State of Lake Huron Workshop Proceedings
Great Lakes Maritime Heritage Center
Alpena, Michigan, U.S.A.
November 4-5, 2015

Prepared for:
Environment and Climate Change Canada

Draft report submitted:
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LimnoTech

Water | Scientists
Environment | Engineers

Cover image: The 1907 shipwreck of the wooden steam barge *MONOHANSETT* in six meters of water on the south side of Thunder Bay Island, Lake Huron.

Credit: NOAA Thunder Bay National Marine Sanctuary.

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1 Introduction

The Lake Huron Partnership (LHP) has worked since 2002 to prioritize and coordinate environmental activities in the Lake Huron basin and to meet the commitments of the Canada-U.S. Great Lakes Water Quality Agreement (GLWQA). This report presents summaries of presentations made and subsequent discussion at the State of Lake Huron Workshop convened by the Lake Huron Partnership at the Great Lakes Maritime Heritage Center in Alpena, Michigan, U.S.A., on November 4-5, 2015. This workshop built on the presentations and discussions of the Lake Huron Binational Partnership Meeting held in Tobermory, Ontario on October 4-6, 2010. Specifically, the Alpena workshop served as an opportunity to present results of research projects that were partially planned at the 2010 Tobermory meeting, and executed as part of the 2012 Lake Huron field year under the binational Cooperative Science and Monitoring Initiative (CSMI). A second goal of the Alpena workshop was to begin establishment of coordinated research plans for the next CSMI field year for Lake Huron in 2017. This summary of the workshop presentations and discussions, along with the slides from the workshop presentations themselves and the companion Lake Huron Partnership Cooperative Science and Monitoring Synthesis report, which was circulated prior to the Alpena workshop, capture both (1) the state of the science regarding Lake Huron and its ecosystems, as well as (2) the future research priorities of the workshop participants and the organizations and disciplines that they represent, with a near-term focus on 2017 experiments and measurements that will fill priority information gaps about Lake Huron.

Critical issues that have previously been identified in Lake Huron include: contaminant status and trends in fish and wildlife tissues, biodiversity and changes in the food web structure and nutrient cycling induced by invasive species, and effective conservation of fish and wildlife habitat. Other issues such as the impacts of record low water levels (recovered in 2014-2015), avian botulism, beach fouling by algae, and contamination of swimming beaches by pathogenic bacteria are also of public concern and pose significant management challenges. Results of this workshop and future planned research are intended, in part, to provide current information to resource managers in the Lake Huron basin, and to contribute to development of a Lakewide Action and Management Plan for Lake Huron and the St. Marys River.

The Cooperative Science and Monitoring Initiative was created as the result of a need to coordinate binational science and research activities in support of management of the Great Lakes. The process includes enhanced monitoring and research field activities which are conducted in one lake per year on a five-year rotating cycle, tied to the needs of the Lakewide Action and Management Plan (LAMP) committees. Two years of intensive study on Lake Huron via CSMI have taken place in 2007 and 2012. In addition, annual science and monitoring activities have been conducted through U.S. and Canadian federal and provincial Great Lakes surveillance programs. These ensure compliance with water quality objectives, evaluate water quality trends, and identify emerging issues. Ongoing academic research and monitoring have also added substantially to the understanding of the Lake Huron aquatic ecosystem.

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Summaries of Workshop Presentations

Workshop Dates: November 4 and 5, 2015

Location: Great Lakes Maritime Heritage Center, 500 W. Fletcher Street, Alpena, MI 49707

Meeting Room: The Great Lakes Maritime Heritage Center's Theater Room and adjacent foyer

Participants: 102, including 70 in-person and 32 webinar participants (Appendix A)

2.1 Day 1: Wednesday, November 4th

2.1.1 Welcome, Introductions, and Meeting Overview

8:30 ***Jamie Schardt*** (U.S. Environmental Protection Agency [USEPA])

Others welcoming included ***Laurie Wood*** (Unit Head - LaMPs - Great Lakes Management and Reporting, Environment and Climate Change Canada [ECCC]) and ***Rick Hobrla*** (Acting Deputy Director, Michigan Office of the Great Lakes)

8:35 **Welcome from the Great Lakes Maritime Heritage Center**

Russ Green *(Deputy Superintendent and Research Coordinator, NOAA-Thunder Bay National Marine Sanctuary [TBNMS])*

Green usually welcomes people highlighting cultural resources (shipwrecks), rather than aquatic science, but was pleased that the group had chosen Alpena as a meeting location. Green briefly described recent work that TBNMS had supported with the neighboring U.S. Fish and Wildlife Service office, University of Michigan/Grand Valley State University research on sinkhole ecosystems near Thunder Bay in Lake Huron, NOAA-GLERL dreissenid mussel research, and artificial reef habitat restoration projects in Thunder Bay with a team including the University of Vermont (Marsden) and Michigan Department of Natural Resources (http://www.uvm.edu/rsenr/thunderbay/DLZ_Thunder%20Bay%20Flier.pdf). Green also described the diving and vessel capabilities of TBNMS that are available to researchers. He then mentioned that TBNMS had expanded in 2014 from 448 to 4,300 square miles, and that part of his role was to convince people that what TBNMS does is important. The sanctuary now has over 100,000 visitors per year, and has made its collection of shipwrecks more accessible by the recent addition of a glass-bottom boat concession for tours. Green, quoting oceanographer Jacques Cousteau, stated, "People will protect what they love." He then noted that it is important to convince people to protect the system holistically, and encouraged the workshop participants to partner with TBNMS in outreach to visitors and local communities. Green then showed a short promotional video titled *Shipwreck Alley* that gave an overview of TBNMS, including the following points: the Great Lakes do not give up their secrets easily; Lake Huron is cold, deep, and one of the best shipwreck sites in the world; shipwrecks are preserved at many depths, and therefore accessible to all, including viewing from the *Lady Michigan* glass-bottom boat; the TBNMS visitors' center has a replica ship (*Western Hope*), and interactive displays that encourage exploration of the sanctuary. Production of the five-minute video, released in 2014, was funded by the Michigan Coastal Zone Management Program. The video is available at: https://www.youtube.com/watch?v=yBT0IQScIdI.

8:45 The Lake Huron Partnership and the Cooperative Science and Monitoring Initiative: Governance, Process, and Coordination (Presentation 0)

Jamie Schardt *(USEPA) and* ***Laurie Wood*** *(EC)*

Schardt and Wood recapped events leading up to this meeting, including the 2012 update of the GLWQA between Canada and the U.S. They stated that this is a broad water quality agreement, and that different agreements govern fisheries and lake levels, but there is interaction among the different agreements. The GLWQA has 10 annexes, including Chemicals of Emerging Concern (Annex 3) and Nutrients (Annex 4). They also stated that the goal of the workshop was better understanding of the state of Lake Huron from all disciplines, and identification of knowledge gaps. Primary drivers behind the workshop were the needs of the Lakewide Action and Management Plan (formerly LaMP [Lakewide Management Plan]) team and the CSMI program, including its reporting requirements. Annex 2 of the 2012 GLWQA covers Lakewide Action and Management Plans (LAMPs), and Annex 10: mentions the Cooperative Science and Monitoring Initiative (CSMI). A new Lake Huron LAMP is being developed by the Lake Huron Partnership in 2016; this is the first such plan for Lake Huron. The Alpena workshop was designed to serve as the scientific foundation for the new LAMP. The CSMI cycle for the next five years is as follows: 2015, Lake Michigan; 2016, Lake Superior; 2017, Lake Huron; 2018, Lake Ontario; and 2019, Lake Erie. Preparations for the 2017 Lake Huron field year are underway now. One workshop goal was to identify high-level research priorities, particularly related to these topics that had previously been identified: nutrient loadings, nearshore nutrient shunting, nearshore/offshore food web linkages, and lower-upper food web interactions (i.e., top-down vs. bottom-up control). Summary discussion of priorities was scheduled for the end of the second day of the workshop (see Section 3 of this summary report). Participants were encouraged to enjoy the presentations, consider multiple perspectives, and add comments to topical summary posters that had been printed and were mounted in the foyer outside the meeting room. Poster feedback was intended to harness thoughts. Participants were also encouraged to make use of side conversations regarding science, projects, and programs.

The core of the meeting was a set of five research presentation sessions organized around the themes of chemical contaminants; nearshore water quality and land-lake interactions; aquatic ecosystem structure, function, and change; habitats and species; and fish and fisheries management. Research presentations were each 15 minutes long and generally given by a single presenter on behalf of a larger research group. Title slides from each presentation are reproduced in Appendix B, and full slide sets for most presentations are available separately from the Lake Huron Partnership.

2.1.2 Research Presentation Session 1: Chemical Contaminants (Air, Water, Sediments, Biota)

2.1.2.a Contaminants in Lake Huron Sediment (Research Presentation 1 – title slides in Appendix B)

9:00 Debbie Burniston (EC-Water Quality Monitoring and Surveillance)

Burniston presented a quick overview of the presentation, which covered sediment deposition, legacy compounds in sediment, new/emerging contaminants, dioxins (PCDDs)—especially in Spanish Harbour Area in Recovery, and future work. Deposition was mostly observed in bays. The sources contributing to the lake's sediment budget have been determined to be, in order of importance: shoreline erosion, river input, and atmospheric input. Lake Huron collects only 6% of total Great Lakes sediment. Legacy contaminant histories determined from sediment cores show maxima around 1970 and declines since then. Mercury and PCBs have declined significantly, along with DDT and lead. Mercury concentrations are less than 170 ppb lakewide, with the highest concentrations in Saginaw Bay and North Channel, but overall they are very low when compared with other Great Lakes. Concentrations of PBDEs are highest in the main basin, mostly from atmospheric deposition with little sediment dilution. Dioxins (PCDD) show distinct congener patterns in Saginaw Bay, Spanish Harbour (pulp and paper impacts from Spanish River), and Whalesback Channel (local sources). A Spanish River/Harbour dioxin study of surface, core, and suspended sediment found little sediment in the river—mostly bedrock, and concentrations in river samples below 10 pg/g. Intensive work near Aird Island (north side), including collection of cores and deployment of sediment traps, showed heterogeneous contamination, with elevated values from all samples, but high variability. Time series from cores showed a peak in 1976 at one site, consistent with pulp and paper processes, but either increases or no trend in some harbor locations over time. No ongoing sources have been identified, but spatial differences in deposition and concentration complicate interpretation of results. Environment and Climate Change Canada has started a Great Lakes Sediment Monitoring Program linked to the CSMI rotation on 5-year (lower lakes) and 10-year (upper lakes) cycles.

2.1.2.b Current (2008-12) Distribution & Body Burden of Monitored Contaminants in Lake Trout & Walleye in the Great Lakes (Research Presentation 2)

9:15 Daryl McGoldrick *(EC)*

McGoldrick presented results of historical contaminant monitoring of Lake Huron fish, current status, and future monitoring plans. Monitoring has been conducted since late 1970s to assess impairment and trends through time. Similar procedures are used by USEPA and EC, with samples collected from 12 permanent Canadian stations and 10 stations per year in each Great Lake that borders Canada. Sampled species include multiple age classes of lake trout, walleye, and some rainbow smelt; USEPA composites fish by size. There are two co-located EC/USEPA stations sampled by U.S./Canada in L. Erie and L.

Ontario. Top predators are monitored because they accumulate contaminants, are wide-ranging and long-lived, and integrate exposure through the lower food web. There is some distinction in the program between monitoring and surveillance. Annual monitoring can be a combination of goal-oriented or targeted for specific questions (e.g., emerging contaminants). Over time there has been a shift from a focus on legacy contaminants to newer classes of compounds. McGoldrick presented a snapshot of 2008-2012 data in the form of a "top 40 list" with some grouping and filtering (detections >10% of the time, five-year mean tracked). Only concentrations were tracked over time, with no weighting by toxicity, etc. Results were binned by lake. In Lake Huron, PCBs, mercury, and DDT were the top three analytes of concern. Lake Huron is the third most contaminated Great Lake by this measure; results feed into State of the Lakes Ecosystem Conference (SOLEC) reporting. In the future, chemicals identified by the GLWQA Annex 3 subcommittee will we assessed by this program if it is determined that they are likely to be present in fish. Data are available through the USEPA Great Lakes Environmental Database (GLENDA); frozen specimen banks are also available for analysis. There is an overall declining trend in contaminants in fish tissue from Lake Huron, but organic compounds (PCBs, pesticides, methyl mercury) are still elevated.

2.1.2.c Great Lakes Chemical Monitoring and Surveillance, a CSMI Perspective (Research Presentation 3)

9:30 Elizabeth Murphy *(USEPA)*

Murphy's presentation highlighted connections between CSMI and monitoring programs, and presented an overview of the status of monitoring, the binational program, and emerging trends and research. Data are collected basin-wide and analytes are not lake-specific. One-time research studies are encouraged, but are not a focus of the program. The monitoring activities received base-level support from USEPA of about $350K/year before the Great Lakes Restoration Initiative (GLRI) began in 2010; since then, budgets have been substantially greater. Media monitored are fish, air, sediment, biota (birds), water, and tributaries. Chemical prioritization is the result of multiple inputs (GLWQA, CSMI partners, Chemical Management Plan in Canada). Routine monitoring is conducted for organic pesticides, PAHs, PCBs, and mercury, with surveillance monitoring of emerging contaminants and breakdown products (e.g., flame retardants, halobenzenes, and pharmaceuticals). The Great Lakes Fish Monitoring and Surveillance Program is executed under contract with Clarkson University and follows the CSMI rotation. In addition to fish, other media monitored more recently include mussels (by NOAA) and other components of the lower food web. PCBs in lake trout show a slow downward trend over time from about 3 ppb to 1 ppb; mercury concentrations are generally flat around 0.1 to 0.2 ppm. In addition to changes in sources, ecosystem changes are also impacting contaminants. For example, the shift of Lake Huron from mesotrophic to oligotrophic has yielded decreases in prey species, resulting in smaller lake trout that are also surviving longer due to lamprey control. A slight PCB increase was observed in lake trout around 2003. Older fish in same size range as what were previously younger fish have accumulated more PCBs, so this is skewing size-based vs. age-based data. The USEPA Great Lakes program also collaborates with Integrated Atmospheric Deposition Network (IADN). Data from IADN show declines in PCBs and PAHs; replacement flame retardants, however, appear to be increasing (*Environmental Science & Technology* paper, *in press*). Sediment sampling as part of the 2012 CSMI in Lake Huron included analysis for emerging contaminants. Preliminary findings include: elevated levels of some of the flame retardants in North Channel; Saginaw Bay had dioxins that were an order of magnitude higher than elsewhere in the lake, as well as high levels of HBB and BB-153; polyhalogenated carbazole loads are 1 to 2 orders of magnitude higher than PCB and PBDE loads; and atrazine concentrations are generally increasing in sediments (a paper describing this has been submitted for Lake Michigan). The Michigan Department of Health and Human Services has issued Lake Huron fish consumption advisories by species, size, and contaminants, as well as meal guidance. The approach by the state deviates from EPA guidelines in some aspects, with a focus on selecting and preparing safer fish rather than on fishing bans.

2.1.2.d PCB and Hg Accumulation Dynamics in Lake Trout and Links with Ecological Processes (Research Presentation 4)

9:45 Ken Drouillard *(U of Windsor)*

Drouillard began his presentation by emphasizing that based on Ontario Fish Consumption Advisories, Lake Huron maintains its status as the second cleanest Canadian Great Lake. Inland lake advisories are mostly for mercury, whereas Lake Huron advisories are driven by PCBs and dioxin. There have been some shifts in intensity and number of advisories, and trigger levels have decreased. A 32 meal-per-month guidance is new, and "do not eat" advisories exist for the main basin of Lake Huron and Georgian Bay for lake trout over 40 cm. There are questions as to why advisories are increasing. Five sampling stations have been monitored in Lake Huron since 2012. Shifts in feeding ecology have been observed that began in 2003. Lake trout diets are still dominated by rainbow smelt, but round goby is becoming more important, except in North Channel. Differences in contaminant concentrations among prey species have been observed. Concentrations in fish from the main basin and Georgian Bay are higher than in North Channel. Stable isotope data (13-C, 15-N) show distinct 15-N values and a range of 13-C values. Age trajectories show no specific trophic trend in 15-N across basins. There is some nearshore vs. offshore distinction in 13-C based on basin. High basin fidelity for individual fish is indicated by combined PCB and isotope data. Real changes in fish bioenergetics have been documented, but growth rate is varies by basin. Prey biomass volume is highest in North Channel and lowest in Georgian Bay. Research is underway on drivers of variable bioaccumulation. Trends have a high slope in Georgian Bay, moderate slope in the main basin, and no slope in North Channel. Because of the nature of current sources, PCB loading is not controllable. Any shift to more bloaters in lake trout diets would likely increase concentrations.

2.1.2.e Long-term Trends of Contaminants in Herring Gulls (Research Presentation 5)

10:00 Shane DeSolla *(EC)*

DeSolla presented data from 1974 to 2013 from 15 sites. Large declines in populations were observed in the 1970s, including entire colony failure, and widespread deformities in hatchlings. Herring Gulls are good integrators of lake conditions because they do not migrate out of the lakes, they eat fish, they have high lipids in their eggs, and they are widely studied. Long time series that permit analysis of spatial and temporal trends exist for gulls from three Lake Huron sites. From 1974 to 1986 data were collected from individual gull eggs. Since 1986, sampled eggs have been pooled by site. Data shown in the presentation were plotted as change from initial measurements. Current results from Lake Huron are at 5-20% of 1974 concentrations for DDT, and 3-12% for PCBs. Most sites show exponential decay in contaminant concentrations over time, with values currently in the range of 2-10 ppb for Lake Huron sites. The Channel Shelter site is most elevated, but fairly variable. Half-lives of PCBs are 11 to 14 years, with dioxin at about 8-9 years. Michigan Department of Environmental Quality maintains two sites, along with Area of Concern sites that have wildlife beneficial use impairments. Toxic equivalents have not declined, while other compounds have. Collection of cormorant data has begun as a backup for Herring Gulls, given some population declines and failed colonies.

10:15-10:30 Break

2.1.3 Research Presentation Session 2: Nearshore Water Quality and Land-Lake Interactions (Land Use and Nutrient Loadings, Beach Health, Harmful Algal Blooms, Cladophora)

2.1.3.a Expanding Community-Based Nutrient Management and Evaluation Efforts along the Southeast Shores of Lake Huron (Research Presentation 6)

10:30 Mari Veliz *(Ausable Bayfield Conservation Authority)*

Veliz described the landscape of this part of Ontario as 80% agricultural. Local communities are concerned about beach swimming bans and algal fouling. Watershed stressors were listed, and an adaptive management framework was described as follows: build awareness >> community involvement >> action >> measure >> repeat. Phosphorus concentrations have been shown to increase in creeks 10-fold during high flow events (up to about 50 mg/L). Because flooding connects the landscape to the lake, best management practices (BMPs) must address storm events. Event-based sampling is critical for both locating and evaluating effectiveness of BMPs. Categories of BMPs include changes in practices as well as structural changes (e.g., gully plugs, water and sediment control basins [WASCOBs], grassed ditches). Numerical models make it possible to simulate BMP improvements (e.g., SWAT, PCSWMM), but there is a need to develop modeling or model output use proficiency in agency staff. Other factors that must be considered include climate variability, metrics, and cultural receptiveness. Important obstacles to effective habitat restoration include issues of scale, the need for innovation (e.g., cover crop tools; field, satellite), and the need to understand baselines better. Beyond the technical challenges, there is also a need to better integrate community resources and to involve all stakeholders.

2.1.3.b Phosphorus Transport in Agricultural Drain Tiles in the Saginaw Bay Watershed (Research Presentation 7)

10:45 David Karpovich *(Saginaw Valley State University)*

Karpovich began his presentation by describing his summer research team, which includes an undergraduate student leader, along with high school students and a middle school teacher. He related that the changing paradigm of consideration of agricultural tile drains as phosphorus sources is, "You get what you inspect, not what you expect." Study sites examined were in the Pine River and Rifle River watersheds in Arenac County, Michigan, near Saginaw Bay. The area is very flat and heavily tiled, with some buffer strips and limited no-till agriculture. Landowner permission was an important control on where samples were collected in the study. Sampled media included soil and tile/ditch water, with a focus on sampling during rain events. BMPs have targeted soil erosion prevention, especially using buffer strips (soil was sampled within strips). Tiles are generally constructed 2-4 feet deep, with laterals running into mains and then discharging to ditches. Soluble reactive phosphorus (SRP) was not previously thought to infiltrate tiles, because it was expected to sorb to soil. Four sampling events were conducted during the study, two during dry weather and two during wet weather. Total phosphorus concentrations in ditch water were 0.1-0.2 mg/L; concentrations were similar to lower in tiles, but with a greater percentage of SRP in tiles (almost two-fold higher SRP in tile water than in ditch water). An important conclusion is that phosphorus <u>is</u> transported in subsurface water, rather than being mostly adsorbed to soil. The study was funded by Dow Chemical Foundation.

2.1.3.c Saginaw Bay Water Quality Update (Research Presentation 8)

11:00 Craig Stow *(NOAA)*

Stow began the presentation with 2015 satellite images that showed the Saginaw River plume (2015) swirling around in Saginaw Bay, and even extending along the southern shore to the open waters of Lake Huron. He related that a phosphorus load to Saginaw Bay of 440 metric tons per year was included in the 1978 GLWQA as a reference condition. Annex 4 of the 2012 GLWQA has the same target, along with narrative algal biomass and cyanobacteria goals. The Annex 4 subcommittee will eventually revisit nutrient targets for Lake Huron and Saginaw Bay. The current target load has only been met (maybe) in 2003. Point sources are responsible for <20% of the load. No overall flow trends have been observed over time for the Saginaw River; March and April flows have been decreasing but May has been increasing. Total phosphorus (TP) in the inner bay is stable around 15-20 ug/L, with chlorophyll a around 5-20 ug/L. Secchi depth has been consistently below the reference condition of 3.9 m. SRP data are sparse, but no trends have been observed in the bay (typically at 0.5 to 1.0 ug/L). No ammonia or nitrate trends have been observed either. The seasonal peak has shifted in recent years for TP and chl a to a September high, from a prior non-seasonal pattern. Net sedimentation is constant over time, but there is some evidence of greater P retention in sediments after mussel invasion in early 1990s (possible evidence of nearshore P shunt to sediments?). Cyanobacteria are mixed *microcystis* and *merismopedia* plus others; microcystin concentrations are typically below 4 ppb. Little correlation has been observed between microcystin and TP or chl a. A 2008-2013 project developed a model to predict chl a concentrations in the bay based on P input concentration (not load) from the Saginaw River. A ReCON buoy has been placed in the deep hole (10-11 m) in the outer bay, which has recorded low dissolved oxygen in late July. Periodic incursions over the bay-mouth sill of cold water from the open lake reoxygenate this basin, but the frequency of these incursions is highly variable. The definitions of water quality objectives for the bay need to be stated more clearly in the future. Process-based (LimnoTech) and empirical models are now available for GLWQA Annex 4 consideration. Stow concluded by stating that the community needs to start thinking about the adaptive management process now in order to take best advantage of upcoming decisions about the future of Saginaw Bay.

2.1.3.d Investigations into Water Quality and Ecological Conditions in Eastern Georgian Bay (Research Presentation 9)

11:20 Todd Howell's work presented by **Ted Briggs** *(OMOECC, Toronto)*

The presentation by Briggs included data from Lake Huron's southeast shores, eastern Georgian Bay, and sentinel stations around Georgian Bay and Lake Huron. The southeast shores project was driven by public complaints about algal fouling at Point Clark and Inverhuron, and included research by David Barton at University of Waterloo and others on algae including *chara*, *cladophora*, and periphyton. The growth response for *cladophora* appears to be controlled by localized nutrient inputs, but *chara* distribution controls are unclear; periphyton (mostly diatoms) forms "lawns" on sediment. Surveys in 2010 showed maximum development at 20 m depth, correlated with mussel occurrence, but overall mussel density was fairly low. Enrichment of P was mostly along the shore, as there are no large rivers in the area, and most offshore waters are ultraoligotrophic. Detailed spatial surveys and lakebed characterizations are limited. In Georgian Bay, Moon River and Shawanga Island water quality surveys were conducted using a flow-through system that measured conductivity, temperature, turbidity, nitrate, and chl a. Conductivity was anti-correlated with P (lake water was more conductive than river water). Benthic surveys were performed in 2014-2015 by divers on hard substrates at 48 sites at depths of 3-18 m. Quadrats were used to determine dreissenid (typically <1000 per square meter) and macroalgae density and species; rock scraping and qualitative goby assessment were also performed. In 2015, ponar grab sampling of soft sediment was also conducted. Sampling at Great Lakes Reference and Index Stations Network sites had limited spatial coverage, but a robust suite of analyses that could be used to relate onshore with offshore data. Very reliable analytical data have been obtained from Dorset Environmental Science Center labs as part of this effort.

2.1.3.e Hydrologic Monitoring Network Data (Research Presentation 10)

11:35 Cynthia Rachol *(USGS-Lansing)*

Rachol gave an overview of data available from the USGS NWIS database, which include data from 196 Michigan streamgages, 40 of which are in the Lake Huron basin including the St. Marys River connecting channel, and 40 real-time water quality sonde stations with 12 in Lake Huron basin that each measure 2 to 5 parameters. The Saginaw River and Rifle River are part of the GLRI Tributary Monitoring Program, which includes both monthly and event-based sampling. Correlations are being developed between grab samples and sonde measurements, with most work being conducted out of the Wisconsin office of the USGS. Saginaw River at Saginaw is part of the USGS toxics program. Analytes or properties monitored from there include wastewater constituents, mercury, bacteria (*E. coli*, *Shigella*, *Enterococci*, human-sourced), optical properties, and metabolomics. Periodic enhanced sampling also includes microplastics (foam, film, fibers, pellets, fragments). In 2012, nutrient and sediment sampling were performed on the Thunder Bay River over five events and locations (tributary mouths and mainstem). The watershed is 44% forested, 29% wetlands, and 10% agricultural. Sampling missed the spring snowmelt freshet, but hit five storm "events." Because the year was dry, however, storm events were unusually small and nutrient concentrations were quite low. Edge-of-field and tile drain monitoring were performed in priority watersheds, subwatersheds, and select fields (<60 acres). These sampling stations have tile monitors, runoff flumes, sampling carousels, plant cameras, meteorological stations, and soil profile thermistors. Equipment is shoveled clear of snow during the winter to capture melt events.

There was no time for questions and answers after any of the morning speakers completed their presentations, but all stayed on schedule within one or two minutes; Bretton Joldersma served as timekeeper. Total attendance for the morning was approximately 60 with up to 19 more online on the webinar. The names of webinar participants were captured at their peak, including affiliations where they had listed them (see Appendix A).

11:50–1:30 Lunch (attendees got lunch on their own in small groups)

Research Presentation Session 2 (continued): Nearshore Water Quality and Land-Lake Interactions (Land Use and Nutrient Loadings, Beach Health, Harmful Algal Blooms, Cladophora)

2.1.3.f Physical Modeling, Observations, and Remote Sensing in Lake Huron, including Saginaw Bay (Research Presentation 11)

1:30 Steve Ruberg *(NOAA-GLERL)*

Ruberg shared that NOAA-GLERL maintained 21 Great Lakes observation points in 2015, and is working toward year-round observations in a few locations using cabled observatories. An upgrade of the Lake Michigan-Huron Operational Forecasting System from a Princeton Ocean Model (POM) base to a Finite Volume Coastal Ocean Model (FVCOM) base is underway with planned completion in 2018. This model will include a nearshore grid spacing of 200 m, and will be linked through the Straits of Mackinac for the first time. Four harmful algal bloom (HAB) sampling stations in Saginaw Bay are sampled every other week during the bloom season. A ReCON buoy is also maintained from spring through fall in the deepest part of Saginaw Bay. Ruberg described MODIS satellite image processing for color-producing agents (CPA) (19 June 2015 example) using an algorithm that can distinguish chl a from dissolved organic carbon and suspended mineral (sediment) components. The algorithm has been optimized for Lake Huron distinctly from the Lake Erie version. Chl a time series for 2002-2014 have been derived from the CPA algorithm for nearshore and open Lake Huron settings (among others). This makes it possible to distinguish overall bloom area from surface scum areas. The bloom "sweet spot" is at intermediate Saginaw River discharge; too much flow mobilizes sediment that shades bloom cells. Optical properties measurement to validate satellite algorithms has been performed using a profiler in combination with a handheld "gun". Aircraft-mounted instrument flyovers have also been correlated with on-water sampling. NOAA has participated in sinkhole studies in Lake Huron near Thunder Bay, including anoxic sulfidic brine seeps at Middle Island and Isolated Sinkhole. New AOK3 and AOK7 sinkholes farther offshore have also been explored in 2015. A combination of discrete sampling and buoy work will continue in the future. Lake Huron CSMI projects in 2017 may include autonomous glider missions, as well as possible year-round measurements (including under ice) if cabled observatory instruments have been installed by then at Thunder Bay Island and/or Spectacle Reef lighthouse.

2.1.3.g Nearshore to Offshore Trends in Zooplankton & Preyfish in the 2012 CSMI Year (Research Presentation 12)

1:45 David Bunnell *(USGS)*

Bunnell stated that the 1970s were characterized by high TP loading, followed by lower nearshore loading by the 1990s, and the development of mussel-induced nearshore shunting of TP in the 2000s (*sensu* Hecky et al., 2004). As part of the 2012 CSMI efforts in Lake Huron, USGS conducted coordinated sampling transects at Hammond Bay and Thunder Bay, with stations at depths of 18 m, 46 m, and 82 m. Sampling was designed to capture all trophic levels, and many targets were sampled both during the day and at night. The expectation prior to the field activities was that the highest biomass would be encountered nearshore and midsummer, because remote sensing (Warren and Lesht) had previously shown chl a to be highest nearshore. Zooplankton were more abundant offshore in most cases, especially at Hammond Bay. Benthic invertebrates were generally most abundant nearshore (benthification), but this was not true for mussels. Hammond Bay had more abundant mussels than Thunder Bay. Fish bottom trawls were conducted at night in combination with acoustics. The most fish were encountered offshore at Hammond Bay; sampling results were more mixed at Thunder Bay. The highest nearshore biomass consisted of round gobies. The nearshore shunt concept appears to work for chl a and non-mussel invertebrates, but it is inconsistent with other measurements. Thunder Bay had higher nearshore biomass than Hammond Bay, but fewer mussels. Important caveats included the following: gobies were not sampled effectively, and there were also other issues with the study design in terms of its ability to test the nearshore shunt hypothesis. The 2015 Lake Michigan CSMI work compared near-tributary transects with non-tributary sites; results from this design should be considered for 2017 planning for Lake Huron. Other considerations in Lake Huron include the idea that *Bythotrephes* may not practically be eating as many zooplankton as possible due to avoidance by *Daphnia*, which migrate diurnally up to 30 m. Consistent undersampling of *Bythotrephes* by day is indicated by a consistent two-fold increase in samples collected at night. The rebound of bloater in Lake Huron, even though they prefer mysids, may indicate that they are also eating more low-quality *Bythoptrephes*.

2.1.4 Research Presentation Session 3: Aquatic Ecosystem Structure, Function, and Change (Nutrients and Major Ions, Benthic and Pelagic Food Web Changes, Invasive Species)

2.1.4.a Trends in Benthic Macroinvertebrates throughout the Lake Huron System (Research Presentation 13)

2:00 Tom Nalepa *(University of Michigan)*

Nalepa began his presentation by stating that mussel, *Diporeia*, and oligochaete worm shifts in Lake Huron have been dramatic and may be broadly consistent with nearshore shunt control. Lake Huron benthic invertebrates has been consistently sampled since 1972 at 25 to 80 sites (2012) across the entire lake. Zebra mussels peaked in 2000-2003 in the main basin of Lake Huron, and in 2007 in Georgian Bay. All were gone by 2012 (only 2 found!), and none were ever found in North Channel. Quagga mussels underwent major expansion in the nearshore after the zebra mussel decline, and then expanded offshore through 2012; there are still none in North Channel. *Dreissena* peaked in Lake Ontario in 2003, and have also probably peaked in Lake Michigan, although numbers are climbing offshore in all lakes. Peak biomass is at 31-50 m in Lake Huron, but numbers offshore are still climbing. Lake Huron overall has low abundance when compared to Lake Michigan and Lake Ontario, but individual mussels from Lake Huron are more healthy. In Saginaw Bay, there was a huge drop in dreissenids in the inner bay from the early 1990s to 2008-2010 (diver surveys); round gobies arrived in Saginaw Bay in 1999 which may explain the drop. *Diporeia* are gone at <50 m in Lake Huron, but are still found in deeper water (they appear in bloater gut contents). They are declining in North Channel especially at deep depths, even without mussels present. *Diporeia* crashed in Lake Huron from 1995 to 2005. Oligochaete abundance climbed rapidly nearshore in 2007-2012 (<50 m), especially in southeast Lake Huron where abundant macroalgae and periphyton are present and sedimentation rates are high. Abundance here is doubling or tripling, likely because of the availability of more abundant detritus to eat (perhaps this is a macroalgal nearshore shunt?). Sphaerids have generally trended downward in Lake Huron, while chironomids have shown little change.

2.1.4.b Long-term Trends in Lake Huron's Lower Food Web (Research Presentation 14)

2:15 Paul Horvatin *(USEPA)*

Horvatin presented data from Glenn Warren and Rick Barbiero on zooplankton, benthos, and chl a from Lake Huron. In terms of zooplankton, cladocerans and both calanoid and cyclopoid copepods underwent big population crashes in 2000 and 2003, especially *Daphnia*, but small upticks were observed in 2010 (also in Lake Michigan). Calanoid biomass has not changed much recently, but is now more similar to oligotrophic Lake Superior, with biomass deeper in the water column. There appears to be convergence in this pattern across the Great Lakes for crustacean zooplankters. As described by Nalepa above, *Diporeia* populations crashed in 2000-2003, while oligochaete abundance has been up since 2007, especially at 30-90 m depths. Some data are missing for phytoplankton time series, but satellite data give the big picture. The loss of the spring bloom consists of filamentous diatom declines in Lake Huron's southern basin, and declines of centric diatoms in the northern basin. There was a big drop in the spring diatom bloom from 2003 to 2005; abundance is fairly flat across seasons now. In summary: *Diporeia* have crashed, oligochaetes are up, quagga mussels are taking over, and the spring diatom bloom is gone.

2.1.4.c High-Resolution Observations of Diel Spatial Interactions of Nutrients, Plankton, and Larval Fishes in Lake Huron (Research Presentation 15)

2:30 Henry Vanderploeg *(NOAA-GLERL)*

Vanderploeg stated that large lakes are highly spatially organized so high-resolution studies are needed to tease these patterns out. To that end, his research team has been looking at patterns in Lake Huron from microbes to fishes. NOAA sampled the same Thunder Bay transects in 2012 as those described in the USGS presentation above (Bunnell). In April, high offshore chl a concentrations and zooplankton abundances were encountered, with Redfield ratios of 13.5 to 15.1, so there was no evidence of P limitation. In July, offshore chl a was generally deep, except for a very nearshore patch, consistent with thermal stratification. In September, downwelling conditions were present, with zooplankton concentrated at the thermocline by day and at the surface at night (copepods and *Daphnia* were separated, high and low, respectively). Some surplus P was still present in the system. Automated Plankton Survey System results compared well with net tow data, but provided better resolution. *Daphnia* were found to move way up in water column at night. Larval fish data show that lake whitefish are present in April, but these disappear later. Whitefish in Lake Huron have low growth rates, but smelt and bloater growth rates are similar to those seen in other lakes. Fish larvae were concentrated in the metalimnion. Use of the new MOCNESS net system with strobe diodes to minimize net avoidance for larval fish, *Bythotrephes*, and zooplankton, is planned for 2017 in Lake Huron. The microbial food web in Lake Huron is mostly unknown, but picoplankton are abundant in Lake Michigan (70% of chl a in <2 micron size class). Vanderploeg presented eight research questions regarding spatial structure, larval fish, dreissenids, seasonality, and biogeochemistry. He also highlighted the need for the next generation of ecosystem models built on the new FVCOM platform (see Ruberg presentation above).

2:45 Break

2.1.4.d Lake Huron Offshore Water Quality (Research Presentation 16)

3:00 Alice Dove *(EC)*

Dove described recent work on nutrient loading and the offshore water quality sampling program that is conducted from the Canadian Coast Guard ship *Limnos*. The cruises provide good spatial coverage, but sampling only takes place every 2 years. In 2012, 50 of 68 target stations were completed in the main basin of Lake Huron, and 18 of 26 stations were completed in Georgian Bay. Analytes included metals, organic compounds, and compounds of emerging concern. Results have been published by Dove and Chapra in *Limnology & Oceanography* (2015). Measured offshore P concentrations are now below GLWQA targets in all lakes except Lake Erie. New contour maps of spring surface P have been produced using recent data. SRP shows no trend over time in Lake Huron, and is approaching the detection limit. Secchi disk depths up to 20 m have been measured, with the increase beginning in 2000. Summer chl a has been stable, while spring chl a has declined from 2 ug/L to 0.04. Spring nitrate-nitrite increased to 2000, and has been declining since the; this is associated with atmospheric deposition changes. The southeast shore has experienced enhancement of nitrate. Spring silica is going up as diatoms decline, but there is still a drawdown in summer. Mercury is very low everywhere except in Saginaw Bay. Lindane has had a linear decrease in Lake Huron. Higher concentrations have been measured in Lake Superior, but these are also declining. Neither triclosan nor bisphenol A was detected in any samples, and there was only a single perfluorocarbon detection; overall there is little concern about these compounds warranted for Lake Huron. The general condition of the lake is ultraoligotrophy and continuing nutrient decline, except for nitrogen along the southeast shore.

2.1.4.e Patterns in Lake Huron Pelagic Food Web (Research Presentation 17)

3:15 David Warner *(USGS)*

Warner began the presentation by describing the combined use of hydroacoustic surveys for pelagic fish studies with productivity data derived from satellite surveys. Chl a and primary production (PP) patterns from 1998-2008 were derived from SeaWIFS and MODIS data, and showed a gradual primary production decline and a more marked chl a decline over time in Lake Huron. Regression modeling with Barry Lesht for Lake Michigan-Huron showed that chl a is driven by TP and quagga mussels in spring, but that the overall annual driver is TP and precipitation (not mussels). In addition to macroalgae mentioned earlier, Warner noted that the southeast shore of Lake Huron also has more fish, especially bloater, associated with resuspension of sediment and possibly declining ice cover (?). Spring PP here is driven by TP and precipitation; summer includes the quagga mussel driver too. Warner matched acoustic survey points to the nearest watersheds, and found that the highest chl a in northern Lake Huron was associated with larger tributaries. The highest chl a concentrations were measured at 35 m water depth. Hydroacoustic and midwater trawl surveys were conducted from 1997-2014. All prey fish declined over this time period, but there has not been much of a trend since 2004. The biggest drop has been in alewife, but there have also been declines in smelt and bloater. Nearshore waters have abundant fish, but small (smelt) vs. offshore larger biomass (bloater). There is little explanatory power based on regressions for spatial variation in abundance. The highest chl a is in waters <75 m deep, and the most abundant fish (by number) are in shallow waters as well. Fish biomass, however, is greatest at 35-135 m.

2.1.4.f Nutrient and Energy Flows in the Food Web of Lake Huron (Research Presentation 18)

3:30 Doug Haffner *(University of Windsor)*

Haffner began by mentioning that Ken Drouillard and Gore Patterson contributed to this talk as well. The basic question posed was whether PCB bioaccumulation can tell us anything about food webs. The PCB source for fish is food only (not gills), and there is little excretion of PCB due to lipid affinity; therefore, total PCB mass should be linked to total food calories eaten (GJ per lifetime). Food eaten is linked to N assimilation and recycling; most N is recycled after age 5 for lake trout (can't grow any more). At the population scale, trout in Lake Huron recycle 482 tonnes of N and 45 tonnes of P per year. Salmon grow faster but don't live as long as lake trout, so they don't recycle N. Therefore, there is offshore N shunting by trout, but salmon compete with trout for food and move P inshore. PCB modeling works for forage fish too (plus gobies and quaggas), so PCBs have great potential as the perfect environmental tracers.

2.1.5 Research Presentation Session 4: Habitats and Species: Status, Trends, and Stressors (Coastal Wetlands, Coastal Terrestrial Habitat, Tributaries and Hydrological Connectivity, Population Status and Trends)

2.1.5.a Health, Population Trends and Ecological Changes of Colonial Waterbirds (Research Presentation 19)

3:45 Shane DeSolla *(EC)*

DeSolla's presentation covered three studies: gulls in St. Marys River AOC, and broader Lake Huron waterbird status (2 studies). The first study consisted of measurement of 30 x 3-egg clutches of gull eggs, and building of enclosures to capture 21-day-old siblings. Sampled eggs were incubated, and stress indicators were measured in feathers. Viability was determined to be >90%, with only 3-5% deformities (this was the same at both AOC and control sites). Lower productivity was observed in the AOC, but it was still above the stable population productivity threshold. Productivity of common terns in North Channel is low, so the population may be declining (separate research project). No differences in stress hormones were measured in feathers between AOC and control sites. Methods are effective based on results at other AOCs, so "no impairment" conclusion at St. Marys River AOC is probably real for gulls. The second study used Herring Gulls as ecosystem state indicators. Stable isotope and essential fatty acid analyses were performed on archived eggs. Patterns observed included declining 15-N (feeding at lower trophic levels); 13-C increase indicating more terrestrial food over time (lower prey fish abundance); along with egg energy content decline, energy density decline, and egg size decline. Declines in energy density of organisms are seen in all parts of food web. The third study examined decadal count of all colonial waterbirds. Results indicate that from 30-80% of all terns in the Great Lakes nest in Lake Huron. Cormorant numbers have skyrocketed to over 20,000. Egret and heron numbers have also increased.

2.1.5.b Changes in Northern Lake Huron Colonial Waterbird Nesting Colonies (Research Presentation 20)

4:00 James Ludwig *(Ecotoxicologist Consultant)*

Colonial waterbirds are in flux in Lake Huron, and have been since alewives arrived. A 2015 study of cormorants and vitamin A status (important for embryo differentiation, deformities with low vitamin A) showed that vitamin A has increased over 600% since 1991, and that deformities are almost unknown now; AOCs still have depressed vitamin A. Dropping trophic level in food webs is partially responsible for vitamin A recovery. A decline of 84% in cormorant numbers at known colonies has been observed since 1995 (culling is a factor here too). There has been a 96% decline since 1995 in northwest Lake Huron, but increases in Saginaw Bay. Caspian Terns have declined 95%, and clutch size has also decreased. Nests are down 80% in Lake Michigan, and many appear to have moved to Lake Ontario. Common Terns have recovered somewhat since 1995, which has been linked to recovery of emerald shiners. Herring Gulls colonies in Grand Traverse Bay are successful. Saginaw Bay cormorant nests are now well over 3,000, possibly linked to the abundance of gobies. Plunge divers like terns can't get deep, but foot-propelled divers (loons, cormorants) go deep – up to 37 m – and catch gobies that others can't reach. The nutrient value of gobies is low compared to alewife (low lipids, low vitamins), however. More than 4,000 white pelicans are now migrating to Green Bay each year; they are also appearing in Saginaw Bay. Egrets are now colonizing Saginaw Bay too, but their diet and drivers of colonization are unknown. Adaptive management requires both modeling and data collection; Ludwig made a pitch for more real field work.

2.1.5.c Invasive Eurasian Watermilfoil and Indigenous Macrophyte Density Shifts in the Les Cheneaux Islands during a Four Year Period Coinciding with an Unprecedented Rise in Lake Huron Water Levels (Research Presentation 21)

4:15 Robert Smith *(Les Cheneaux Watershed Council)*

Smith stated that data collection efforts are mostly grassroots in the Les Cheneaux Islands area near Cedarville, Michigan in the Upper Peninsula. They have also been working with EnviroScience consultants. Water depths in the islands are generally less than 15 m, and often less than 5 m. Forty percent of the workforce in the area is tied to tourism, including support of cruising boats that are able to cut through the islands to North Channel under high water conditions. Phragmites colonized the area during low water. Eurasian watermilfoil in Cedarville Bay and Sheppard Bay covered >300 acres. Control by planted weevils yielded mixed results whereas a native fungus was highly effective. With higher water, pondweed became dominant in 2013; milfoil was almost gone by 2015 (90% decline in Shepherd Bay). Most phragmites is being drowned by higher water, and small trees (aspen, cedar) that colonized beaches are also being drowned. Perch are recovering in the area along with cormorant depredation efforts. Phytoplankton are also being monitored

2.1.6 Day 1 Question and Answer Period, Group Discussion (Brief)

4:25 Facilitated by **Jamie Schardt** *(USEPA)* and **Greg Mayne** *(EC)*

Facilitators shared that 2012 CSMI priorities were nutrient loading, nearshore shunting, and shifts among trophic levels, and solicited feedback based on new information from Day 1 presentations.

Question 1: **Jeff Schaeffer** (USGS) – The past three Lake Huron CSMI years have been devoted to understanding food web shifts, and application of new technologies and sampling schemes. Do we really need more data for this? Should we shift gears completely? Move away from nearshore shunt studies? Focus on remaining resources, especially nearshore fish communities?

There were no responses to the question, so it was left as a prompt for informal discussion.

Question 2 (webinar): Michael Stoll (Les Cheneaux Watershed Council) - Expressed interested in water level changes and adaptive management.

Greg Mayne responded that this will be addressed in presentations on Day 2.

4:37 After a call for additional questions that solicited none, the meeting was adjourned for the day. There were approximately 15-20 afternoon webinar participants.

2.2 Day 2: Thursday, November 5th

2.2.1 Research Presentation Session 4 (continued from Day 1): Habitats and Species: Status, Trends, and Stressors (Coastal Wetlands, Coastal Terrestrial Habitat, Tributaries and Hydrological Connectivity, Population Status and Trends)

2.2.1.a Lake Huron Coastal Wetland Status - Assessment, Synopsis and Needs (Research Presentation 22)

8:30 **Jan Ciborowski** *(University of Windsor)*

Ciborowski presented results from a large group of collaborators, integrating a meta-synthesis of 20 years of work from 7 programs (GLEI, GLEAM, etc.). They attempted to integrate stressors and responses; patterns observed depended on the interests of the observers. Stressors examined included agriculture, development, shoreline, local water quality, and invasives. Basin stress maps of major watersheds were developed; and example showed agricultural stress on a map by watershed with color gradations from red to blue. Great Lakes Coastal Wetland Monitoring Sample sites (2011-2014) were binned by geomorphology. An attempt was made to standardize stressor scales from 1-5 from poor to excellent states (red to green). Nine geographic subregions for Lake Huron were created, with stresses computed by consideration of land cover, shoreline, and water quality. Responses were examined using biological measures including multi-metrics, multivariate statistics, and ecological footprints. Lake Huron data are generally rather sparse. Stakeholder-accessible summaries for each individual wetland were created. Threshold Indicator Taxon Analysis was performed by determining sensitivity of particular species, especially fish and plants. A strong gradient from north to south became evident, with Saginaw Bay and the Southeast Shore consistently degraded by agricultural impacts. One research need is integration of stressor and response data into a single database. Water level change is critical, but not integrated into any of the measures used to date. The focus has been large wetlands, but small ones are abundant and important for connectivity.

2.2.1.b Early Response of Coastal Wetland Habitat to Increased Water Levels in Georgian Bay and Lake Huron (Research Presentation 23)

8:45 Pat Chow-Fraser *(McMaster University)*

Chow-Fraser stated that most Georgian Bay wetlands have minimal human impact, but that sustained low water levels from 1998-2014 have had substantial impact (191 months below mean!). Wetland zonation has been impacted by low water, which has only recovered for the last 18 months. At average condition, fish habitat is 1-2 m depth with vegetation that is not too dense. Zonation is: forest – meadow – emergent – floating – submergent – open water. A disturbance regime is expected in healthy lakes. There is a lag time in response to recent water level rise (e.g., drowning of recently submerged terrestrial vegetation). Data exist, opportunistically, from 2002-2014 for 163 wetlands in Georgian Bay. The focus has been overnight Fyke netting of fish, along with other habitat descriptors. Data from 10 sites in southeast Georgian Bay yield a fish index that shows little change over the period of record. The relative abundance of piscivores has increased over time. It is currently difficult to sample with Fyke nets because the depth range of interest is now in inundated meadow and forest edge. Invasive locations have also changed with the appearance of phragmites and gobies.

2.2.1.c What is the Best Range of Water Levels that Allows for Ecosystem Functions & Healthy Aquatic Systems; Facing Climate Change and Why it is Important to be able to Retain Water in all the Great Lakes (Research Presentation 24)

9:00 Mary Muter *(Sierra Club Canada Foundation)*

Muter described how 2014 was globally warm, but cool and wet in the Great Lakes, with extreme ice cover and associated scour. In contrast, the winter of 2015-2016 is forecast to be mild due to El Niño influence. Lake effect snow can carry water out of the basin to the east. The outlet of Lake Huron at Sarnia-Port Huron has been heavily modified, including hardening of the shoreline, filling, and channel deepening. Dredging through a gravel bar that was present at the outlet in the late 1880s and early 1900s at south end of Lake Huron has impacted outflow. Major effects of sustained low water on coastal wetlands have included loss of fish diversity (especially declines in pumpkinseed sunfish). Harmful algal blooms have become common in Sturgeon Bay. Bird kills and fish kills have occurred in the fall on the south shore of Georgian Bay; sturgeon seem to be particularly impacted. In 2012, an International Joint Commission public meeting in Midland that was related to lake water levels was attended by 600 people. Possible actions considered by various groups to stabilize Lake Huron water levels include St. Clair River compensation works (submerged sills, "hydraulic airplane wing structures"). Muter emphasized the need to reduce variability in the range of Lake Michigan-Huron levels, but not overly so (e.g., Lake Ontario situation).

2.2.1.d Water Level Impacts on Coastal Wetland Inventories (Research Presentation 25)

9:15 David Sweetnam *(Georgian Bay Forever)*

Sweetnam presented results of a NASA with focus areas in Lake Ontario and Georgian Bay. The investigators were looking for a way to monitor wetland condition using automated remote sensing, due to difficulty in accessing many coastal wetlands. They identified the need to create time series to see trends. Bathymetry data in Georgian Bay are admittedly relatively poor. The study used data from Landsat 5 and 8, ASTER DEM, TOPEX/Jason-1, OSTM/Jason-2, and in situ gages. A 10-km inland buffer band was analyzed, and 1987 data were compared with 2013 data. Digital subtraction showed gain of wetlands in north Georgian Bay, and loss in the south. Glacio-isostatic rebound rates of 18 to 30 cm per century impact Georgian Bay. The study also compared 2008 SOLRIS data with the 2013 map; differences indicate the need for ground trothing. In addition, the NOAA C-CAP classification was also considered and inconsistencies were noted. Use of the thermal band, DEM, and slope reduced forest error. In the final analysis, a 3.8% drop in total wetlands area was determined from high to low water conditions.

2.2.2 Research Presentation Session 5: Fish and Fisheries Management (Fish Species Diversity, Prey Fish Dynamics, Nearshore Fish Status and Trends, Native Fish Conservation and Management Needs)

2.2.2.a Fish Community Dynamics in Ontario Waters of Lake Huron (Research Presentation 26)

9:30 Arunas Liskauskas *(OMNRF)*

Monitoring was conducted by Ontario using offshore and nearshore assessment programs. The offshore program assessed year class strength, growth and maturity, abundance, and diversity for a variety of species (lake whitefish, lake trout, walleye, yellow perch). Four areas were monitored: Cape Rich (oldest-1979), Southampton, Grand Bend, and Clapperton Island. Graded mesh gill nets were used, with 24-hour sets, which were depth-stratified. Buildup of stocks in the 1980s was documented, associated with the onset of lamprey control, followed by mussel-linked decline. There was also a change in net composition (multifilament to monofilament), but the new nets were calibrated against the old nets before the transition was completed. Alewife and smelt were key species in the post-mussel decline. Lake trout and whitefish have declined since the early 1990s, along with most other species. Few walleye have been collected over the full time series, so trends are hard to detect. Catches per net night have generally been <200 individuals at all sites since the mid-1990s, and <25 at Cape Rich since 2004. The commercial whitefish harvest peaked in 2000, and has declined to levels similar to the 1980s. Chinook salmon are not well monitored due to their pelagic distribution. Nearshore data mostly consist of snapshots, with opportunistic sampling of tributaries for walleye in particular. Low walleye abundances have been observed, with declines in Georgian Bay and the North Channel. Pike have also declined with low lake levels due to the loss of wetland spawning sites. Smallmouth bass have benefited from warmer water as well as from feeding on round goby. Good trend data only exist from Severn Sound where bass are up, panfish are down, and bottom feeding fish are stable (especially bullheads). Smallfish population assessments have been performed since 2003 using Fyke nets and graded mesh gill nets. Alewife are still abundant along parts of the southeast shore of the main basin, minnows are prominent in the North Channel, and Georgian Bay is variable (gobies, panfish).

2.2.2.b Fish Community Dynamics of Saginaw Bay (Research Presentation 27)

9:45 David Fielder *(MDNR-Alpena)*

Fielder noted that the *RV Chinook* is being decommissioned after 68 years, and replaced by a new vessel in April. Fielder then shared that walleye recovered in Saginaw Bay after alewife disappeared (no fry predation), and that native non-hatchery fish began to rebound in 2003 and have taken off since then. Recovery targets were met in 2009, although no commercial fishery has been established yet. A rapid turnaround in the ecosystem has been observed with the removal of invasives. Acoustic tracking shows outmigration of walleye from Saginaw Bay in summer (even to Georgian Bay), and return over winter, with spring spawning in tributaries. Forage fish biomass data exist back to 1971, and show declines since 2003 when walleye rebounded. Yellow perch young of the year exploded in 2003, but older perch are not observed anymore; catch rates and commercial yields are way down (perch are effectively whitefish bycatch now). Walleye diet used to be alewife and gizzard shad, but now they are eating yellow perch. Rebounded cormorants (>6,000) in Saginaw Bay are also eating perch in the spring, and then gobies in the summer. There is a history of coexisting perch and walleye, but now this is not the case due to loss of alewife (a predation buffer for perch; native cisco served this role before alewives). The loss of pelagic planktivore linkage to the main basin by mussel grazing of the food source may have been key break for cisco loss. Increasing walleye harvest is likely to benefit perch, and cormorant reduction is also underway (10%). Plans are underway to reduce perch harvest and attempt to restore cisco in Saginaw Bay. Unknown include where and how young perch go away over winter (thermal mortality along with predation?); status and trends of invertebrates (mussels, zooplankton, mayflies); details on walleye spawning; and whether sediment conditions are favorable for natural cisco spawning.

2.2.2.c A Fishery Perspective on Lake Huron Food Web (Research Presentation 28)

10:00 Ji He *(MDNR)*

The presenter began with two questions: Can we simulate a new equilibrium in Lake Huron food webs? What changes are expected going forward? Recent step declines were noted due to *Bythotrephes* invasion, mussel invasions, *Diporeia* decline, and alewife loss. Whitefish, bloater, cisco, and Chinook declined since about 2000 for various reasons; lake trout, however, are naturally reproducing. Perch have declined in Saginaw Bay, but increased in Ontario waters, although they are living at the deep end of their prior range. In summary, predation buffers are needed for recruitment success, nearshore habitat is critical even for many offshore fish, and changes in spatial habitat use by remaining healthy stocks are common. We need year-round data to better understand ecosystem dynamics and linkages (nearshore-offshore, pelagic-benthic, top-down vs. bottom-up, inter- and intra-specific life history scopes). We also need data on piscivore food demand, planktivory demand and spatial structure, and nutrient movement at large temporal and spatial scales (including upwelling)

10:15 Break

2.2.2.d Lake Huron Prey Fishes (Research Presentation 29)

10:30 Ed Roseman *(USGS)*

Data were analyzed from annual bottom trawl surveys (fall) from 1976-2014. Surveys are conducted at seven fixed transect sites (including Goderich, Ontario), and a mid-lake ridge trawl, at depths of 9-110 m. Not all depths are collected at all transects, and all surveys are conducted in daytime. Data are plotted as abundance (fish/ha) and biomass (kg/ha). Alewife crashed in 2003, but are still present at very low abundance. Bloater have rebounded since 2005, but there are now fewer large bloater, with lower weight per length, deeper occurrence, and lesions observed on some. Rainbow smelt and sculpin have been low since the late 1990s. Round goby peaked in 2002, with another peak in 2011-12, but are now low again; better sampling methods for goby are being developed. Stickleback and trout perch are rare. Some young lake trout are caught on the bottom, and more perch and walleye have been appearing in trawls since the mid-2000s (eating bloater chubs based on gut contents). New papers are out on burbot diet, larval fish, transient larvae in St. Clair-Detroit Rivers (especially burbot), and young lake trout diets.

2.2.2.e Nearshore Fish Community Response to Invasive Species: Effects of Nutrient Rerouting on Lake Whitefish Recruitment Indices, Thunder Bay Area (Research Presentation 30)

10:45 Jim Johnson *(retired MDNR)*

Johnson related that whitefish spend their first few years along beaches and in nearshore areas. A leading hypothesis is that whitefish recruitment decline has been the result of competition with mussels for food, and subsequent predation. Eggs hatch nearshore in early April. The larval food source was formerly the spring diatom bloom, but its depletion has created a food bottleneck. Young whitefish live in waters <30 m for their first 3 years. Collaborative 2012 CSMI work in Thunder Bay, described above, showed low phosphorus nearshore in April, and zooplankton present offshore. There is a feast/famine comparison of Saginaw Bay to Thunder Bay, respectively. Larval whitefish are restricted to nearshore, but larval smelt span nearshore to offshore, and larval bloater stay offshore. The dam impoundment in the lower Thunder Bay River removes nutrients that would otherwise end up in Thunder Bay. A total of 1100 whitefish tows have been conducted in Thunder Bay since 1986, with low abundance observed since 1996 with the arrival of mussels. Whitefish survived beyond the alewife collapse but showed almost no older fish beyond young-of-year; smallmouth bass also declined in Thunder Bay. Recruitment in Lake Huron's nutrient-poor bays may be especially vulnerable to mussels. The obvious question then is: If mussel biomass starts to decline, will fish recover? We need to compare Lake Michigan whitefish recruitment with Lake Huron recruitment (and Thunder Bay, with Saginaw Bay; possibly need to modify trawl locations).

2.2.2.f The Role of Lake Sturgeon in a Dreissenid Dominated Ecosystem (Research Presentation 31)

11:00 Andrew Briggs presenting for James Boase *(USFWS)*

Lake sturgeon grow up to 8 feet long and can weigh >300 pounds. They can live over 100 years, and do not mature until age 12-20 years, after which time they do not spawn every year. They are bottom feeders with specialized mouths and sensitive whisker-like barbels. There are five known sturgeon spawning areas in the lake, mostly in northern Lake Huron. The historic abundance was 70,000 to 350,000 fish in Lake Huron, and they were harvested until about 1900. Lake sturgeon caviar is worth $20/oz. Active habitat restoration is underway including building of spawning reefs and dam removal in tributaries to allow access to spawning habitat. Lampreys feed on sturgeon and gobies feed on sturgeon eggs, which pose additional threats to recovery. Research is underway on whether sturgeon can help control dreissenids (a related experiment was published on Oneida Lake, which included stocking of sturgeon). There are approximately 45,000 sturgeon in Lake St. Clair. In the early 2000s, 41 sturgeon in Lake St. Clair were studied for diet. Their most common prey was chironomids, with little dreissenid predation. There are no current population estimates for Lake Huron sturgeon, but their favored habitat is <40 m depth, and they have lower food consumption in cooler water. Lake Huron sturgeon density is insufficient to impact dreissenids, based on analogy with Lake St. Clair.

2.2.2.g Aquatic Invasive Species Early Detection & Monitoring in Lake Huron (Research Presentation 32)

11:15 Anjanette Bowen *(USFWS)*

Some invasive detection strategies are common for USFWS across the Great Lakes, and some are specific to Lake Huron. The goal is detection of non-native species when they are rare to make control possible. The National Invasive Species Act (1996), Executive Order 13112, GLWQA 2012 (Annex 6), and a GLRI focus area all target invasives. The GLANSIS invasives database includes a watch list of 67 species that pose a risk to the Great Lakes. Surveillance for Eurasian ruffe has been underway since 1996, eDNA sampling for Asian carp in the Great Lakes and their tributaries has been underway for several years, and early detection for all non-native fish is a goal for USFWS. Ruffe surveillance by bottom trawls in harbors and tributaries is conducted at 10 monitoring locations in Lake Huron, similar to programs in Lake Erie and Lake Ontario. Ruffe initially became established across the Lake Superior south shore, and were discovered in 1995 in Thunder Bay River. They have also been observed by lamprey program staff in the Cheboygan River and Trout River. In 1999, 470 ruffe were captured in Thunder Bay River, but they have been absent since 2005, even with small-mesh gillnet sampling that detected ruffe in 2003 and 2004. Ruffe have possibly been displaced by goby or challenged by winter conditions. One ruffe was caught in

Cheboygan River at the dam in both 2011 and 2012. Two ruffe were caught in Trout River in 2008 by a lamprey control crew, but none have been observed since, including during electrofishing surveys. Goby are also being monitored, but sampling gear is not ideal as they live in rock crevices. Asian carp eDNA sampling was initiated in 2015, with 200 samples analyzed to date, but so far there have been no detections for bighead or silver carp. Water samples are centrifuged and analyzed at a genetics lab in LaCrosse, Wisconsin. There are four USFWS offices in Great Lakes: Ashland, Alpena, Green Bay, and Buffalo. All do invasives surveillance. In addition to Lake Huron, the Alpena office also covers western Lake Erie and the Huron-Erie corridor. Priority sampling areas are identified based on vector risk assessment (9 in Lake Huron) weighted by port tonnage, recreational boat slips, etc. Ontario monitors the upper St. Marys River. USFWS has followed the Trebitz et al. (2009) St. Louis River approach to detect rare species using multiple types of gear and oversampling to detect 95% of species that are currently present. Electrofishing yields the greatest diversity of species. USFWS is hoping to include icthyoplankton sampling in the future. Citizen reports are also important, including a recent *hemimysis* report in lake trout stomach contents collected from deep water (54 m).

11:40 Organizers (Jamie Schardt) relayed that they would attempt to summarize research needs for each of the five topical session themes over lunch, which would then be refined by group discussion after lunch.

11:40-1:00 ***Lunch*** (attendees got lunch on their own in small groups)

2.2.3 Cooperative Science & Monitoring Initiative

1:00 **Jamie Schardt** *(USEPA)* and **Laurie Wood** *(EC)*

Overview and introduction to afternoon session by Laurie Wood

- 2002 - Cooperative Monitoring Initiative established
- 2006 - Expanded to include research
- 2008 - Last LaMP documents completed for lakes, then connecting channels added

CSMI follows a 5-year rotation, focuses government resources from U.S./states and Canada/provinces; CSMI does not set priorities or replace other programs – priorities are set by the Lake Huron Partnership.

Review of Process:

Year 1: Review last CSMI, identify issues by meeting or workshop (example is the current Alpena workshop) to guide prioritization, preparation of guidance documents (proceedings; e.g., this document)

Year 2: CSMI Task Team looks at prioritized list to create actual field plan

Year 3: Intensive field year

Years 4 and 5: Researchers analyze samples and data, and report out in venues and formats of their choice (IAGLR, peer-reviewed journals, reports), CSMI Task Team prepares short summary of activities performed during field year; in current Alpena workshop reporting out of 2012 results and planning for 2017 are combined.

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3
Summary of Group Discussion

2012 Information Gaps and Science and Monitoring Priorities

Focus was on nutrient cycling changes and food web linkages: chemicals, nearshore, ecosystem functions and change, habitat and species, fisheries management

Comment: consideration of physical processes, hydrodynamics, and water level change are lacking in the current discussion and research program

What We Know and Existing Information Needs

1:15 ***Jamie Schardt*** (USEPA) facilitated discussion of five Lake Huron topical summary bullets compiled over lunch by organizers

- 1. Chemical: monitoring needs to continue across Lake Huron and the entire Great Lakes basin, along with new methods and analyses of emerging contaminants of concern

Comment: add something about transport, fate, and effects of chemicals?
Comment: cannot look for everything everywhere; need screening level efforts at limited locations
Comment: what about modeling to allow prediction of climate change impacts on transport and fate of chemical movement?
Schardt: maybe climate change should be an overarching goal? Put comment in parking lot for later consideration? (No edits of summary bullets at this time.)
Comment added later: any monitoring of chemical contaminants in aquatic plants?
Response: U.S. fish program has incorporated analysis of phytoplankton for contaminants

- 2. Nearshore: continue to try to understand land use and lake linkages, improve understanding of nearshore dynamics and linkage to offshore

Comment: bring in nearshore framework?
Schardt: good comment, make sure to link with GLWQA Annex 2 efforts
Comment: need for better Canadian bathymetry data (in Georgian Bay)
Schardt: agreed, general information gap (high resolution) – bullet text modified
Comment: get bottom hardness and roughness along with bathymetry so this can be translated into habitat maps?
Comment: prioritize research and monitoring to guide management actions to address problem areas from tributary loading impacts and results of habitat restoration projects
Schardt: each bullet has a "why we want this information" component as well; LAMP process should capture this as part of action element, so we won't add this here
Comment: think about application of information, but differentiate between resolvable versus unresolvable problems; don't squander funds on unresolvable
Comment: mussels need to be specifically mentioned here
Schardt: included under "biological processes" in current bullet text?

Comment: all talking about cause-effect linkages, but what was omitted? Diseases, parasites – "four horsemen of the apocalypse" leads to disease and death due to nutritionally weakened state of organisms (caloric, vitamin); management actions might make some of these conditions worse; example of unexplained ulcerations on fish mentioned in passing in earlier presentation (Roseman); die-offs of birds, mud puppies, etc. not being systematically addressed
Comment: fate of nutrients loaded to nearshore needs to be better understood, as well as the role of loading from offshore to nearshore; what are the consequences of specific loading—need to model on FVCOM foundation; this is a challenge
Schardt: some later slides talk to this
Comment (cont.): nearshore changes and offshore starvation are distinct from other lakes in Huron
Comment: diverse disciplines here, but collapses of species and nutrient availability are not linked by explicit study to precipitous water level drop around lake

- 3. Aquatic ecosystem structure: especially better characterization of lower food web needed, new emphasis on better sampling of rocky areas that are hard to sample, new depositional areas noted (SE shore) and undersampled areas too (North Channel)

Comment: importance of microbial food web neglected, undersampled, and little understood; need to better characterize basic components, linkages of microbial food web
Schardt: modifying bullet text to capture this explicitly, challenging to word this, left in somewhat awkward form
Comment: lots of chl a measurements, but fewer measurements of primary productivity
Comment: we want to understand food web better, but most data are post-mussel; maybe do cross-basin comparisons with North Channel where mussels are absent; also need to consider spatial component of dreissenid density, bottom mapping needed – especially on hard substrates; need a whole-lake picture of this
Schardt: good point, letting this hang through discussion of next two slides
Comment: need more sophisticated spatial analysis techniques including not just depth but substrate factors
Schardt: adding "spatial" to bullet text

- 4. Habitat and species: waterbird and coastal wetland monitoring needs to continue; we also need better process understanding of coastal wetland linkages to lake water quality and ecosystem processes

Online comment: how would planning for chemical or petroleum spills in Lake Huron be handled?
Schardt: Coast Guard planning may cover this, but we should consider mentioning
Comment: should this group be involved?
Schardt: can connect interested group members who are interested with EPA and Coast Guard programs that cover this
Comment: understanding response to water level changes needs more work – critical
Comment: not only ecosystem benefits but human benefits of coastal wetlands should be better characterized
Schardt: added "human use and values"
Comment: is "continuing monitoring" really a CSMI priority, or should we say "support and enhance" for CSMI purposes?
Schardt: no new species of waterbirds or coastal wetlands properties, but CSMI needs monitoring to continue
Comment: make bathymetry and bottom mapping an important component of "habitat"
Schardt: consistency is the hobgoblin of mediocre minds, but we will make a related noted

Comment: “continue monitoring” should be changed to “restore monitoring”
Schardt: agreed

- 5. Fisheries: not just the job of GLFC; greater spatial assessment of spring bloom (outside of Thunder Bay); understand lower to upper food web linkages; look for “missing biomass” (goby, cladophora/macroalgae, cyanobacteria) not captured in current sampling (include dynamic biomass movement); continue fishery stock assessments

Comment: incorporate concept of fish as spatial integrators connecting nearshore and offshore, nutrient cycling (e.g., lake trout)?
Comment: under missing biomass consider bythotrephes, mysis, and larval fish (net escapement issue, incorporate MOCNESS gear with strobe), and diurnal or seasonal migration
Comment: cisco movement of biomass into tributaries, also transport contaminants into tributaries (see State of Lake Michigan presentation from last week)
Online comment: need to stick to higher level statements
Comment: huge data gap regarding goby biomass, linked to bottom mapping techniques to better characterize substrate (e.g., use AUVs?)
Schardt: good recent discussions about sampling where we haven’t and using new methods to capture what we haven’t
Comment: importance of this goes right to fishery objectives, real effect of dreissenid invasions hard to determine without ability to quantify gobies
Comment: need to link water levels and macroalgae into fish with respect to spawning and preyfish
Schardt: rewording bullet to include “limiting factors (such as water levels)”
Comment: look more at diets using isotopes, fatty acids, etc. to understand what particular fish species and ages are actually eating
Comment: limiting factors are more than just gross energy and gross physical parameters, including parasitism, commensalism, disease, density-dependent population controls
Comment: nearshore shunt hypothesis (Tobermory meeting focus) does not cleanly fit here in Lake Huron; this is very exciting
Schardt: yes, simplistic nearshore shunt breaks down—benthic shunt?
Comment: science progresses by disproving hypotheses
Comment: bigger synthetic questions still not well understood; new tools (e.g., high resolution models) and data can be brought to bear on questions; will climate change cause greater variability? What about ice? Need to develop on FVCOM framework—wonderful opportunity; wave history and wind fields recreated back to the 1950s and 1960s; opportunities to do retrospective analyses with much more holistic perspective
Schardt: future research teams need to think in this context

Schardt: bold statement >> we may have reached a good stopping point or ending point, offline discussion can continue; thanks for the quality of presentations and conversations – this bodes well for the upcoming field year

2:45 Jamie Schardt closed the meeting.

Lynzi DeLuccia, a reporter from Alpena's WBKB Channel 11 (ABC affiliate) interviews Paul Horvatin and Jamie Schardt (USEPA) after the workshop. The segment can be viewed here: https://www.youtube.com/watch?v=Tmpujouz9-M

Appendix A:
Workshop Participants

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Below is a list of all participants who attended all or part of the 2015 State of Lake Huron Workshop in Alpena in person. A separate listing of webinar participants for Day 1 and Day 2 of the workshop follows that list. Webinar participants are identified by the information they submitted when they registered, which is incomplete in some cases. The webinar participant information does not include any indication of the timing (e.g., which sessions) or the duration of participation on a given day, nor does it indicate the number of repeat logins by an individual on the same day.

In-person attendees (list below): 70 (registrants that did not attend = 9, second list below)
Webinar participants (third list below): Day 1 total = 21; Day 2 total = 23
Combined total of apparent unique webinar participants (either or both days): 32
Total in-person and webinar participants: 102

In-Person Attendee	Organization
Brook Alloway	Alpena Conservation District
Sean Backus	EC
Ashley Baldridge	NOAA GLERL
Anjanette Bowen	USFWS
John Bratton	LimnoTech
Andrew Briggs	USFWS
Ted Briggs	OMECC
David Bunnell	USGS Great Lakes Science Center
Debbie Burniston	Environment and Climate Change Canada
David Bywater	Georgian Bay Biosphere Reserve
Hunter Carrick	Central MI Univ. - Inst for Great Lakes Research
Mark Chambers	Environment and Climate Change Canada
Matthew Child	International Joint Commission
Patricia Chow-Fraser	McMaster University
Jan Ciborowski	University of Windsor
Mark Clymer	Les Cheneaux Watershed Council
Shane de Solla	Environment and Climate Change Canada
Lisa Derickx	St. Marys River Remedial Action Plan
Alice Dove	EC
Ken Drouillard	University of Windsor
Dave Fielder	MDNR Fisheries
Roger Gauthier	Restore Our Water International
Russ Green	NOAA Thunder Bay National Marine Sanctuary
Doug Haffner	Great Lakes Institute for Environmental Research
Ji He	MDNR Fisheries
Brad Hill	Saginaw Bay RC&D
Katy Hintzen	Michigan Sea Grant/MSU Extension
Rick Hobrla	MDEQ-OGL
Paul Horvatin	EPA-GLNPO
Jim Johnson	retired MDNR Fisheries

Bretton Joldersma	MDEQ-OGL
David Karpovich	Saginaw Valley State University
Matthew Konieczki	Bay Mills Indian Community Biological Services Department
Frank Krist	DNR Lake Huron Citizens Fishery Advisory Committee
Erinn Lawrie	The Lake Huron Centre for Coastal Conservation
Arunas Liskauskas	Ontario Ministry of Natural Resources and Forestry
Julie Lowe	MDEQ
James Ludwig	Ecotoxicologist Consultant
Chris May	The Nature Conservancy
Greg Mayne	Environment and Climate Change Canada
Daryl McGoldrick	Environment and Climate Change Canada
Elizabeth Murphy	USEPA
Mary Muter	Sierra Club Canada Foundation and Restore Our Water International
Thomas Nalepa	Water Center, Graham Sustainability Institute, Univ. of Michigan
Scott Parker	Parks Canada
Doug Pearsall	The Nature Conservancy
Cynthia Rachol	USGS
Michael Ripley	Chippewa Ottawa Resource Authority
Jason Ritchie	OMNRF
Ed Roseman	USGS Great Lakes Science Center
Steve Ruberg	NOAA GLERL
Ed Rutherford	NOAA GLERL
Jeff Schaeffer	USGS Great Lakes Science Center
James Schardt	USEPA-GLNPO
Roy Schatz	Sierra Club Canada Foundation and Restore Our Water International
Emily Sewell	Alpena Conservation District
Ruth Shaffer	USDA-Natural Resources Conservation Service
Teresa Sherwood	MDEQ
Robert Smith	Les Cheneaux Watershed Council
Craig Stow	NOAA GLERL
David Sweetnam	Georgian Bay Forever
Henry Vanderploeg	NOAA GLERL
Mari Veliz	Ausable Bayfield Conservation Authority
Ed Verhamme	LimnoTech
David Warner	USGS Great Lakes Science Center
Ben Wickerham	The Nature Conservancy
Todd Wills	MDNR Fisheries
David Wolf	Restore Our Water International
Laurie Wood	Environment and Climate Change Canada
Tom Young	MDARD

The following nine individuals registered for the Alpena workshop, but did not ultimately check in:

James Boase	US Fish and Wildlife Service
Mark Chambers	Environment and Climate Change Canada
Kay Cumbow	Citizens for Alternatives to Chemical Contamination
Bob Dunn	Les Cheneaux Watershed Council
Scott Koproski	U.S. Fish and Wildlife Service
Pamela Martin	EC - Wildlife and Landscape Science Directorate
Chris Marvin	Environment and Climate Change Canada
Virginia Radatz	We love the Great Lakes
Wes Raymond	Citizens for Alternatives to Chemical Contamination

	Webinar Day 1 (Nov. 4)	**Webinar Day 2 (Nov. 5)**
1	Aisha Chiandet	Aisha Chiandet
2	Andrea Maguire	Carolyn Paterson
3	Brock	Catherine Riseng
4	Carolyn Paterson	Dave G
5	Catherine Riseng	Dave Warner USGS
6	Cheri Meyer (DTE)	DLZ Corporation
7	Cindy Hudson	Ellen Perschbacher
8	Dan Kraus	Gillian Sutherland-Jones
9	Dave G	Jerry Smitka
10	Ellen Perschbacher	Jess Ives
11	Jerry Smitka	Jessica Moreno (Ontario)
12	Jess Ives	Jo-Anne Harbinson
13	Jessica Moreno (Ontario)	Kay Cumbow
14	Jo-Anne Harbinson	Mark
15	John Jackson	Michael Stoll Les Cheneaux Watershed
16	Kay Cumbow	Michelle Hudolin
17	Michael Stroll Les Cheneaux Waters	Norris Clark Bryson
18	Pine River Watershed Initative	Rachael Franks Taylor
19	Rachael Franks Taylor	Randy Mellberg – NRCS-CD
20	Shaun Anthony	Robin DeBruyne
21	Tom Skinner	Sean Rootham
22		Tricia Stinnissen
23		Tyler Miller

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Appendix B:
Title Slides of Presentations

Available separately.

Appendix C:
Summary of Poster Feedback

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Inputs

- **Saint Marys River**
  - Sediment sources in U.S. have been remediated.
  - Sediment sources in Canada are undergoing natural

  Danger of re-suspension unless institutional co
  on dredging are implemented

- **Georgian Bay/North Channel**
  - Spanish Harbor AOC is now an Area in Recovery.
  - Collingwood Harbor and Severn Sound AOC are deli

  Still fish consumption restriction
  But is that a AOC issue, or one for a la

(add c

St Marys River

- Contributes minor inputs, likely no major change in tributary loa recent years.

  How do we know this? Don't believe the required monit being conducted

  Lake Superior input likely unchanging; may be local infl

  *Please consider "hole" in geographic extent of SMR. A extends to Iroquias/;Gros cap, however, GLFC conside compensating gates as northern limit therefore there is Mile gap that is being missed.

Cross Basin compari

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- Total biomass of invasive mussels appears to be steady or incr

  Toms says decreasing <90m increasing >90m Zebra m
  dreissenids in general?

  Have mussels creasted?

  Increasing at >90m

  Stable/decreasing at <90 m

Cross Bas

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- Diporeia continue to be at historic lows. Mechanism regulating t population continues to be unknown, despite extensive study.
    - (Are there any notable refuges in Lake Huron?)

    Still in diets of deep water scupins diporeia at >90m still slowly declining

- Total biomass of invasive mussels continues to increase.

    Depends on depth <90m decreasing >90m still increasir

Pr

- Consider topic areas including: physical processes, zooplankto bacteria, cladophora, nutrients, plankton, wetlands, wildlife, anc

Water level changes and direct measurable ir

Gr

- **Consider topic areas including:** physical processes, zooplankto
bacteria, cladophora, nutrients, plankton, wetlands, wildlife, anc

Consider management effectiveness research and mon
research