phased implementation of this adaptive strategy has focused on priority wetlands with capacity for water level management which provides opportunity for chemical management. After the second year of management, phragmites has been reduced by 92% and native aquatic species are regenerating. Invasive species management strategies for DSV and phragmites have changed over time, with adaptations based on successes and lessons learned. Small battles are being won at TTP, but this is only part of a large war against DSV and phragmites across Lake Ontario ecosystems. Widespread victories for management and eradication are dependant on collaborative information sharing and adapting management based on lessons learned.

SNODGRASS, B.[1], DELANEY, P.[2], ROSE, G.[3], [1]City of Toronto - Toronto Water, [2]DHI Group, [3]Golder Associates. **Development of the Lake Ontario Hydrodynamic and Water Quality Forecasting System (LOWQFS)**.

Lake Ontario is the primary source of drinking water for approximately half the population of Ontario. A Lake Ontario Hydrodynamic and Water Quality Forecasting System (LOWQFS) is being developed to provide information on real-time dynamic water quality conditions and forecasting of future conditions to local municipalities (i) to respond to contaminant spills which could reach treatment plant intakes, (ii) assess the potential impacts of new infrastructure, and (iii) assist with adapting to climate change. The LOWQFS is a significant Source Water Protection element. This paper discusses the development of the LOWQFS, including its data sources. The LOWQFS will be a decision support system (DSS) on a web-based platform using the MIKE 3 hydrodynamic and water quality computer code. The LOWQFS needs real time data from a variety of sources. Forecasts will be updated every 3 – 6 hours based on using new meteorological forecasts available from Government agencies. Year round installations of current meters together with existing seasonal arrays will provide data against which model forecasts of water circulation can be compared. Temperature data from water treatment plant intakes will assist in assessing upwelling and downwelling events. Methods to adjust model forecasts based on real time observations are under consideration. As well, real time monitoring of water quality (water temperature and conductivity) and flow rates from influent tributaries to Lake Ontario will support the simulation of their influent plumes into the Lake Ontario Coastal Zone.

STILLE, J., RAMESBOTTOM, A., ESSON, P., Toronto and Region Conservation Authority. **Determining Practical Key Performance Measures for Wetland Restoration Practitioners: Challenges and Considerations**.

Evaluating the success or failure of wetland restoration is critical to understanding the effectiveness of current practices and fostering support for current and future restoration initiatives. Ecological restoration practices are rooted in both broad based regional targets and reversing acute local impairments. Determining key performance indicators (KPIs) can be a challenge in this regard due to different temporal and spatial indices within an open system with variable inputs. As such, it is critical to determine what metrics can most meaningfully describe natural system and ecosystem service gains of restored wetlands. Wetland restoration prioritization in the Greater Toronto Area utilize data on water quality, water quantity and natural heritage to locate areas most in need of wetland restoration. Those same metrics can be used to track changes over time and can help to predict the trajectory of watershed health as it relates to future wetland restoration projects. At a local level, data has been collected and modelled at three completed projects and the results look promising. Based on these results, Toronto and Region Conservation Authority is developing a suite of metrics that will help understand wetland restoration performance in the Greater Toronto Area. This presentation will provide initial KPI results of these restored wetlands and discuss recommendations for future direction and priorities.

SULLIVAN, C., U.S. EPA. **Building a Database for the 2018 Lake Ontario CSMI Field Year**.

Through Great Lakes Restoration Initiative (GLRI) funding and collaboration between various partners, the U.S. EPA has created a database to act as a storage repository to house various types of water quality and biological data collected during the 2018 Lake Ontario Cooperative Science and Monitoring Initiative (CSMI) Field Year. CSMI field research is part of a binational effort between Canada and the U.S. to monitor and report on the state of the Great Lakes on a 5-year rotational basis. The database includes a number of parameters tied to the ecological health of the Lake including, but not limited to, water quality (nutrients such as nitrogen and phosphorus) and chemistry (temperature, dissolved oxygen levels, conductivity), chlorophyll concentrations, and phytoplankton and zooplankton measurements. Researchers and scientists typically analyze and synthesize this type of data to help address important management questions that critically influence Lake Ontario resources such as invasive species impacts on the lower food web, coastal wetland status, nearshore and offshore nutrient dynamics, and whole-lake nutrient transport and algae growth including the excessive growth of nuisance algae (Cladophora). Using a database to store information on all these parameters allows us to see relationships, and therefore better analyze data and provide opportunities for learning and public engagement. The creation of an accessible and transparent database is essential to encourage collaboration between researchers and scientists from various agencies and organizations, provide access to the current state and health of Lake Ontario, and engage and educate the public as to why monitoring the Great Lakes is so crucial.

T

TARIQ, A., GHUNOWA, K., ZIMMER, C., SINGH, A., Credit Valley Conservation. **Municipal Risk and Return on Investment Tool (Version 1.0)**.

Trends in Canada and Ontario with respect to weather-related risk show increases in damages borne by property owners and municipal governments with respect to extreme rainfall events . Predictive climate change modelling technology is becoming more advanced and is being used on an increasing basis to estimate increased risk due to changes in climate patterns, however, a gap remains in understanding the full financial implication of these events. National Disaster Mitigation Program Stream 3, Disaster Mitigation Action Fund (DMAF) and Infrastructure Canada's Climate Change Lens require a climate change risk assessment and return on investment analyses as prerequisites for infrastructure funding. With support through the National Disaster Mitigation Program and Region of Peel, Credit Valley Conservation Authority and partners are developing a Risk and Return on Investment Tool for stormwater infrastructure to help municipalities and conservation authorities to make evidence-based cost-effective decisions to reduce flood and erosion risks. The Risk and Return on Investment Tool (RROIT) will perform the following key functions: 1) Regional climate change projections; 2) Assess baseline flood and erosion risks associated with varying rainfall events, and quantify the potential impact (damage in Dollars) to private and public infrastructure under current and future climate; 3) Evaluate and compare risk-reduction that can be achieved by various management options (e.g. grey, green and natural assets); 4) Perform a financial assessment for each management option by considering life cycle costs and benefits (damages averted) achieved by reducing flood and erosion risks to assess return on investment under historic and climate change conditions; 5) Identification of high-risk areas that considers social, health, infrastructure, and environmental vulnerability to prioritize asset investment; and 6) Make the case for green infrastructure/ low impact development to reduce pollutant loading into Lake Ontario

THOMAS, K.[1], CHOMICKI, K.[2], KIRKWOOD, A.[1], [1]Ontario Tech University, [2]Toronto and Regional Conservation Authority. **Long-term monitoring of four Lake Ontario coastal wetlands reveals functional differences between natural and hydrologically altered ecosystems**.

Coastal wetlands adjacent the Great Lakes are the front-line ecological transition zones situated between tributaries exiting watersheds and nearshore zone environments. Land-use activities within watersheds (e.g., urbanization and agriculture) directly influence water quality of tributaries flowing into these ecosystems. Although coastal wetlands are distinct and vital ecosystems within the Great Lakes basin, they are also impacted and degraded by human activities. The Toronto and Region Conservation Authority (TRCA) has collected over a decade of detailed spatial and temporal water quantity and quality data along a longitudinal axis of ecosystems from tributaries, to coastal wetlands and the nearshore zone of Lake Ontario. This dataset offers important information on how tributary flows and loadings influence water quality in receiving water bodies in coastal wetlands. The objective of this study was to assess spatial patters of 4 coastal marshes of western Lake Ontario (Duffins Creek Marsh, Carruthers Creek Marsh, Rouge Marsh and Frenchman's Bay). These wetlands differed in structure with 2 'celled' wetlands (Duffins Creek Marsh and Rouge Marsh) and two 'un-celled' wetlands (Carruthers Creek Marsh and Frenchman's Bay). Using measures of phosphorus (TP, SRP), Nitrogen (TN, NH3, NNO), ions (Cl, Si), and limnological variables (Temperature, pH, conductivity, alkalinity, depth, total dissolved solids), transport and transformation of water quality variables was examined along a transect of the wetlands from river entrance to lake outlet. Longitudinal nutrient patterns differ between wetland types (celled vs un-celled), indicating distinct biogeochemical processes may be occurring. Insights from this research will be used to inform management of coastal wetlands, including the potential impact of wetland alteration on nearshore water quality in Lake Ontario.

TYLER, C., CHOMIAK, K., BANGKONG, C., CHADO, M., CUREAUX, M., DAILY, J., DAY, S., DIAZ, R., EDDINGSAAS, N., HOFFMAN, M., HUDSON, A., MARTIN, O., SCHNEIDER, N., WONG, N., Rochester Institute of Technology. **Impact of microplastic on benthic ecosystem function in Lake Ontario**.

A growing body of work encompassing both hydrodynamic models and empirical study indicates that in freshwater ecosystems such as Lake Ontario, microplastic particles are largely deposited in the benthos. However, the impact of plastic on biogeochemistry and ecosystem function in sediments is largely unknown. Further, the transformation of chemical and physical properties and associated changes in biofouling communities, which varies with polymer type, will significantly influence the rate of particle delivery and the ultimate fate and impact to organisms and processes. Our work aims to provide a holistic view of the life cycle of plastics in Lake Ontario, with a focus on shifts in benthic function resulting from plastic contamination. We are evaluating the chemical and biological changes that take place as plastic "ages" in the Lake at both the surface and in the sediments and evaluating how these changes impact potential delivery of particles to the benthos. Then, in a series of microcosm experiments, we assess the cascading impact that these changes have on benthic metabolism, sediment-water column coupling, nitrogen removal, and microbial community composition. Substantial variation in settling velocity, chemical composition and biofouling over time and among polymer types lead to shifts in risk and toxicity in the benthos. Further, polymers such as polyethylene terephthalate fibers and polyvinyl chloride, two of the most commonly found materials in freshwater sediments, have divergent impacts on benthic ecosystem metabolism and nutrient cycling.

U

UZARSKI, D.[1], LAROCQUE, S.[1], JOHNSON, T.[2], O' MALLEY, B.[3], WEIDEL, B.[3], FISK, A.[1], [1]University of Windsor, [2]Ontario Ministry of Natural Resources and Forestry, [3]U.S. Geological Survey. **Trophic Relationships of Zooplankton and Benthic Invertebrates in Lake Ontario**.

Investigating the interactions of the lower trophic organisms of Lake Ontario can improve our understanding of energy and biomass pathways in the food webs of the Laurentian Great Lakes. Trophic relationships in upper trophic organisms are relatively well understood compared to zooplankton and benthic invertebrates that form the base of the food webs in the Great Lakes. To determine the trophic relationships and isotopic niches for species composing Lake Ontario's lower trophic levels, zooplankton, benthic invertebrates, and prey fish were collected from April to December in 2012 and 2013 and were analyzed for stable isotopes of carbon (δ13C) and nitrogen (δ15N). Values of δ13C within species varied significantly among the ecoregions of Lake Ontario but less variation was found for d15N. The largest isotopic niche was occupied by Bosmina species while the benthic slimy sculpin (Cottus cognatus) the smallest. However, significant seasonal variability contributed to isotopic niche space in nearly every taxon. C. pengoi occupied one of the lowest trophic positions, based on d15N, contrasting with two other predatory zooplankters, which occupied some of the highest. Many of these primary and secondary consumers utilized similar carbon sources based on δ13C and had overlapping trophic positions based on δ15N. The wide range of stable isotope values reflect both pelagic and benthic carbon sources and overlapping isotopic niche space suggest omnivory among these taxa.

V

VALIPOUR, R., ZHAO, J., JABARI, A., LEON, L., RAO, Y., Environment and Climate Change Canada. **Episodic nearshore-offshore exchanges via coastal upwelling events in Lake Ontario: Observations and three-dimensional modelling**.

We used extensive field observations and a high-resolution three-dimensional numerical model to study episodic coastal up/downwelling events along the northern shore of Lake Ontario in 2018. Our results show that coastal up/downwelling events had a duration of less than six days and developed in response to sustained wind events. During the upwelling events, the vertical exchange coefficients in the nearshore waters decreased to values as low as 10-4 m2/s to 10-3 m2/s. The model results consistent with observations show that after the wind event subsided, the elevated thermoclines started cyclonically propagating as an internal Kelvin wave following by a strong coastal jet.

W

WALKER, D., SALAZAR, K., UTLEY, L., Purdue Extension / IL-IN Sea Grant. **Engagement Uploaded; A Virtual Approach to Environmental Planning**.

The Tipping Point Planner Decision Support System (www.tippingpointplanner.org) is a robust online suite of data, models, and sample best management practices that has assisted several Great Lakes communities' efforts to develop more sustainable land use policies, with emphasis on the issue of nutrient runoff and its impact on water quality. The tool is paired with an in-person community engagement meeting series which is facilitated by the Tipping Point Planner outreach team. The broad geographic applicability of the system, the system's relative complexity, and its original design as a facilitated in-person program has presented implementation challenges in the era of COVID-19 travel and meeting restrictions, and budget uncertainty. Presenters will familiarize attendees with the Tipping Point Planner decision support system by providing a walk-through and discussion of its capabilities, applications, and design. Workshop implementation will be characterized through a case study of program delivery in a Great Lakes coastal community. The team will then describe how we have planned, created, and used an online training course and companion online engagement format to provide for more agile delivery of the program and to increase both regional awareness of the system and the number and distribution of trained facilitators in the Great Lakes region.

WALLACE, A., Toronto and Region Conservation Authority. **Don River Mouth Naturalization Project: Restoration of Fish Habitat in Toronto - The First Piece in a Very Large Puzzle**.

The Don Mouth Naturalization and Port Lands Flood Protection Project is one of the largest infrastructure projects in Toronto's history. It involves the re-configuration of the existing mouth of the Don River which currently has an almost 90-degree angle and flows into the Keating Channel with hardened vertical walls before entering Lake Ontario. This work involves digging a new, kilometer long river valley and creating a new naturalized river mouth. The future naturalized river mouth will include the creation of 11 ha of coastal wetland, 5 ha of upland terrestrial habitat and almost 14 ha of aquatic habitat. Although the river mouth is not expected to be completed for another three years, two fisheries coves were completed in autumn 2019. These coves are located near the existing Keating Channel, an area known to have very limited fish habitat. These coves were constructed as part of a lake infilling project and were designed to create aquatic habitat heterogeneity. This presentation will look at the first year of post-construction aquatic monitoring results.

WAN, L., KENDALL, A., MARTIN, S., HAMLIN, Q., HYNDMAN, D., Michigan State University. **Quantifying Nutrient Loads to the Great Lakes Coastline with a Spatially Explicit Nutrient Transport Model, SENSEflux**.

Nitrogen (N) and phosphorus (P) loading have affected in-stream and coastal water quality. The Great Lakes, one of the world's largest surface freshwater ecosystems, are threatened by increasing nutrient inputs and subsequent eutrophication. Lake Ontario is one of the most environmentally stressed of the Great Lakes due to numerous anthropogenic stressors that have affected the lake's water quality and ecosystems. To control N and P pollution effectively, it is important to understand the inputs of these nutrients and their transport across the landscape to surface waters. Typical nutrient loading models generally lump nutrient sources or average them across relatively large watersheds. To examine relationships between nutrient applications, landscape processes, and instream loads across the Great Lakes basin, we pair a maps of source-specific nutrient loads at 30 m resolution (SENSEmap) with a new Spatially Explicit Nutrient Source Estimate and Flux model (SENSEflux). SENSEflux seasonally simulates the total nitrogen and phosphorus delivered to the Great Lakes coastline, estimates the relative contributions of different sources, and explicitly describes their attenuation across distinct pathways. Total nitrogen and phosphorus concentration data from 2008 to 2012 are compiled to calibrate and validate the model, which provides reasonable predictions with low residuals. The model results indicate that there is high variability in seasonal nutrient deliveries, which can be much higher (7x) for N and 4x for P during melt conditions than during baseflow. The agricultural sources contribute more than 50% of N and P to the Great Lakes coastline. For Lake Ontario, the contributions of manure are above 36%. This work provides valuable information for environmental managers to target efforts to reduce nutrient loads to surface waters. SENSEflux can be used to target regions where management actions may be most effective by quantifying the proportion of landscape-applied nutrients that reach the Great Lakes coastline.

WATKINS, J.[1], RUDSTAM, L.[1], KARATAYEV, A.[2], [1]Cornell University, [2]SUNY Buffalo. **Walking the tightrope in Lake Ontario between nutrient levels and fish production, 2000-2020**.

Periodically scientists and managers seek to summarize the current state of large lakes such as Lake Ontario through a comprehensive evaluation of the status of the ecosystem. These are important moments when current research directions are evaluated and emerging issues are identified, collaborative efforts that inspire a call to action and a redistribution of resources to both solve problems and fill information gaps. For example, Christie (1972) presented a dire picture of Lake Ontario that had been overloaded with phosphorus and having a fish community decimated by overfishing and the addition of nonnative species. This report inspired considerable binational remediation efforts in both water quality and fishery management, and thus by the time of Mills et al. (2003), general success had been reached in both bringing down phosphorus levels and creating a productive recreational salmonid fishery. However, one unplanned update in Mills et al. (2003) was the emergence of exotic dreissenid mussels, which within a decade after introduction had dominated the entire benthic community, with clear ramifications extending into water column production and an uncertain effect on future fish production. For 2020, it is again time to evaluate the continued expansion of dreissenid mussels, but also highlight achievements such as maintenance of a continued productive salmonid fishery through careful management and developing an exciting state of the art coregonid restoration program. The objective of this talk is to summarize the historical context and findings of the 1970 and 2000 efforts, and then recruit scientists across disciplines for a 2020 effort. We will provide an initial outline of candidate issues to focus on for discussion. Many recent changes observed are consistent with those observed in the upstream Great Lakes, however some are unique to Lake Ontario.

WHITMORE, E., CONNOLLY, J., WATKINS, J., RUDSTAM, L., Cornell University. **Diversity and potential impact of often overlooked Benthic Radopoda (Cladocera: Anomopoda) in Lake Ontario**.

Planktonic cladocerans such as Daphnia (Aradopoda) are well studied, however little is known about cladocerans that live primarily in the benthos of the Great Lakes, and the limited information available is from the nearshore (under 10 meters deep). Benthic cladocerans of the suborder Radopoda are notoriously difficult to sample; many live buried in the sediment and cannot be sampled with standard plankton nets. In 2018, 26 Lake Ontario stations were sampled with benthic ponar grabs to focus on meiobenthos using fine mesh sieves. We used these samples to study the community composition of benthic cladocerans and the effect of bottom depth on species presence. The stations sampled ranged in depth from 0.1-185 meters and covered the eastern, central, and western basins of Lake Ontario. Out of the 26 stations sampled, 19 had benthic cladocerans. Benthic cladocerans were found at stations as deep as 62 meters, substantially deeper than previously believed (Adamczuk 2014). Lake Ontario had 16 different species from 6 different genera with Alona quadrangularis the dominant species. Our findings are consistent with previous findings for the Lake Michigan nearshore that found Alona to be a common genus; however Lake Ontario had higher overall species diversity.

X

XIANG, E.[1], MUGALINGAM, S.[2], DITTRICH, M.[1], [1]University of Toronto Scarborough, [2]Lower Trent Conservation Authority. **Characterization of labile phosphorus fractions and phosphate sorption in two agricultural soils and manures in the catchment of Lake Ontario (Bay of Quinte)**.

The Bay of Quinte in Lake Ontario has a history of eutrophication and is presently designated as an area of concern (AOC). Kaiser Lake farm, a no-till farm near the Bay of Quinte uses poultry manure amendment on the agriculture-based land which brings excessive P as non-point P sources and may contribute to extensive P loading to catchment. The leaching of P from surface applied manures and soils is highly related to the P in drainage water. However, the efficiency of manure fertilization and the behavior of soil fertility is not clear in this agricultural land. Therefore, this study analyzed the distribution of phosphorus binding forms and P sorption capacity through P fractionation and soil incubation experiments to understand P dynamics and compositions in manures and soils from this farm. Two manures and two soils (canola plants and corn plants) were sampled in Summer 2019 from Kaiser lake farm. Our results showed that 37.0-55.6% of P in manure samples were in water-soluble form indicating potential of runoff. Total P in the two soils were much less compared to that in manures, indicating a P fertilization efficiency of 1.66–2.05%. Results from soil incubation experiments indicated a negative correlation between adsorbed P and added P. The dissolved ferric ions, organic matter, degree of phosphorus saturation (DPS), and the presence of Ca were analyzed as potential factors contributing to the P desorption phenomena. In short, dissolution of goethite (iron oxide source) directly led to P desorption because of reduced sorption surface area. The abundant amount of OM and Ca negatively correlated to P adsorption onto iron oxides. DPS of these two soils (95.78 and 82.46% for canola soil and corn soil, respectively) exceeded the threshold of P saturation level in agricultural soils (80%) and explained the release of P from solid phase.

Y

YANG, S., TWISS, M., FERNANDO, S., GRIMBERG, S., YANG, Y., Clarkson University.
Control Harmful Algal Blooms Using Electrochemical Oxidation Method: From Bench-scale Study to Field Application.

Harmful algal blooms (HABs) have become an emerging threat to the recreational use of lakes and sources of drinking water. In addition to the negative impacts posed by HABs on the ecosystem, cyanobacteria, a group of hazardous strains amidst the algae, could excrete microcystins which are known as hepatotoxins and tumor promoters. It is challenging for conventional water treatment techniques to mitigate algae bloom at lake scales. In this study, we proposed an electrochemical oxidation (EO) method using a conductive metal oxide coated filter anode coupled with a porous stainless steel cathode to simultaneously inactivate cyanobacteria and degrade microcystin. Electrolysis at various current density (8-16 mA/cm2) and circulation flow rate (0.5-1.5 L/min) was performed in lake water spiked with cyanobacterium (Microcystis Aeruginosa) and microcystin-LR (MC-LR). Bench-scale studies indicate that 1) 90% of chlorophyll a (C0 = 25 µg/L), an indicator for cyanobacteria concentration, could be removed in 1 minute at 16 mA/cm2 and circulating rate of 1.5 L/min; 2) 90% of MC-LR (C0 = 1 µg/L) was decomposed within 5 minutes in all tests; 3) disinfection by-products including chlorate, perchlorate, trihalomethanes, and haloacetic acids in the treated effluents were below health guidelines; 4) low energy consumption (0.12-0.38

kWh/m3) was achieved. Pilot-scale prototype with treatment capacity of 500 m3/day was designed based on the lab-scale test results.

YU, J.[1], HELM, P.[2], DIAMOND, M.[1], [1]University of Toronto, [2]Ministry of Environment, Conservation and Parks. **Sources of microplastics in surface waters of the Great Lakes**.

Microplastics are of increasing concern due to their widespread occurrence across all five Great Lakes and their tributaries. Greater abundances of microplastics have been found in Lake Ontario, particularly near urban centers with plastic manufacturing industries. Microplastics are diverse and enter lakes from a variety of sources which are not well understood. Microplastic morphologies can help indicate from where particles originate. To date, microplastics are commonly grouped into five categories: fragments, films, foams, fibers/lines and pellets/spheres. These categories broadly allude to potential sources and do not provide sufficient information for source identification. The goal of this study was to first assess the sufficiency of these categories for source identification and then to augment the current categorization scheme by introducing a source-based categorization framework developed to aid with source identification. Our motivation is the need to reduce emissions at their source. This framework was applied to 48 surface water samples collected using manta trawls (335µm net) from sites around Lake Ontario, Lake Erie and Lake Superior in 2018-19. Sampling sites were chosen to capture a range of influences from urban areas and remote settings in each lake. Microplastics are visually counted and grouped according to source-based categories including fragments, pellets, commercial fragments, spherical microbeads, irregular microbeads, tire wear, paints, films, and different types of foams. A subset of particles from each category are analyzed for polymeric material using micro-FTIR. Results will be discussed. This study will provide information on sources and their relative contributions to the overall microplastic load in the Great Lakes. Improving our knowledge on sources is necessary to target management actions and prevent future microplastic pollution to these environments.