Data Gaps and Research Needs

In addition to compiling and summarizing the most recent research available on the 11 ecosystem health indicators, another primary goal of the *State of the Bay* report is to identify and present data gaps and research needs. This is an important step in directing future research in order to help improve our understanding of ecosystem health.

The *State of the Bay* Technical Report features data gaps and research needs for each of the 11 indicators, and a consolidated list is provided below. Academics, researchers, and interested individuals are encouraged to have a look at this list and consider how they can contribute to filling knowledge gaps. Please contact David Bywater, Conservation Program Manager, (conservation@gbbr.ca, 705-774-0978) about research and monitoring opportunities.

Water Quality: Total Phosphorus

There is a gap in knowledge on conditions in the shallow nearshore (i.e., <3 m depth) in terms of nutrient variability, algae growth (both phytoplankton and periphyton), and benthic invertebrates. Anecdotal evidence exists of increased productivity in this zone, in some areas resulting in heavy growth on rocks and built structures. It is unclear whether this periphyton production is the result of point source nutrient loading like septic runoff and greywater discharge, or a lack of invertebrate grazers. There are indications to suggest a combination of the two factors. Similarly, in the water column, the growth of algae may be due to nutrients or a lack of zooplankton grazers. Qualitative observation has shown an increase in suspended algae in the shallow nearshore over the last 5-10 years across Severn Sound. The shallow nearshore ecosystem is complex and sampling it adequately is outside the scope of large monitoring programs. This type of work could be made more feasible by partnering with university researchers, local cottage associations, and citizen scientists.

There is also a data gap in Environment and Climate Change Canada's meteorological monitoring network in the southern portion of Georgian Bay. The weather station that was maintained on Beausoleil Island and had been recording hourly data since 1994 was taken offline in 2007, leaving a gap in high resolution temperature, humidity, wind, and pressure data. Currently, there are only stations at Parry Sound, the Western Islands, Collingwood, and Wiarton that provide hourly data in close proximity to the coast. Given the variability in weather conditions, a station should be re-established on Beausoleil Island to capture conditions in the south-eastern corner of the Bay. Meteorological data of this kind informs the modelling and reporting of features (e.g., thermal stratification) and drivers (e.g., exposure, short term water level fluctuation) that contribute to gradients in water quality in eastern Georgian Bay.

Hourly tributary flow data, such as that provided by the Canadian Hydrographic Service's hydrometric station network, is needed for the majority of tributaries along eastern and northern Georgian Bay, from Severn Sound to the French River. This information has numerous applications, such as calculating nutrient loading from watershed sources, and fisheries and watershed management.

The main data gaps and research needs from the lower food web indicator are also applicable to the total phosphorus indicator, as they are centered on establishing regular monitoring programs to measure and help understand lower food web productivity and trophic interactions.

Lower Food Web

The main lower food web data gaps and research needs are centered on establishing regular monitoring programs to measure and help understand lower food web productivity and trophic interactions:

1. Phytoplankton - Assessment of seasonal plankton production, especially spring bloom conditions and possible implications for zooplankton timing and larval fish food supply at locations throughout eastern Georgian Bay. Late summer blue-green algae blooms are also important to track in a variety of locations in order to better understand causes of dominance in some locations and not others.

2. Zooplankton - Studies to identify the drivers of recent shifts in zooplankton community structure (e.g., roles of *Bythotrephes* and *Leptodora*, top-down versus bottom-up mechanisms, and declines in *Diporeia* populations) including a detailed examination of trophic interactions. Food preferences of the dominant Great Lakes zooplankton need to be investigated, and whether they are able to tolerate shifting diets.

3. Benthic macroinvertebrates - Studies are required to better characterize the spatial differences across eastern Georgian Bay. Programs should include under-sampled species and aquatic habitat types (e.g., rocky substrates and depositional areas). Monitoring would include protocols like that of the Great Lakes National Program Office (GLNPO) and the Canadian Aquatic Biomonitoring Network (CABIN) including nearshore and hard substrates in addition to soft substrates, to identify temporal and spatial trends in the benthic community.

Assuming that many of the identified trends in this report will continue, it will be important to identify the potential future impacts of these trends on the entire aquatic food web. Detailed seasonal sampling of phytoplankton, zooplankton and benthos is needed to better characterize trophic interactions. With better understanding it may be possible to predict future effects on the higher trophic levels (i.e., coldwater fisheries). In order to complete the sort of sample analysis necessary to better characterize the lower food web, efforts need to be made to training a new generation of taxonomists.

Additional research needs have been identified by Severn Sound Environmental Association (SSEA) for the Severn Sound area that also likely applies to other parts of the Georgian Bay coastline. SSEA has identified a gap in knowledge on conditions in the shallow nearshore (i.e., <3m depth) in terms of nutrient variability, algae growth (both phytoplankton and periphyton), and benthic invertebrates. Anecdotal evidence exists of increased productivity in this zone, in some areas resulting in heavy growth on rocks and built structures. It is unclear whether this periphyton production is the result of point source nutrient loading like septic runoff and greywater discharge, or a lack of invertebrate grazers. There are indications to suggest a combination of the two factors. Similarly, in the water column, the

growth of algae may be due to nutrients or a lack of zooplankton grazers. Qualitative observation has shown an increase in suspended algae in the shallow nearshore over the last 5-10 years across Severn Sound. The shallow nearshore ecosystem is complex and sampling it adequately is outside the scope of large monitoring programs. This type of work could be made more feasible by partnering with university researchers, local cottage associations, and citizen scientists.

Prey Fish

1. Coordinated studies to better characterize the linkages between the lower and upper food web.

2. Improve quantification and biomass estimates for key and under-sampled components of the food web (e.g., fish production – including round goby).

3. Continued assessment of the forage community (benthos, zooplankton, prey fish) structure and function relative to the suite of environmental stressors on this system.

4. Investigation of the factors controlling the distribution and structure of the prey fish populations.

5. Addressing the knowledge gap for round goby biology, importance as prey, abundance/distribution/spread.

Smallmouth Bass

1. Enhanced spatial and temporal coverage of smallmouth bass data. At present, smallmouth bass data are collected at a limited number of locations and, with the exception of Severn Sound, there is insufficient data to assess trend through time.

2. Quantify predation impacts on eggs and fry from round goby on nesting bass.

3. Shoreline development and alteration to nearshore cobble and rubble spawning habitat for smallmouth bass.

Northern Pike

1. Enhanced spatial and temporal coverage of northern pike data. At present, northern pike data are collected at a limited number of locations and, with the exception of Severn Sound, there is insufficient data to assess trend through time.

2. Development and alteration of riverine and deltaic wetlands spawning and nursery areas supporting northern pike.

Muskellunge

1. Enhanced spatial and temporal coverage of muskellunge data. At present, muskellunge data are collected at a limited number of locations and, with the exception of Severn Sound, there is insufficient data to assess trend through time.

2. Invasive species (e.g., round goby) impacts (e.g., predation of eggs) on coastal wetland spawning and nursery areas supporting muskellunge.

3. Shoreline development and alteration of critical coastal wetland spawning and nursery habitats.

Walleye

1. Improve understanding around the attributes that Shawanaga River exhibits in order to support such a robust spawning population of walleye, compared to other areas in Georgian Bay.

2. Develop a comprehensive estimate of recreational and Indigenous subsistence walleye harvest across the basin.

3. Conduct netting surveys at locations where walleye spawning stocks have not been assessed in many years.

4. Monitor locations where spawning bed enhancement work has been undertaken in order to evaluate success and identify the need for additional work.

Lake Trout

1. Improve understanding of:
    a. The impacts of invasive species on lake trout populations;
    b. Changes in the prey community and their impacts on lake trout populations; and
    c. Key attributes of lake trout spawning habitat that have been associated with successful natural reproduction.

2. Updated reviews of all LTRZs and the draft lake trout rehabilitation plan according to designated timelines.

Coastal Wetlands

1. A sustainable, reliable source for coastal wetland cover information. NASA satellite imagery is not easy to obtain in Canada and is very costly. American scientists can access this data for free in the U.S., but due to a lack of sharing agreement, Canadian researchers must purchase the data. In order to monitor and report on coastal wetlands over the long term, as they relate to natural variation in water levels, it is crucial to determine a reliable, accessible long-term data source.

2. If possible, the next *State of the Bay* may report new WMI information (in order to report on wetland condition). Alternatively, new data sources could be sought. For example, one or more of the survey or map assessments described in the Ciborowski et al. (2015) report could potentially be used as a data source for future wetland condition reporting.

3. Greater involvement in citizen science, for example Bird Studies Canada's Marsh Monitoring Program, to supplement coastal wetlands related data collection. If citizen science data are to be used in future *State of the Bay* reports, more advertising and outreach will be required to engage a larger number of citizens.

Landscape Biodiversity

1. As noted in discussions with ECCC-CWS, the criteria used to assess and map habitat conditions does not take into consideration rock barrens, which is a significant habitat type along northern and eastern Georgian Bay. For example, Figure 43 (see Technical Report) presents a significant portion of rock barren habitat as 'grassland'. Rock barrens are important habitats for certain reptiles at risk, and as islands, may provide safer nesting locations for several species of birds.

2. As noted in discussions with ECCC-CWS, the bird data for the boreal hardwood transition is not comprehensive. Ideas are needed to determine how to improve this and how to make various citizen science programs work for this area (Breeding Bird Survey, atlas, etc.).

3. As noted in discussions with ECCC-CWS, the human influence analysis considers built up/developed areas, but does not capture much of the Georgian Bay seasonal 'footprint' such as: cottages, camps, and other housing areas, particularly along shorelines and within littoral areas of Georgian Bay. An example of a potential gap of human influence data may be the mouth of the Key River where there is a dense collection of camps and cottages and the accompanying boat traffic that comes with this 'roadless' environment. Approaches are needed to assess areas like this in the future.

4. The human influence layer of the CWS analysis does not include boat channels. Because roads are in fact not densely located in much of the archipelago landscape, boating is the main transportation method for accessing waterways, bays, and islands. How this type of human disturbance pattern affects the integrity of the biodiversity is not well understood, and should likely be included in a human disturbance analysis of eastern and northern Georgian Bay. The human traffic instigated by boats for commuting, fishing, or touring includes disturbances such as: noise; pollution (e.g., release

of fuel emissions); wastewater and garbage; disturbance from wakes and shoreline wash; and increased potential for collisions with wildlife on local and longer range migration routes.

5. Potential sources for boat traffic data were explored for 2018 *State of the Bay* reporting. However, none were specifically available for our purposes. The Canadian Coast Guard (CCG) keeps commercial traffic records for all of Canada, not for Georgian Bay specifically. Dalhousie University conducted research called *Search and Rescue Needs Analysis 2006 – 2008*, during which they did surveys via marinas. It is possible that these methods could be duplicated in a future study regarding boat traffic for Georgian Bay.

6. Other potential resources for boat traffic include Dalhousie University's *Maritime Activity and Investigation Network (MARIN)* that studies maritime activity and incident levels of Search and Rescue clients across Canada. One particular study, *Canadian Maritime Traffic Patterns in 2000-2004*, evaluated traffic density, incident density, and seasonal activity trends. It is possible that their scientific methods could be duplicated for studies specific to Georgian Bay.

7. Consider incorporating new data from Ministry of Natural Resources and Forestry (MNRF) in future *State of the Bay* iterations. In the coming years, the MNRF will conduct an inventory and complete mapping of Great Lakes shoreline ecosystems as part of their role in a baseline assessment (Annex 7 of GLWQA) and complementary to the Nearshore Framework for monitoring and assessment. The inland scope will likely extend up to 2-5 km.

8. Cumulative effects of multiple factors in cottage country need to be explored, as is noted in *How Much Disturbance is Too Much*? (EC, 2014, p.39): "Overall, what is missing with respect to edge effects to forests in the context of the southern Canadian Shield is research on the cumulative effects of cottage developments, and associated infrastructure, on plant communities and wildlife species on a landscape scale".

Climate Change

Our assessment of the available data suggests it would be valuable to continue, and to increase the spatial coverage of monitoring in the Georgian Bay area for physical variables like water temperature (especially in the nearshore) and river flow, and climate variables like wind (especially in the Severn Sound area). The prescribed goal under Annex 9 of the Great Lakes Water Quality Agreement is to enhance monitoring of relevant climate and Great Lakes variables to validate model predictions and understand current climatic changes and their impacts. With this in mind, improved monitoring on Georgian Bay could be considered and facilitated by installing more instrumentation. Currently, there are two buoy stations on Georgian Bay managed by ECCC (Figure 58 (see Technical Report); station 45137 – Georgian Bay and station 45143 – south Georgian Bay) that monitor wind, waves, atmospheric pressure, air, and water temperatures. Data are reported hourly and are available on ECCC's Marine Forecasts website and on NOAA's NDBC website. There are four land based weather stations relevant for eastern Georgian Bay: Killarney, Parry Sound, Western Islands (offshore), and Muskoka (inland). Data gaps exist for the Severn Sound and French River areas.

Location of current ECCC buoy and land meteorological monitoring stations. The land station on Beausoleil Island was discontinued in 2007.

The water temperature and ice cover data derived by CoastWatch is analysed and presented on a Lake Huron scale. It may be of interest to understand the water temperature and ice cover data on a Georgian Bay scale in order to look at trends specific to Georgian Bay. George Leshkevich, scientist at CoastWatch, suggested that Georgian Bay data would likely show very similar trends to Lake Huron data, but that the water temperature and ice cover on Georgian Bay may show a difference in the timing of changes.