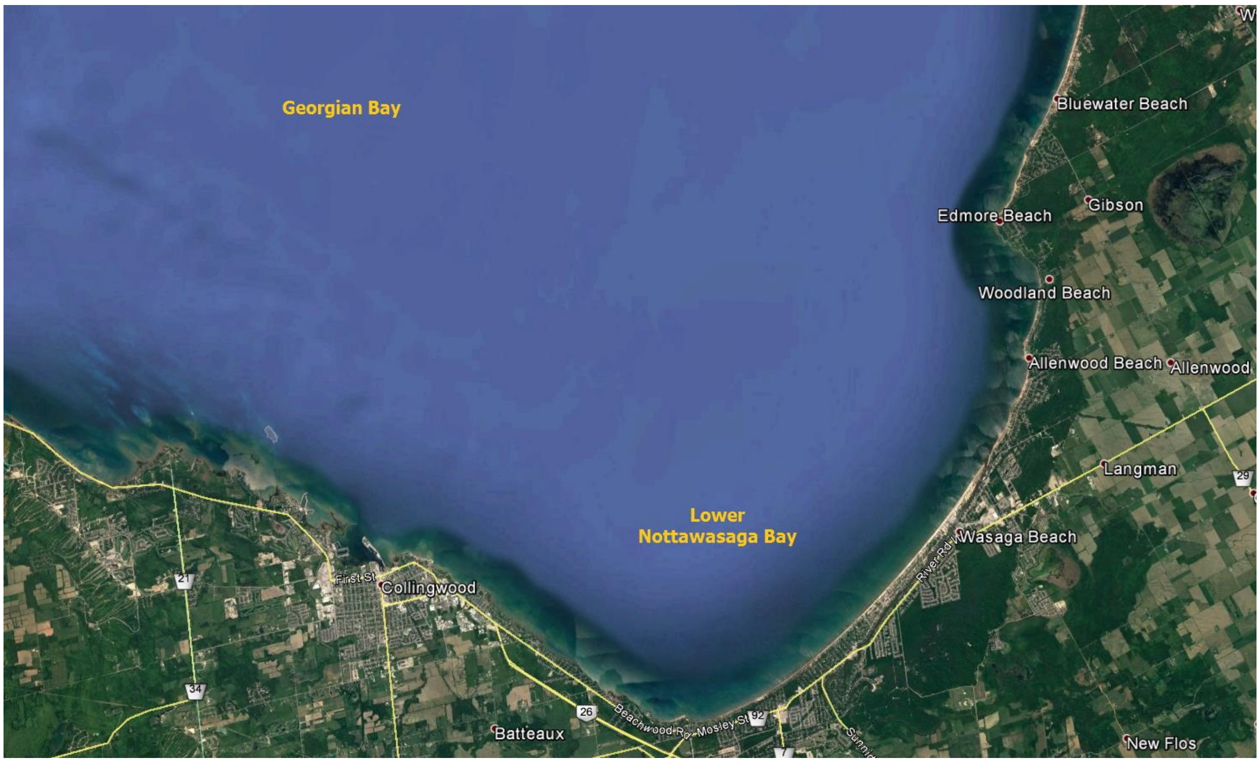
Bathymetry and Biodiversity in Lower Nottawasaga Bay



Produced for:

Nottawasaga Valley Conservation Authority

March, 2017

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Acknowledgements

WILD Canada Ecological Consulting would like to acknowledge the support of the individuals and agencies that have lent their support to the completion of the field studies and this summary.

WILD Canada thanks:

The Nottawasaga Valley Conservation Authority for staff time and resources made available. In particular, thanks go out to Lyle Wood for GIS programming and mapping, Hendrick Amo for mapping and David Featherstone for use of photographs, as well as input to, and review of, this final report.

1.0 Introduction

In the summer of 2016, the Nottawasaga Valley Conservation Authority received funding under the Lake Simcoe/South-Eastern Georgian Bay Clean-Up Fund (LSSGBCUF) to administer a large-scale project for the “Mapping of Dynamic Beach, Flood Hazard Limit, Nearshore Bathymetry and Biodiversity for the Wasaga Beach and Collingwood Shoreline”. WILD Canada Ecological Consulting undertook the Wasaga Beach Shoreline Biodiversity Study component, as well as boat operation for the bathymetry data collection and aquatic macrophyte mapping components of this over-arching project. Skelton Brumwell & Associates undertook the shoreline biodiversity study for Collingwood.

The southern Georgian Bay shoreline continues to be under intense pressures from development and recreational use. Some components of the biodiversity of this region, whether individual species or vegetation communities, have been recognized as locally, provincially, nationally, or even globally imperilled. The biodiversity of this shoreline, and associated threats, must be clearly understood for the development of programs to conserve and restore biodiversity along this pressured shoreline.

To this end, the study focused on:

- mapping of onshore topography from water’s edge to an elevation of 180 m
- mapping vegetative biodiversity of the coastal habitat
- recording significant wildlife habitat and populations in the aquatic and nearshore environments
- the mapping of bathymetry (lake-bottom contours) from 0.5m depth to 5m depth
- mapping aquatic macrophyte beds

It is widely recognized that nearshore bathymetry and lake-bottom substrate are intimately connected with many components of nearshore and shoreline biodiversity. This report will discuss the findings of these separate studies and link the dynamics of Nottawasaga Bay bathymetry with the shoreline biodiversity.

1.1 Regional Context

Nottawasaga Bay makes up the southernmost reach of Georgian Bay, itself an extension of Lake Huron. Cape Rich, on the Bayview Escarpment to the west of the Town of Meaford, is the western entrance to Nottawasaga Bay, while Christian Island, off the northwest corner of the Penetanguishene Peninsula forms the eastern entrance. From west to east, the communities that lie along the shore include Meaford, Town of Blue Mountains, Collingwood, and Wasaga Beach (Encyclopedia Britannica, 2017). These studies focused more specifically on Lower Nottawasaga Bay, the area between the eastern end of Wasaga Beach and the Western side of Collingwood.

The biodiversity component of the composite shoreline project was designed to assist in addressing and/or contributing to key principles outlined in the Lake Huron-Georgian Bay Framework for Community Action as well as conservation strategies identified in the International Biodiversity Conservation Strategy for Lake Huron. These include:

Lake Huron-Georgian Bay Framework for Community Action

- Principle 1 – Building Awareness and Capacity
- Principle 3 – Take Action to Restore and Protect

International Biodiversity Conservation Strategy for Lake Huron

1.1 Effectively conserve a system of public and private conservation lands for coastal terrestrial, nearshore zone and island features that are resilient to changes in land use and climate.

2.6 Develop and implement programs that identify and conserve priority coastal terrestrial, nearshore zone and island habitats

3.1 Restore native populations of Lake Huron's aquatic and terrestrial species.

4.3 Increase community engagement, awareness, understanding and commitment to coastal terrestrial, nearshore zone and island conservation.

8.6 Enhance research and monitoring of the nearshore zone and coastal terrestrial margin.

It is intended that this project will contribute to the Canadian vision for the Lake Huron Watershed along this portion of the Georgian Bay shoreline to ensure that:

- degraded areas are restored and environmental health sustained;
- our use of land and water is ecologically sound; and
- our open waters, shorelines, farmlands, forests, rivers, streams, and wetlands across the watershed, are protected today and for all future generations.

1.2 Local Context

The Town of Wasaga Beach is located along a 14 km stretch of shoreline, starting at the southern extreme of Nottawasaga Bay, and extending northeastward up the coast. The mouth of the Nottawasaga River, which winds its way through the community and empties into Nottawasaga Bay towards the eastern end of Wasaga Beach, lies well north of the Town of Collingwood, which is situated on the southwest shore of the bay. The most easterly portion of Wasaga Beach, at Archer Street, lies further north still. The beach is widely recognized as the largest freshwater beach in the world.

Wasaga Beach has been a destination for beach-goers and cottagers since the early 1900's, but gained real popularity starting in the 1920's. Cottage development paralleled the beach, and much of the foredune and backdune lands were significantly altered for family cottages, cottage-courts, stores, dance halls, hotels, and other attractions.

The Town of Wasaga Beach currently has a year-round population of 19,500 people. This number jumps significantly during the summer vacation/tourism season. The majority of the more than one million annual visitors to Wasaga Beach come for the recreational opportunities based around the beach. This puts a great deal of pressure on those who manage the beach to maintain it for tourism. At the same time, many provincially and globally significant wildlife and plant species are found at Wasaga Beach, so sound management must also take those species and their habitats into account.

The Town of Collingwood is situated adjacent to Wasaga Beach, and extends along the southwestern edge of Nottawasaga Bay, northwestward from Wasaga Beach, to the border of Simcoe and Grey Counties. Collingwood is bounded to the west by the Niagara Escarpment and to the north and east by Nottawasaga Bay. Collingwood is a major year-round tourist destination, with pursuits based mainly around outdoor activities. Tourists come for festivals, skiing, hiking and biking on the nearby Niagara Escarpment, kayaking, travelling the extensive trail system, and many other events and past-times (Town of Collingwood, 2017). Much of Collingwood's 50kms of shoreline, particularly the area between Sunset Point and Hen and Chickens Island, is in public ownership (Town of Collingwood, 2016).

Collingwood is currently ranked as Canada's 24th fastest growing community outside a metropolitan area (Statistics Canada, 2016). The population of Collingwood is currently reported at over 21,000 full-time residents, with growth projections to approximately 30,000 by 2030 (Simcoe.com, 2017). As with Wasaga Beach, improperly planned and managed rapid growth and development in Collingwood has the potential to impart serious deleterious effects on highly sensitive shoreline and aquatic biodiversity.

2.0 Studies of the Biodiversity and Bathymetry of Lower Nottawasaga Bay

As part of the Mapping of Dynamic Beach, Flood Hazard Limit, Nearshore Bathymetry and Biodiversity for the Wasaga Beach and Collingwood Shoreline project managed by the NVCA, three biodiversity studies were completed in lower Nottawasaga Bay, along with detailed near-shore bathymetric mapping. The intent of these studies was to study, catalogue and map current extent of vegetation communities, and sensitive species and their key habitats; map the lake-bottom structure and substrates; research and discuss potential impacts to these areas; and to provide recommendations for best practices to manage these resources.

2.1 Wasaga Beach Shoreline Biodiversity Study

Natural backdune, foredune and beach vegetation communities were documented in the field along the entire 14 km stretch of Wasaga Beach, from Archer Street at the east end of town to 71st Street at the west end, and inland to the shoreward extent of these natural communities on public property. Based on past studies, portions of these communities are known to be provincially rare and contribute to broader lake biodiversity. Field studies were undertaken between August 15 and October 19, 2016.

During field studies, all identifiable vegetation species were recorded. Dominant species and their affiliates were used to determine vegetation communities, per Ecological Land Classification (ELC) standards (Lee et al, 1998), using the most current, updated and accepted coding nomenclature from 2009. Vegetation communities and significant individual occurrences were accurately mapped using hand-held GPS and portable GIS software on a data-recording tablet. Vegetation community polygon boundaries were further refined through combining field data and the most up-to-date ortho-rectified aerial imagery (2016), using the ESRI ArcMap GIS program.

180 species of plants were recorded in 46 vegetation communities along the Wasaga beach shoreline during this study. Only one of these species, Long-leaves Reed Grass *(Calamovilfa longifolia var. magna)*, is considered significant in Ontario (S3). However, 24 vegetation communities (2 Great Lakes Coastal Meadow Marsh; 8 Open Dune; 3 Shrub Dune; and, 11 Treed Dune) are considered significant in Ontario. 24 significant vegetation communities (just over half of the total recorded) is very rare. It underscores the fact that while most species are reasonably common, their associations in shoreline communities is very rare in Ontario, and extreme measures must be taken to protect this shoreline. 50 of the plant species recorded (28%) are not native to Ontario (Martin, 2017).

Recommendations for protection and restoration are provided in this report, with the hope of forming a valuable input into the ongoing Wasaga Beach Provincial Park Management Plan update. This information should also inform ongoing beach stewardship work at the Park and within Town of Wasaga Beach shoreline management practices. It is expected that results of the inventory will also be used to inform regulated dynamic beach discussion associated with the engineering component of this project.

2.2 Collingwood Shoreline Biodiversity Study

Collingwood contains many sensitive shoreline habitats, including several sizeable wetlands used for fish spawning and rearing habitat, waterfowl congregation, colonial wading bird feeding and shoreline buffering, as well as lake level- and water quality-sensitive, globally imperilled Great Lakes Coastal Meadow Marsh habitats (Fleming, 2017). While much of the shoreline wetland communities are situated on public land, much is also on private property. As such, this study focused on 5 large wetland communities on, and accessible by, public property. Planned development activities for Collingwood could place considerable pressure on the shoreline and aquatic biodiversity of the area, whether directly along the shoreline or compounded through a variety of developmental impacts to ground and surface water around the community. Understanding the current diversity and extent of shoreline wetlands, and potential impacts upon them, will aid management agencies, such as the Town of Collingwood, NCVCA, and the federal Department of Fisheries and Oceans to plan accordingly for the long-term sustainability of these areas.

One hundred thirty-two (132) species of plants were recorded in 13 vegetation communities within the shoreline zone. One unconfirmed plant species, *Solidago houghtonii* (S2) and two vegetation communities, *Shrubby Cinquefoil Coastal Meadow Marsh Type* (S1) and *Graminoid Coastal Meadow Marsh Type* (S2) are listed as provincially rare. Sixteen of the plant species recorded (12%) are not native to Ontario (Fleming, 2017).

Recommendations for protection and restoration were provided, and should form a valuable input for Town management of these public lands, along with identifying opportunities for community stewardship partnerships.

2.3 Bathymetric Data Collection

Existing bathymetry for the Collingwood and Wasaga Beach coastal area is available through the Canadian Hydrographic Service at a scale of 1:50,000 - 150,000 and the onshore OBM mapping is at a scale of 1:2000 with 1 m contours. These scales are too coarse to accurately model coastal processes and hazard lands.

To provide significantly more finely-detailed mapping of these near-shore processes, bathymetric mapping of the near shore zone was undertaken by staff from the NVCA and WILD Canada Ecological Consulting. During the summer and autumn months of 2016, detailed transects were driven, by boat, to record and map the bathymetry (depth and contours) of the lake bottom from Archer Road at the east end of Wasaga Beach to Long Point Road at the west end of Collingwood.

Using a Garmin echoMAP CHIRP 75sv Chartplotter/Sonar Combo, bathymetry data was collected from 0.5 m water depth to at least 5 m depth, with the goal of providing near shore bathymetry to approximately 0.25 m vertical accuracy. The Garmin unit tracked the survey boats' positions, and transects were taken both parallel to, and perpendicular to (depending on depth, hazards and other factors), the shoreline at approximately 25 m intervals. Collingwood has a much more diverse shoreline pattern than does Wasaga Beach, and considerable effort was spent to capture all accessible areas. The Garmin units also provided information on bottom structure, which was mapped, along with location and extent of vegetation beds as they were encountered.

All bathymetry data was post processed by NVCA staff to correct for lake level and provide a seamless product across the waterfront. In total, bathymetric data was collected for approximately 36 km of shoreline. This report will provide input to the interactions of the aquatic and shoreline habitats and the relationships between bathymetry, substrate, and biodiversity.

2.4 Aquatic Macrophyte Survey

During bathymetric data collection, the locations of aquatic macrophyte beds was recorded. Macrophyte species were documented, where accessible and identifiable due to depth and water conditions. Potential function of aquatic macrophyte beds was also assessed.

Significant changes were seen in the size and abundance of macrophyte beds when compared to those recorded by Featherstone in 2015. More specifically, the aquatic macrophyte beds within Collingwood Harbour were greatly expanded, while all beds outside of the harbour were significantly reduced in number and size. This is most likely a result of the substantial increase in lake level since the 2015 survey. With greater water depth, the plants outside the sheltered harbour must grow substantially taller to reach the sunlit growing zone while remaining rooted in traditional sediment pockets. Increased lake level also means that most of the beds would have been subjected to increased wave energy and ice scouring. With greater wave energy also comes the potential for more suspended sediments, which naturally cloud the water column, reducing light penetration for plant growth. At eth same time, the increased lake level has brought water up to a more optimal depth for the proliferation of aquatic macrophytes across a greater portion of the inner harbour.

3.0 Bathymetry and Substrate: Contributions to Biodiversity

3.1 Archer Street Point, West to 72nd Street Point (Brock's Beach), Wasaga Beach (Figures 1 and 2)

The lake bottom offshore from the sand point at Archer Road, at the eastern end of Wasaga Beach, is strewn with many large rocks and boulders, which rise quickly to the surface at the point. The boulder field reaches more than 200 metres out into the lake off the point, and stretches south-eastward along the shore at high concentration for approximately 200 m and in lower concentration for about 300 m further. While no fish species were recorded during the surveys, this boulder field does provide potential for nesting and foraging fish species, such as Small-mouthed Bass *(Micropterus dolomieu)* (figure 2). While unconfirmed, it is believed that there also are Lake Whitefish *(Coregonus clupeaformis)* spawning areas on off-shore gravels, away from shifting sand substrates (D. Featherstone, pers. comm., February 9, 2016).

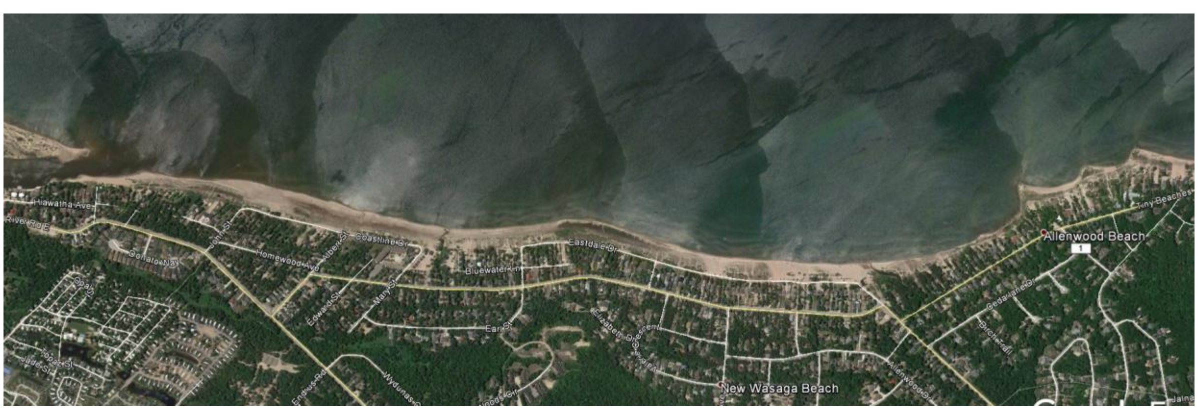

Figure 1: Archer Street Point, west to Nottawasaga River mouth, Wasaga Beach

Further to the SW, the lake bottom substrate turns to fine silted and wave-washed lacustrine sand, stretching to, and beyond the Nottawasaga River mouth. The wide sandy flats at the mouth of the Nottawasaga River provide a staging area for salmonids during fall upstream migration (figure 2).

From the mouth of the Nottawasaga River south-westward across virtually all of Wasaga Beach (figure 3), the substrate is wave-washed sand with an extensive series of dynamic and often very shallow sandbars. The lake bottom has a very long, gradual slope, with water depth only reaching 2 m at around 2-300 m offshore, and not reaching 6-8m depth until approximately 500 metres or more from shore.

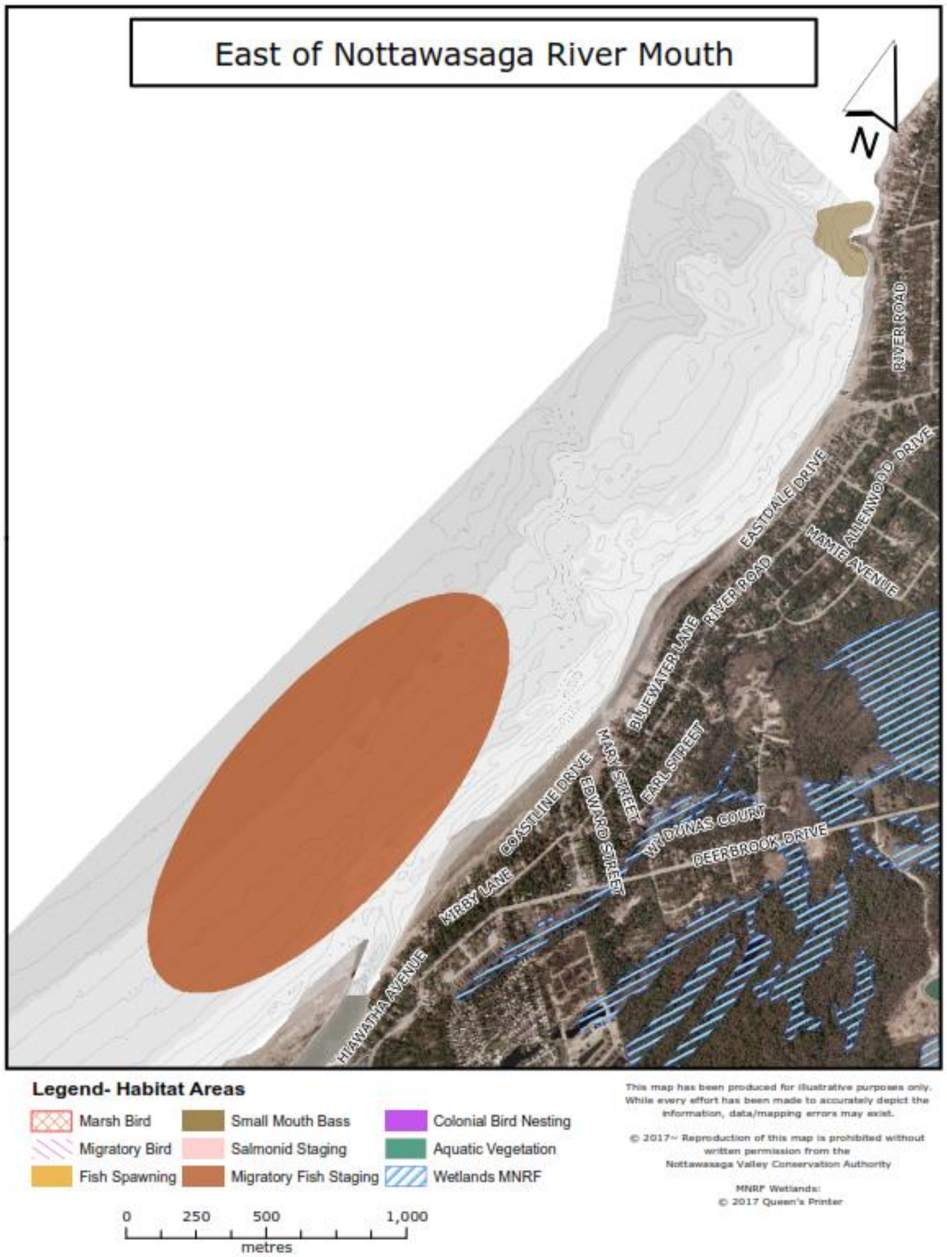

Figure 2: Bathymetry and biodiversity east of Nottawasaga River mouth

The point at 72nd street is the result of a large, artificially-created groin, composed of large boulders. This groin has gathered a considerable amount of sand since its creation, allowing for the development of a wide sandy beach on the western side. However, the accumulation of sand on the windward side of the groin has significantly reduced natural sand deposition on the leeward side. During the high lake levels of 1985/86, severe storms damaged a portion of the tip of the groin and dispersed many of the boulders along the adjacent lake bottom. This boulder field is similar to, but shallower and not as extensive as, the one at Archer Road at the east end of Wasaga Beach. Yellow Perch and Small-mouthed Bass have been observed in this boulder field, and are most likely using it for foraging and spawning habitat.

The prevailing winds are from the NW, and blow directly, and often fiercely, onto this shoreline. Waves can easily reach heights of 1-2 m in these near-shore areas, which keeps the lake bottom highly dynamic. These dynamic sands do not support sustainable aquatic macrophyte root establishment. The sandy lake bottom also contains few nutrients for sustaining concentrations of aquatic macrophytes. No aquatic macrophyte beds were recorded in this stretch of lake bottom.

Figure 3: Nottawasaga River Mouth, west to 72nd Street point (Brock's Beach), Wasaga Beach

The majority of the lake-bottom sand originated with the retreat of the Wisconsin Ice Sheet. It was deposited as till and lacustrine sediment as the last glaciers retreated from this region approximately 12,000 years before present, along with deposition during successive inundations as various post-glacial lakes covered the area and spillways opened and altered course (Kor, 1997). Since the stabilization of Georgian Bay in its present state, these nearshore sands have been highly dynamic and have been instrumental in the building of the provincially significant ANSI parabolic, transverse and raised beach ridge dunes found throughout Wasaga Beach.

A small portion of the sand on the nearshore lake bottom has been washed downstream by the Nottawasaga River as it carves its way through the large, inland transverse and parabolic dune system created approximately 3,000 years ago as post-glacial Lake Nipissing retreated (Kor, 1997). While there is some ongoing input of new sand to the system, the majority is of ancient origin with very minor new inputs, so the beach is considered a “relict beach” (Kor, 1997). Sand in the dynamic beach system must remain a fluid part of the foredune/sandbar system. Any sand lost from this system, whether to erosion or beach management practices, cannot be naturally replenished. Continued sand loss will result in failure of the dynamic beach system.

While these dynamic nearshore sands inhibit aquatic macrophyte bed establishment, they are instrumental in building and sustaining the on-shore beaches and dunes and the provincially significant vegetation communities that rely upon them, including rare and significant Open Dune, Shrub Dune, Treed Dune, and Great Lakes Coastal Meadow Marsh. Along with rare vegetation communities, these beach and dune systems also are home to provincially and globally rare plant and animal species, such as Hill’s Thistle *(Cirsium pumilum var. hillii)*,

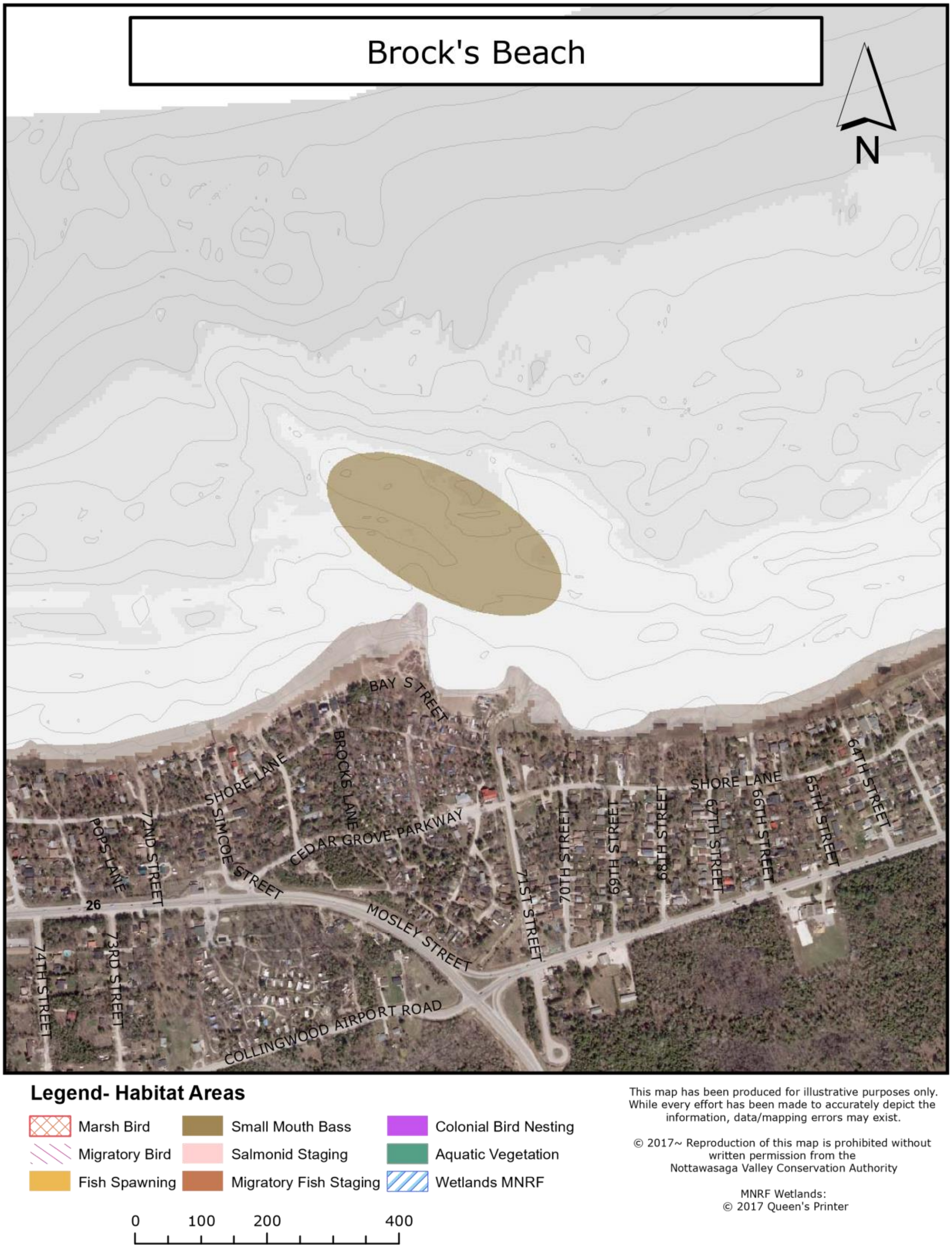

Figure 4: Bathymetry and biodiversity at Brock's Beach

Pitcher's Thistle *(Cirsium pitcheri)*, Monarch *(Danaus plexippus)*, Piping Plover *(Charadrius melodus)*, and Eastern Hognose Snake *(Heterodon platirhinos)*.

3.2 72nd Street (Brock's Beach), Wasaga Beach, West to Sunset Point, Collingwood (figure 5)

The substrate to the east of 72nd Street, Wasaga Beach, is bolder and cobble over packed and wave-washed lacustrine sand. Heading NW towards Collingwood, the cobbles and boulders become larger and more numerous, often creating shallow bays that can be quite treacherous for manoeuvering even small, shallow-hulled watercraft. Exposed bedrock starts to become noticeable around Edgar Road, Collingwood, and becomes more plentiful heading NW, typically overlain with boulders and large cobbles. Exposed bedrock starts to dominate the substrate just west of the Blue Shores housing development, near the mouth of the Pretty River, and becomes a shallow limestone pavement around Sunset Point.

Figure 5: 72nd Street, Wasaga Beach (Brock's Beach), west to Sunset Point, Collingwood

While boulders and cobbles are plentiful along this stretch of shoreline, they are generally not in high enough concentrations, nor at proper depth to provide significant foraging or nesting habitat for sportfish species. The shallow, exposed, rocky nearshore area with high wave energies is also not conducive to sustaining aquatic macrophyte beds. One exception to this was recorded. Just offshore from a minor recess in the coastline between Theresa Street and King Street (centred around Arthur Street), Collingwood, there is a bedrock shoal that reaches very near the water surface, to approximately 0.5 m. Just inshore from this shoal, there is a 20-30 m wide, 2-3 m deep depression running parallel to the shoreline for approximately 400 m.

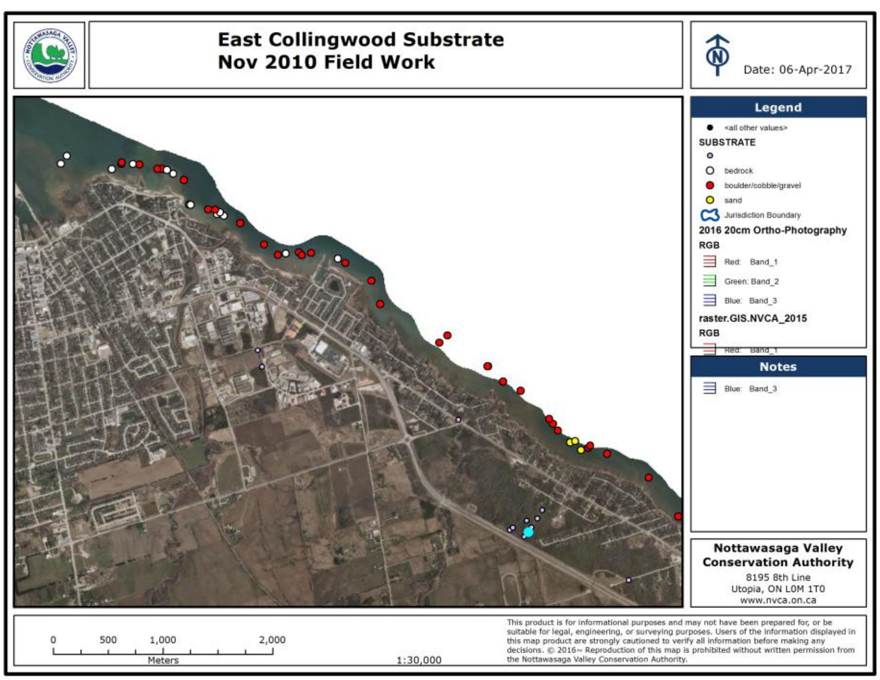

Figure 6: Nottawasaga Bay nearshore substrate east of Collingwood

This pocket is dominated by a significant aquatic macrophyte bed, comprised seemingly singly of Eurasian Water Milfoil, which reaches to the water's surface (figures 7, 8). This non-native species is known to not sustain as much biological diversity as native macrophyte beds. The very shallow shoal is extremely effective at reducing the energy of waves approaching shore. This reduction in wave energy would allow sediments carried on, and churned up by, the waves to fall out of suspension and be deposited in the depression, creating a suitable soil base for plants to root. This bed is actually situated in the deeper water pocket immediately offshore adjacent to the area indicated in figure 8.

As the prevailing winds come from the NW, many shallow, cobble/boulder bays of this undulating stretch of shoreline are subjected to reduced wave energies compared to the southeastern shoreline of the bay, allowing narrow, shallow, shrub and graminoid wetlands. The many dozens of man-made groins along the shoreline also serve to reduce wave impacts and provide some protection for shoreline wetlands, but much of the shoreline hardening practice has eliminated wetlands. There still can be significant wave energy impacting the shoreline during storms from the north and north-east, which limits wetland growth, as waves, along with the effects of winter ice, can easily scour the roots to the bedrock/cobble substrate. These bays, and their wetlands, provide sheltered moulting and staging areas for waterfowl and feeding areas for shorebirds.

Figure 7: Eurasian Water Milfoil bed, offshore from Arthur Street, Collingwood

The extensive shallow shelf of boulders on bedrock at the mouth of the Pretty River (figure 8) provides a staging area for salmonids before autumn upstream migration. Many salmonids were documented sheltering at these boulders during bathymetry field work. In deeper water offshore, the MNRF has determined that the area provides spawning and nursery habitat for Lake Whitefish and possibly Lake Trout *(Salvelinus namaycush)*.

Figure 8: Bathymetry and biodiversity at east Collingwood

3.3 Collingwood Harbour Area (figure 9)

The Collingwood Harbour area, from the Sunset Point wetlands to Lighthouse Bay, with its diversity of water depth, substrate and shoreline structure provides habitat for a very diverse range of wildlife species and communities. An extensive series of often shallow limestone bedrock shoals surrounds Collingwood Harbour. The open waters surrounding the harbour can build some considerable waves, but these shoals provide significant wave-breaking action. Over time, the reduction in wave energy directly impacting the shoreline has allowed many sizeable and biologically-significant coastal wetlands to develop. These are part of the Silver Creek Wetland Complex, which is designated at provincially significant due to biological function, rarity of species and vegetation communities, and other factors. The shoreline of the Collingwood Harbour area is comprised of a combination of natural spits and hardened structures, such as harbour breakwalls, marinas and armoured shoreline, which has created a variety of sheltered, variable depth embayments. This, along with the diversity of substrates, from bedrock to cobble and boulder, to mineral sediments and organics, has created an assortment of vegetation communities.

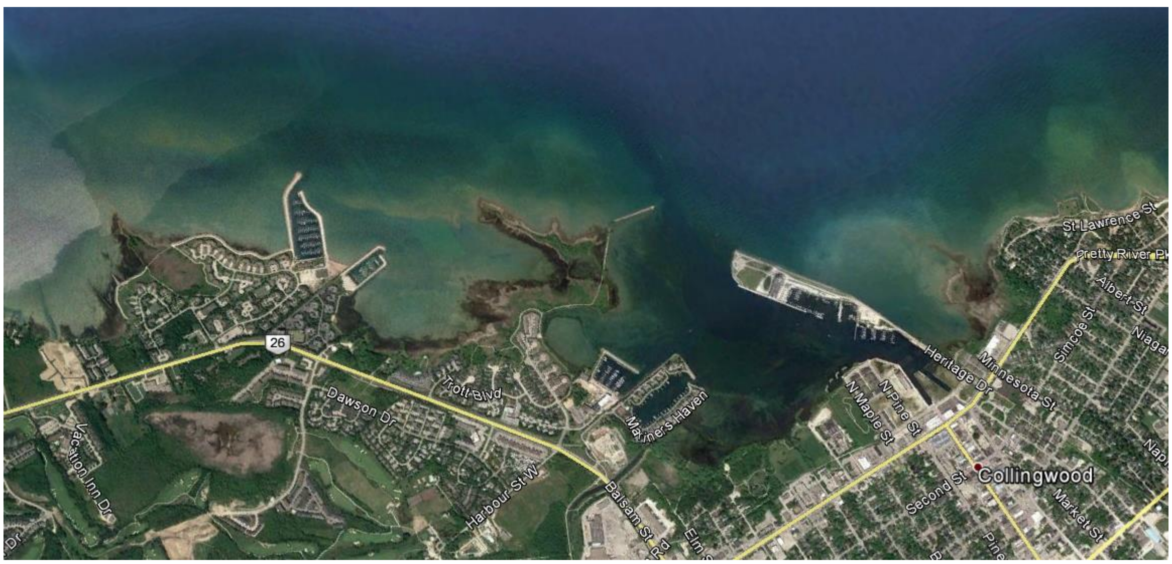

Figure 9: Collingwood Harbour area

In portions of the Sunset Point wetlands, between Niagara Street and Heritage Drive, bedrock often rises to the surface as a limestone pavement, creating vegetation communities reminiscent of rare shoreline alvar wetlands found on Manitoulin Island. These Great Lakes Coastal Wetlands are very sensitive to changes in lake levels. Plant growth is limited to very shallow organic and mineral accumulations and many plants are only found growing in cracks in the bedrock where their roots can find adequate moisture and gain a strong foothold. Without the wave-breaking action of the shoals, these wetlands would never have the opportunity to develop or thrive.

Conditions very similar to Sunset Point exist along the shore of White's Bay, just to the west of the inner harbour, where a shallow shoal stretches from the western entrance to the harbour, across the lakeward side of Hen and Chicken Island and across to the Lighthouse Point marina. This shoal not only protects the shoreline wetlands from the energy of Georgian Bay waves, but also protects the low-lying terrestrial vegetation communities.

The shallow flats off Sunset Point wetland and those of West Bay and Lighthouse Bay further to the west provide confirmed spawning and nursery grounds for several fish species, including Common Carp *(Cyprinus carpio)* and Longnose Gar *(Lepisosteus osseus)*. There is potential for Northern Pike *(Esox lucius)* to also spawn in the flooded grasses of these areas. Shoreline shrub, graminoid and meadow marsh wetlands also provide sheltered marsh bird nesting (figure 13).

Sediment and organics accumulation has been most significant at the southern end of the inner harbour. The natural bay has been enhanced as a harbour by the creation of a large breakwall on the eastern side, separating it from the Sunset Point wetlands. The wave-breaking functions of the natural shoal, Hen and Chicken Island, and the breakwall have allowed sedimentation and the accumulation of organics over many years. This accumulation of organics and nutrient-rich sediments has led to the development of significant plant growth in this area, including aquatic macrophyte beds and shoreline graminoid wetlands.

Figure 10: Least Bittern nest in Collingwood harbour wetland *(photo credit: D. Featherstone)*

Collingwood Harbour was a grain shipping port and ship-building centre in the past. A deep channel has been cut along the SW side of the breakwall to allow for the passage of deep-hulled boats. The channel is too deep to allow much aquatic macrophyte bed growth, but from the western edge of the channel towards the shore, where sunlight can easily reach toward the bottom of the water column in depths of approximately 1.5 m to 4 m, growth is very thick. This transition can easily be seen on aerial photographs (figure 9). The range of these beds is approximately double that shown on figure 13, encompassing virtually all undredged area between Mariner's Haven marina and the harbour mouth, in addition to the area indicated. These aquatic beds support some large Northern Pike and Largemouth Bass *(Micropterus salmoides)*, as well as prey species like Yellow Perch and Pumpkinseed *(Lepomis gibbosus) (P. Reid, pers. comm., September 17, 2016).*

The shallower flats closer to shore, off Harbourview Park, are recognised areas for Carp spawning. Colonial wading birds, such as "S2"-listed Great Egret *(Ardea alba)* and "S3"-listed Black-crowned Night-heron *(Nycticorax nycticorax)* can often be found feeding in these shallow waters and the shoreline wetlands. Least Bittern *(Ixobrychus exilis)*, listed as "Threatened" in Ontario, have been confirmed nesting in the Harbourview Park shoreline wetlands (figure 10), as have many marsh bird species. The shallow waters of West Bay (figure 11) provide spawning and nursery grounds for Smallmouth Bass, as well as protected nesting for Mute Swans *(Cygnus olor).*

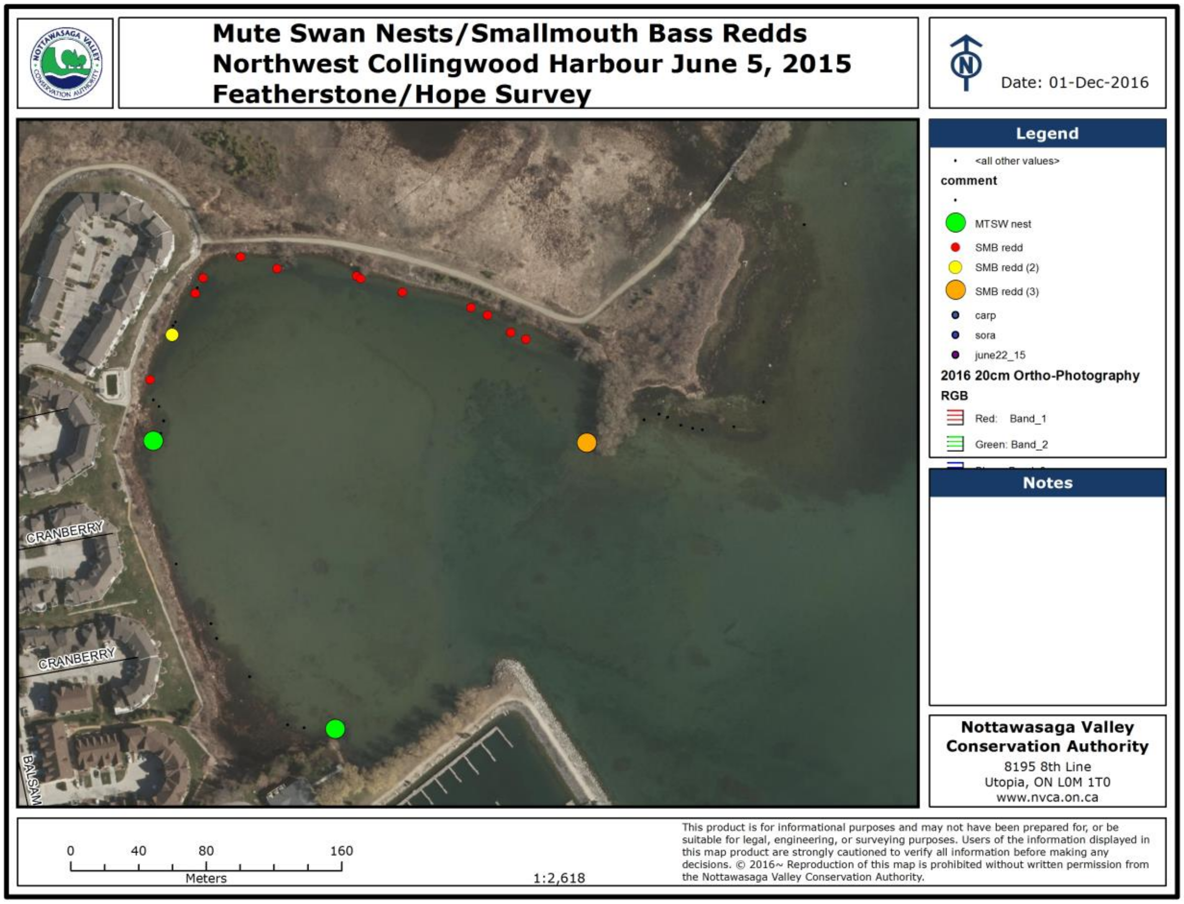

Figure 11: Mute Swan nests and Smallmouth Bass redds in West Bay, 2015

Many shorebirds and waterfowl stopover in the Collingwood Harbour area wetlands and sheltered bays during southward migration in late summer and fall, while others use the sheltered inner harbour all winter (figure 12). Bald Eagles *(Haliaeetus leucocephalus)* are often sighted hunting waterfowl along the Collingwood Harbour shoreline in winter. This is also a good location to spot Snowy Owls *(Bubo scandiacus)* in winter, as they search for their prey on the harbour's frozen wetlands. Some winters, a Peregrine Falcon *(Falco peregrinus)* can also be seen around the inner harbour, hunting its prey, which may include waterfowl finding refuge in the shoreline wetlands.

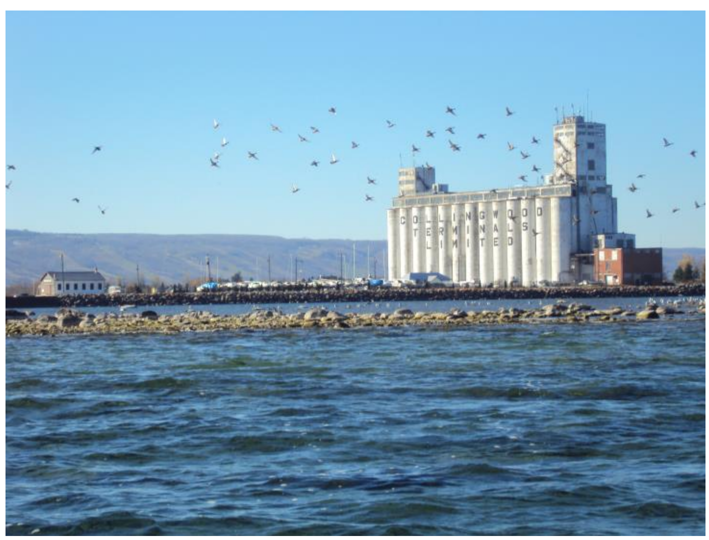

Figure 12: Mallards congregating in Collingwood Harbour during autumn migration *(photo credit: D. Featherstone)*

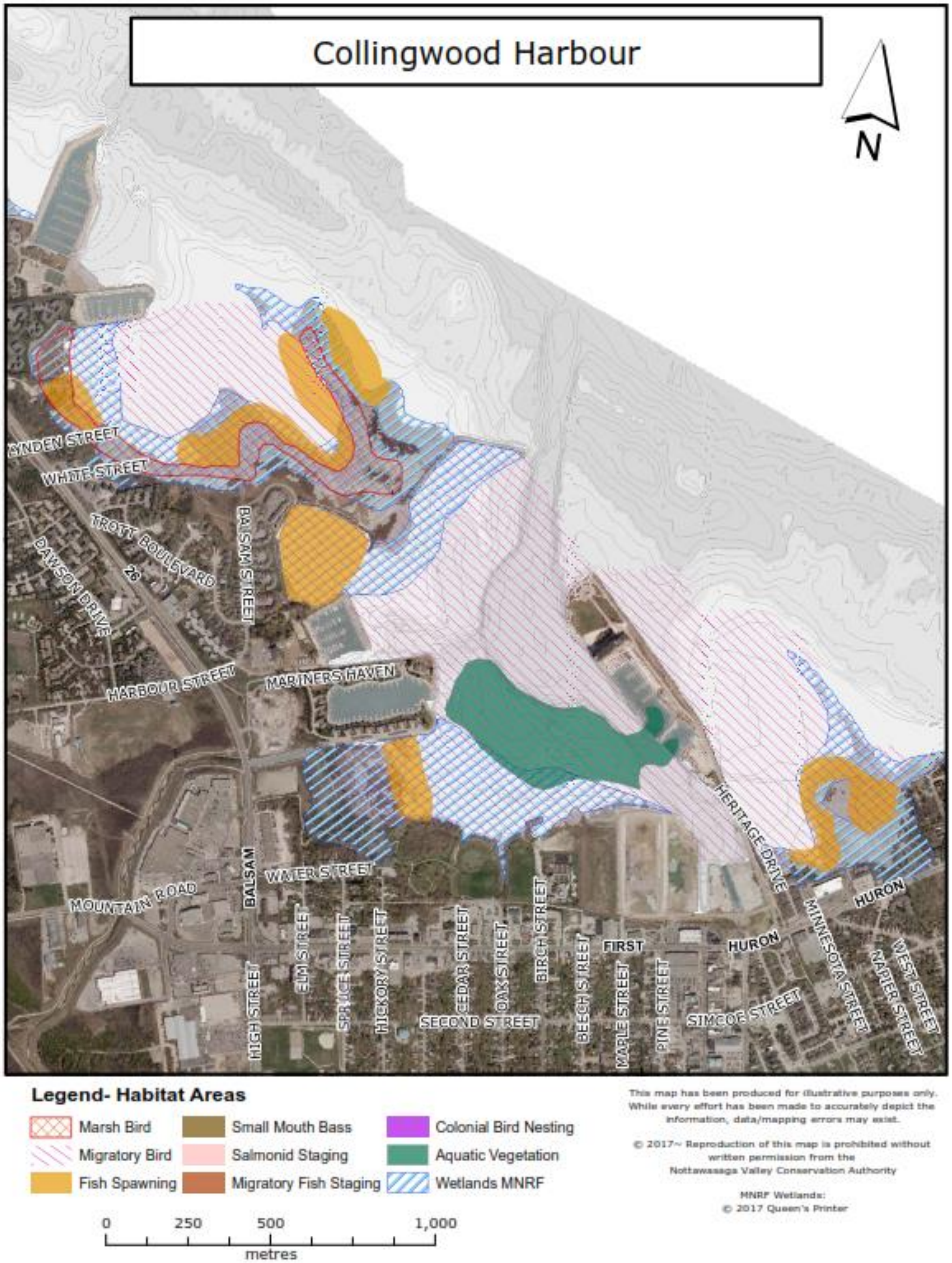

Figure 13: Bathymetry and biodiversity around Collingwood Harbour

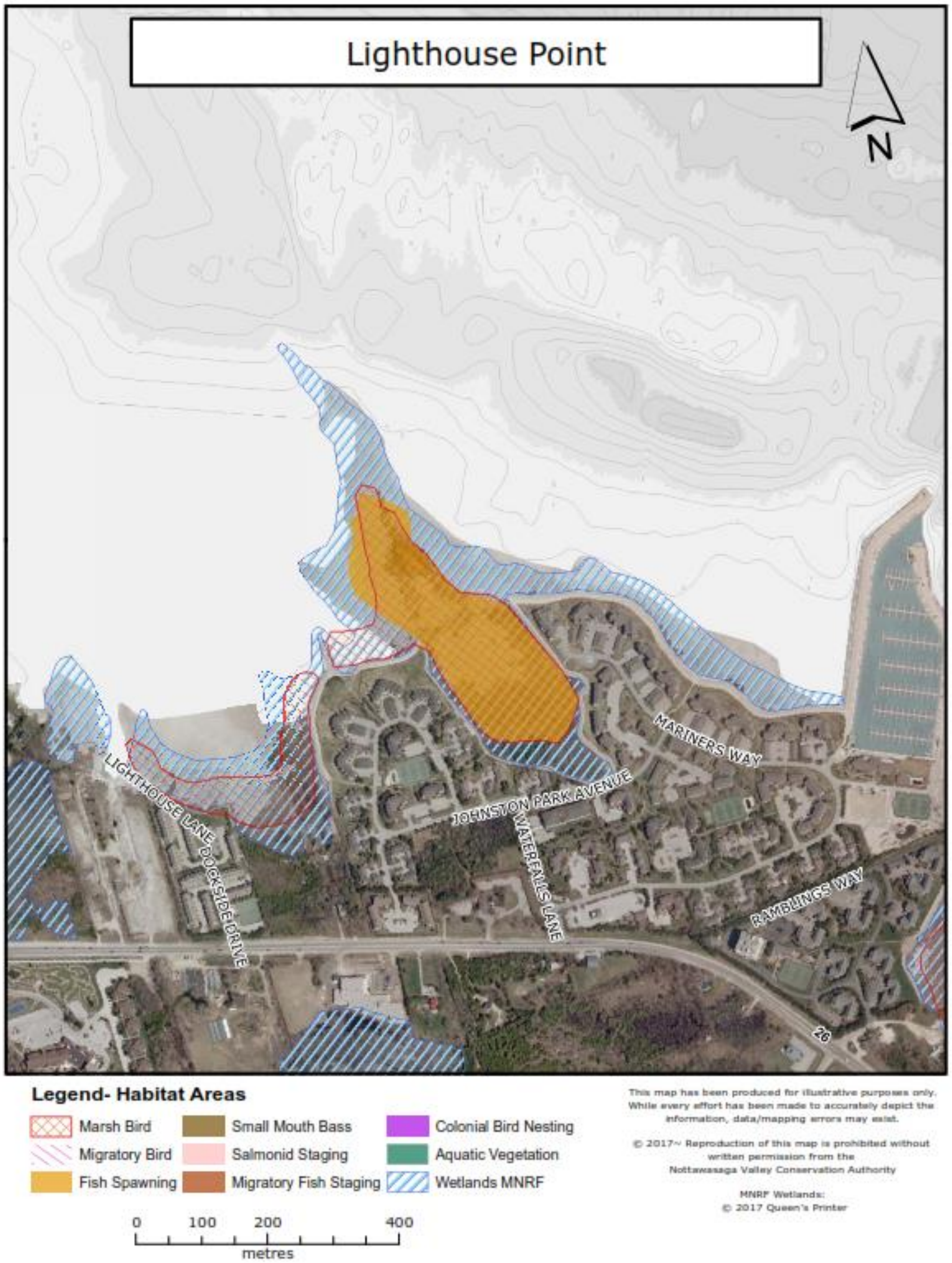

Figure 14: Bathymetry and biodiversity of the Lighthouse Point area

Most of the shoreline is hardened from Rupert's Landing marina, west to Lighthouse Point, significantly limiting the development of shoreline wetlands and their natural wave-breaking and shoreline stabilization functions. From the eastern edge of Lighthouse Point, westward around the spit towards Princeton Shores Blvd, the shoreline of Lighthouse Bay is left mostly natural, except for a few groins. South-eastern Lighthouse Bay and Lighthouse Point is home to shoreline shrub and graminoid wetlands. The wetlands at Lighthouse Point also include an inland extension of several hectares. These wetlands provide nest sites for marsh birds, and spawning and nursery grounds for several fish species (figure 14).

3.4 Collingwood Islands and Shoals, West (figure 14)

The shoreline and near-shore areas of the islands and shoals west of Collingwood is highly bathymetrically diverse. In some locations, water depth may range from over 10m deep up to less than 1 m deep within a distance of only 100-200 m. Most of the zone between Nottawasaga Island and the mainland shore is in the range of 0.5 m to 3 m deep, with several deeper pockets ranging to 6 or more metres deep. The substrate varies between bedrock plain, and bedrock overlain with boulders, cobble and occasionally gravel or silt (figure 20).

Figure 15: Islands and shoals west of Collingwood

While shoals around the islands are very effective at breaking or reducing what can often be very considerable wave energy from the open lake, waves can still easily reach over 1m around the islands. During the survey period in the summer of 2016, Georgian Bay lake levels were quite high. This caused several areas, marked on earlier maps as islands, to be inundated. With high lake levels, waves and winter ice can move large boulders, so the underwater zone is quite dynamic. Lying just under the water surface, these boulders and the undulating bedrock make for quite treacherous boating conditions, but do provide a variety of opportunities for small pockets of aquatic macrophytes and fish habitat. Aquatic macrophyte beds previously noted by Featherstone in 2015, were either significantly reduced or non-existent during this survey work. This is most likely attributable to the higher water levels, which would allow more wave energy to reach the plants, easily uprooting them and redistributing the sediment in which they were rooted.

These islands have been recognised by the NVCA and the MNR (2010) as a valuable Lake Trout spawning and nursery habitat, in association with the larger Mary Ward shoals further to the northwest (figure 15).

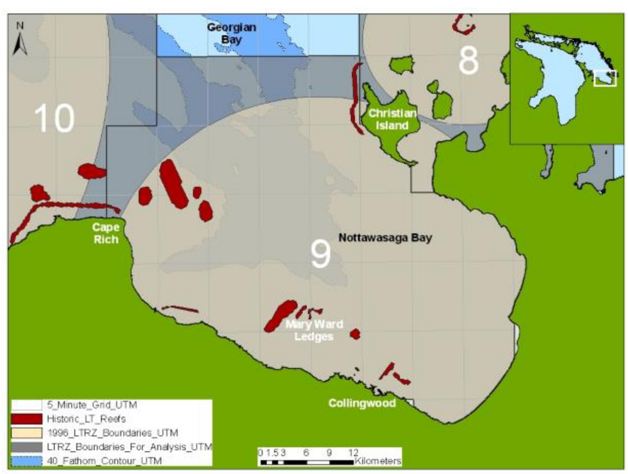

Figure 16: Historic Lake Trout spawning reefs in Nottawasaga Bay (*Source: MNR, 2010)*

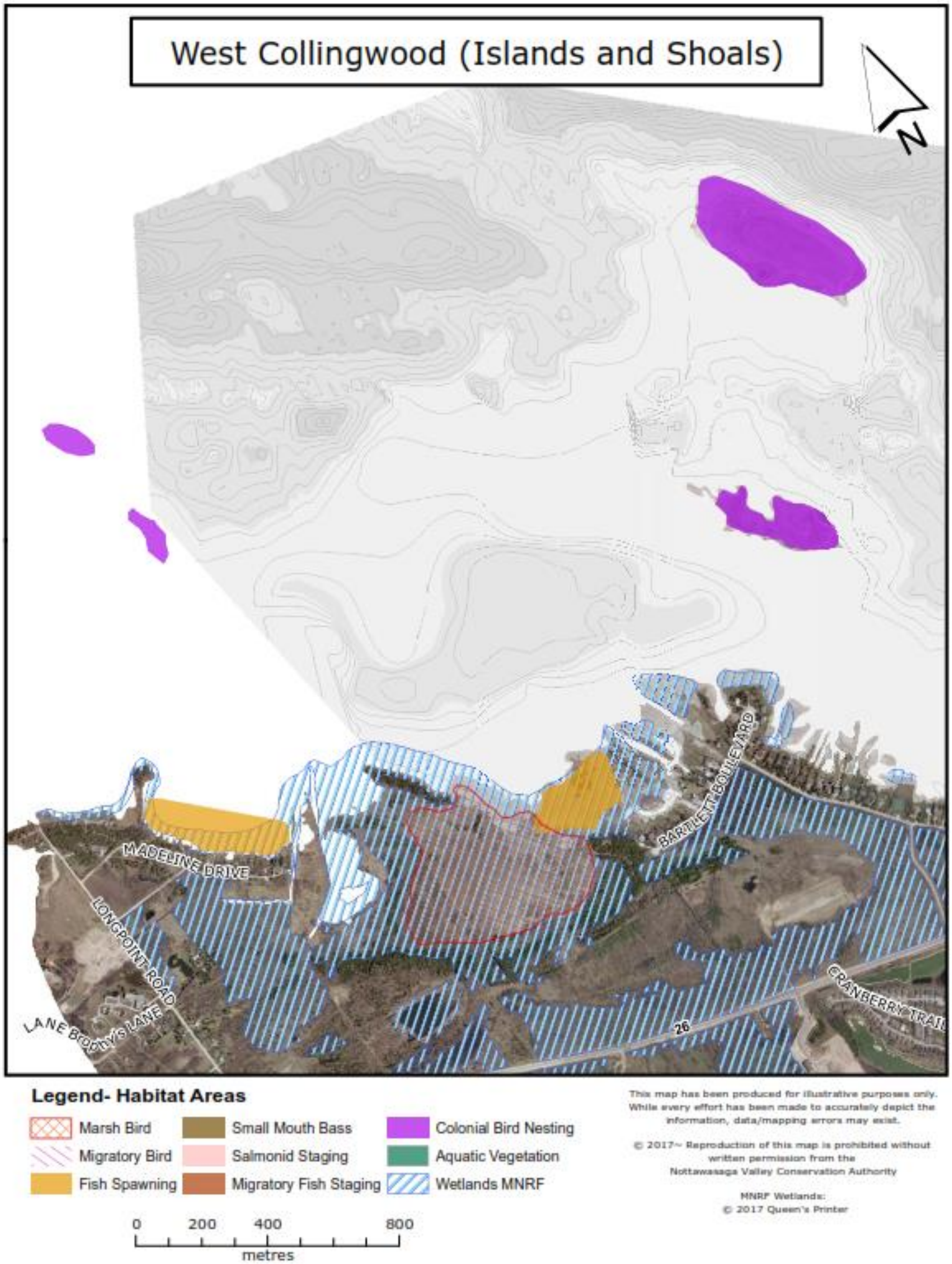

Figure 17: Bathymetry and biodiversity around islands and shoals west of Collingwood

The west Collingwood islands provide a remote location for such colonial nesting birds as Double-crested Cormorant, Great Blue Heron (*Ardea herodias*), Great Egret, Black-crowned Night-heron, Ring-billed Gull *(Larus delawarensis)*, Herring Gull *(Larus argentatus)*, and Great Black-backed Gull *(Larus marinus)*, listed as S2 in Ontario (figures 17-19). A small breeding population of Caspian Tern *(Hydroprogne caspia)* and Common Tern *(Sterna hirundo)* also utilizes a smaller island in this group.

Figure 18: Great Blue Heron, Double-crested Cormorant and Gulls nesting on Nottawasaga Island
(photo credit: D. Featherstone)

According to the Important Bird Areas Canada website (http://ibacanada.ca/site.jsp?siteID=ON153)...

"Several species of colonial waterbirds breed on Nottawasaga Island. Of particular note is the large number of Great Egrets that breed here. In 2000, 60 nests were counted containing 171 young. In 1991, there were only seven pairs of Great Egrets. This is one of only four large Great Egret colonies in Canada.

Figure 19: Great Egrets nesting on Nottawasaga Island
(photo credit: D. Featherstone)

Also in 1991, 107 pairs of Black-crowned Night- Herons (almost 3% of the national population) and 105 pairs of Great Blue Herons nested on the island. In 2000, Black-crowned Heron nests were only partially counted (46 nests). Other breeding birds on Nottawasaga Island are: Green Heron (at least one nest), Great Black-backed Gull (1 nest), Herring Gull (2380 nests in 1999) and Ring-billed Gull (1741 nests in 1999)."

Figure 20: Hundreds of Gulls nesting on Nottawasaga Island
(photo credit: D. Featherstone)

On the mainland, slightly further west of Lighthouse Point, between Princeton Shores Boulevard and Long Point Road, is a large portion of the provincially significant Silver Creek Wetlands Complex (figure 17). This area has evolved on historic shoreline wetlands and includes the eastern extent of some ancient raised shoreline ridges. This topography has created a diverse complex of wetland and upland vegetation communities, including forest, swamp, swamp thicket, marsh, and globally rare Great Lakes Coastal Meadow Marsh, which provide nesting habitat for marsh birds and spawning habitat for fish. The wave-breaking action of the nearshore shoals and islands protects the shoreline and the Silver Creek Wetlands.

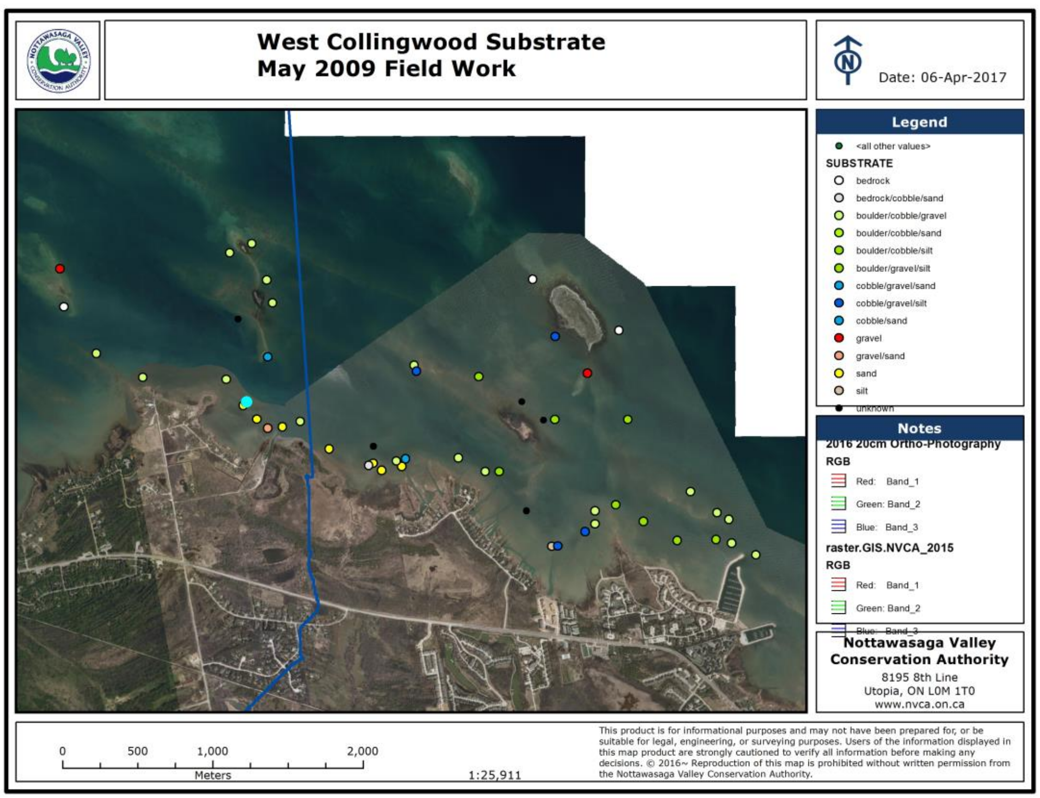

Figure 21: Nottawasaga Bay nearshore substrate around west Collingwood islands and shoals

4.0 Threats to Biodiversity

The bathymetry of lower Nottawasaga Bay is directly linked to nearshore and onshore biodiversity. The nearshore zone is considered the most productive portion of Lake Huron with influences that extend offshore and inland (LHBCSCT, 2010). Almost all fish inhabiting Georgian Bay utilize the coastal wetlands, sand, gravel, or cobble substrates associated with the nearshore zone at some point during their life cycle. Most Great Lakes fish utilize coastal wetlands for at least one life cycle stage, while nearshore reefs provide critical habitat for lake herring, lake trout and lake whitefish.

The nearshore zone of Nottawasaga Bay supports a variety of substrates and areas of aquatic vegetation that provide habitat for shorebirds, waterfowl, and fish. Exposed reefs and islands provide thickets and open forests that provide habitat for colonial nesting bird species such as terns, gulls, herons, egrets, and cormorants. The nearshore area is intrinsically connected to coastal terrestrial features within 2 km of the shoreline (LHBCSCT, 2010).

The population of the lower Nottawasaga Bay area is increasing rapidly. As development pressures and the number of people utilizing this resource for various reasons increase, so too do the potential impacts we might have on this shoreline. As can be expected, some of the most significant threats to the biodiversity of the lower Nottawasaga Bay shoreline are born by human actions.

4.1 Invasive Species

Invasive species can have a significant effect on the natural functions ad biodiversity of the nearshore zone. Whether plants or animals, species introduced to the natural system can change the natural balances and reduce productivity.

The introduced variety of Common Reed *(Phragmites australis subsp. australis)* has been spreading rampantly around the shore of Georgian Bay over the last decade or more. The plants grow in very thick mats, to the exclusion of most native species. The can alter the habitat value, productivity, water regime and many other factors of shoreline areas. Low water levels allowed the plants to dominate nearshore areas that would otherwise not have been available to them. Storms during current high water levels dislodge the plants and break apart root mats (which can reproduce vegetatively), redistributing the plants far and wide along the Georgian Bay coast.

Purple Loosestrife *(Lythrum salicaria)* has been a troublesome invasive plant in local wetlands for over 25 years. Each plant can produce over 3 million seeds annually and the plant can also reproduce vegetatively. While introduced beetles have been effectively controlling the population, along with natural cyclical population fluctuations, Purple Loosestrife can reproduce in such large numbers that it forces out native vegetation and the wildlife that relies upon it.

Zebra Mussels *(Dreissena polymorpha)* and Quagga Mussels *(D. bugensis)* were introduced to the Great Lakes in ballast water from transoceanic ships in the late 1980's. They are native to the Black Sea region of Eurasia. Zebra and quagga mussels are capable of heavily colonizing hard and soft surfaces, including, docks, boats, break walls and beaches. These colonizations are also responsible for clogging intake structures in power stations and water treatment plants. Zebra and quagga mussels filter water to the point where food sources such as plankton are removed, altering food webs. This also causes clearer water, allowing sunlight to penetrate deeper, increasing growth of aquatic vegetation. Large colonies affect spawning areas, potentially impacting the survival of fish eggs. They can also impact fish and wildlife by increasing toxic algal blooms and are believed to be responsible for botulism outbreaks which have killed thousands of diving ducks and bottom feeding fish such as Lake Sturgeon *(Acipenser fulvescens)*.

The Round Goby *(Neogobius melanostomus)* is a small fish introduced into the Great Lakes from Eurasia in 1990. It has spread extremely quickly into all five Great Lakes, aided in part by their aggressive eating habits and the fact that they can spawn several times per season. They feed heavily on introduced Quagga and Zebra Mussels, but also readily eat eggs and young of native fish. They can sometimes be found in densities of up to 100 fish per m^2. According to the Ontario Invasive Species Awareness website, (http://www.invadingspecies.com/invaders/fish/round-goby/)

- The fish compete with and prey on native bottom-dwelling fish such as Mottled Sculpin (*Cottus bairdii*) and Logperch (*Percina caprodes*). Round goby also threaten several species at risk in the Great Lakes Basin, including the Northern Madtom (*Noturus stigmosus*), the Eastern Sand Darter (*Ammocrypta pellucida*), and several species of freshwater mussels.
- Round goby have reduced populations of sport fish by eating their eggs and young and competing for food sources.
- Researchers believe the round goby is linked to outbreaks of botulism type E in Great Lakes fish and fish-eating birds. The disease is caused by a toxin that may be passed from zebra mussels, to goby, to birds, resulting in large die-offs of fish and birds.

4.2 Shoreline Alteration and Dredging

Shoreline hardening effectively removes nearshore habitats and degrades or even eliminates connections to wetland and terrestrial features along the shoreline (MNR, 2010). Further, this hardening disrupts natural nearshore coastal processes that drive erosion and sediment transport. Disruption of these processes alters the character and extent of nearshore habitat and the vegetation and habitat structure of the shoreline.

Groins alter shoreline processes like water flow and sediment transport. Structures that extend out 150 m -300 m into the lake are particularly disruptive. The east shore of Collingwood has more than 30 groins/km while the remainder of Collingwood has 1-10 groins/km (MNR, 2010). The east shore tends to have many small, single lot-based groins whereas those associated with the central shoreline, though fewer, are much larger in scale.

Low Georgian Bay water levels prior to 2014 exacerbated impacts to the nearshore zone, where many shoreline residents responded to sustained low water levels by dredging to maintain boat access. On average, much of the Collingwood shoreline has 1-10 dredging events/km; however, this increases to 11-30 events/km between Bartlett Boulevard and Collingwood Harbour (MNR, 2010). Fine materials suspended during dredging activities can bypass standard erosion and sediment controls and disperse some distance into the nearshore area. This can result in sediment plumes that extend far beyond the project area. Suspended colloidal sediments and siltation can reduce aquatic macrophyte growth by limiting sunlight penetration. As they settle out of the water column, these sediments can also affect the hatching success of fish eggs.

Maintenance practices and visitor management at Wasaga Beach pose the most significant threats to that stretch of shoreline. Of most particular concern is the practice of beach raking and detritus removal. This alters the form and function of the dynamic beachfront, inhibiting the natural growth and stabilization of dune ecosystems. Provincially and globally rare plant species and vegetation communities depend on the natural cycle of beach/dune evolution. Nationally Endangered Piping Plovers nest at Wasaga Beach, but depend almost exclusively on areas where beachfront maintenance is austere.

5.0 Conclusions

Lower Nottawasaga Bay has a highly diverse shoreline, with many plant and animal species, and vegetation communities, that are provincially, nationally, or even globally rare. These species and communities are inextricably dependent on the connections between nearshore bathymetry and substrate, topography, and shoreline dynamics. This interconnectedness is not always limited to the immediate shoreline. Including forests, coldwater streams and ancient sand dunes, these effects sometimes extend 1-2 kms or more inland, creating a hotspot for biodiversity along the Nottawasaga Bay shoreline. Such is the case with Wasaga Beach's ancient transverse and parabolic dunes, and the Silver Creek Wetland Complex at the west end of Collingwood. Neither of these communities would exist without the dynamic relationship between nearshore bathymetry, substrate, and onshore topography.

As the Nottawasaga River flows into Georgian Bay, its course and current, and their effects, are dictated by the shallow basin and wide sand plain along Wasaga Beach. The wide, flat lakebed with sand substrate is what has led to the creation of the massive inland dune system in Wasaga Beach, and continues to sustain shoreline dune building. This dynamic system of beach processes supports provincially rare dune and marsh communities along Wasaga Beach and directly supports endangered species like the Piping Plover.

The lakebed offshore from Wasaga Beach is virtually devoid of aquatic macrophytes, which is a factor of the sand substrate not being able to sustain and protect aquatic macrophyte beds. Salmonids stage for upstream migration on the sandy flats at the mouth of the Nottawasaga River, but spawning and nursery habitat along the Wasaga Beach shoreline is limited to rocky underwater points where the boulder and cobble substrate acts to reduce wave energy and supply shelter, and ambush points for feeding, thus providing the necessary protection for fish and their eggs.

The undulating coastline and shallow bays of the shoreline from Brock's Beach to Blue Shores significantly reduce wave energy impacting the shore, and provide locations where natural wetlands can take hold. These wetlands provide habitat for an array of marsh birds, along with nursery habitat for small fish. While the dozens of artificially created groins along this stretch of Nottawasaga Bay have altered the natural nearshore flow and natural processes of the shoreline, the also have significantly increased water/shore littoral contact zones and sheltered many small shoreline wetlands and their inhabitants.

From Blue Shores to Sunset Point, Collingwood Harbour and all the way to Long Point Road, reefs, shoals and islands, natural spits, anthropogenic features such as marinas, breakwalls and harbour, shoreline materials and underwater substrates create diverse structural habitats and have tremendous impact on the biodiversity of the shoreline and nearshore zones of Nottawasaga Bay. Boulders, cobbles, and gravel reduce wave energy and provide spawning and nursery habitat for many fish species. The limestone bedrock shoals have been worn through thousands of years of wave action, creating a substrate with a wide range of depths and contours, providing habitat for a variety species. The bedrock shoals and natural topography of the area has allowed the creation of Collingwood Harbour, Hen and Chicken Island, West Bay, Lighthouse Bay and more. The west Collingwood Islands, which provide so much protection for mainland shoreline communities, are themselves built up on the bedrock shoals. While the islands protect areas closer to shore from the effects of Georgian Bay waves, they are also very significant in their own right for the colonial bird nesting sites and fish spawning opportunities they provide.

The “Mapping of Dynamic Beach, Flood Hazard Limit, Nearshore Bathymetry and Biodiversity for the Wasaga Beach and Collingwood Shoreline” project has shown that nearshore bathymetry and lake-bottom substrate are intimately connected with many components of nearshore and shoreline biodiversity. Bathymetry, substrate, and shoreline dynamics provide critical support for a range of biodiversity elements along the Nottawasaga Bay shoreline, as well as inland from the shore.

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