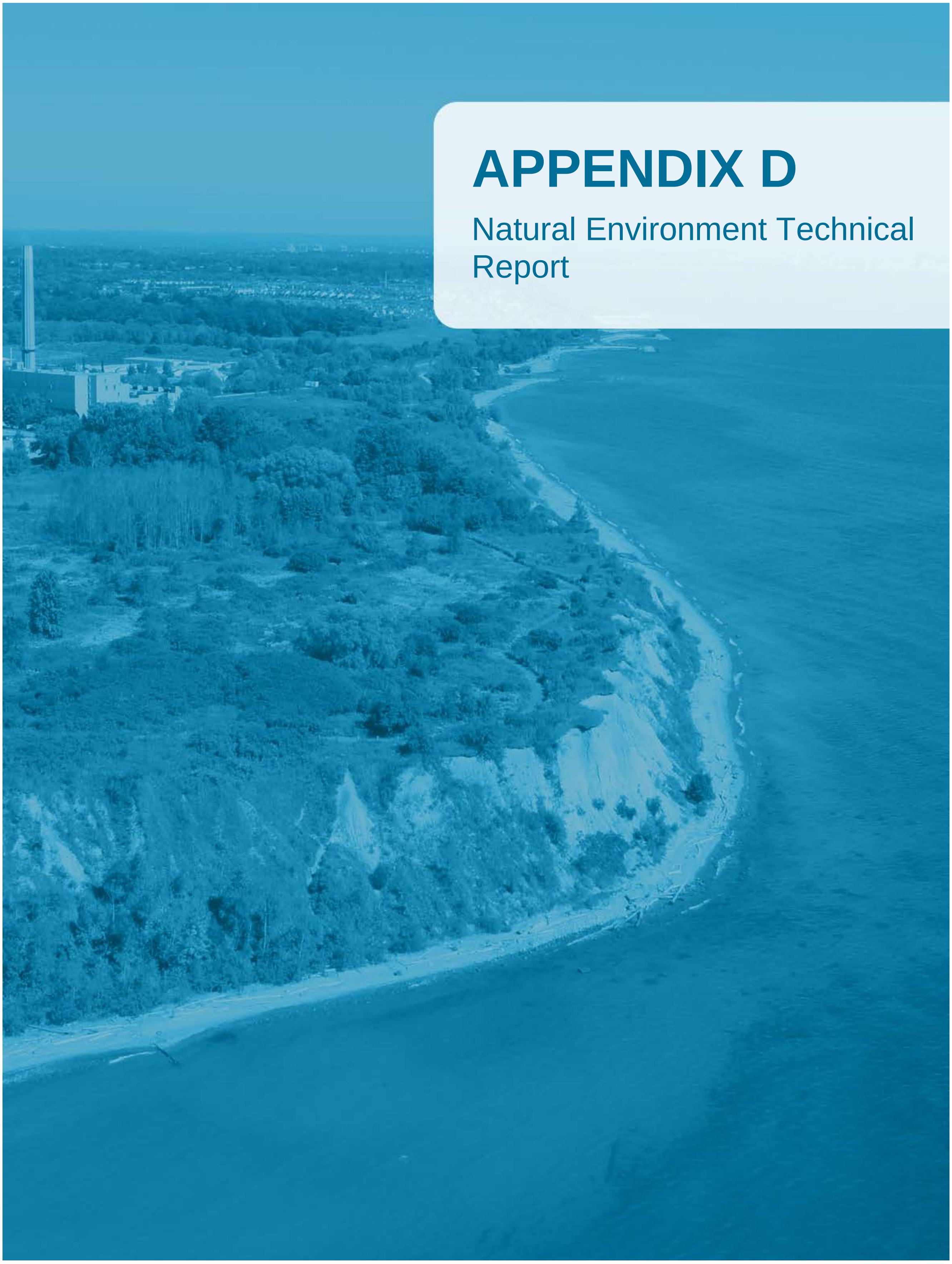
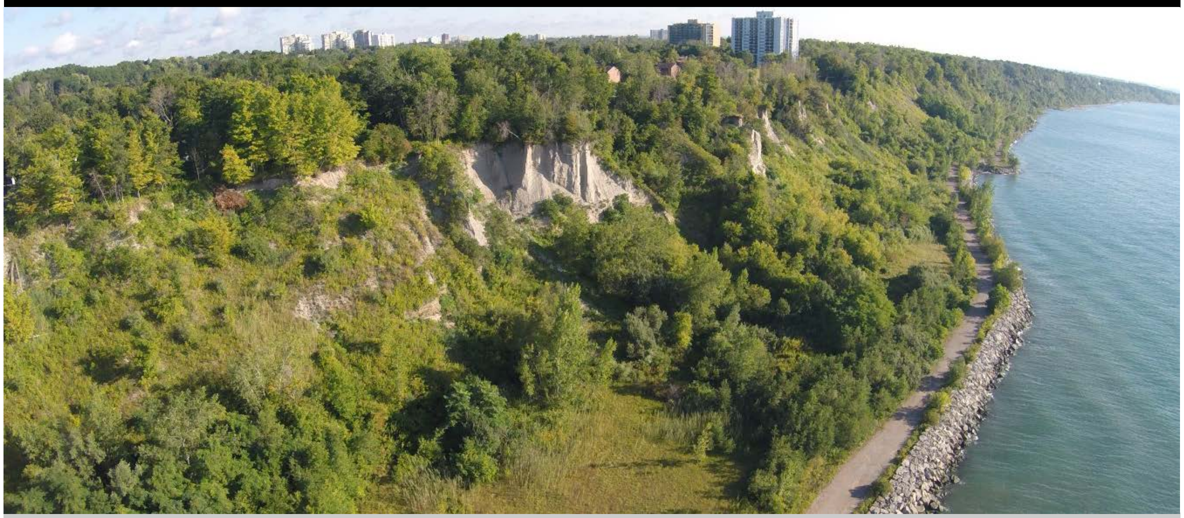


APPENDIX D

Natural Environment Technical Report



Scarborough Waterfront Project Environmental Assessment

Natural Environment Technical Report

Final Report – January 2018

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1. Introduction

1.1 Project Description

Toronto and Region Conservation Authority (TRCA), in partnership with the City of Toronto, is proceeding with an Environmental Assessment (EA) for the Scarborough Waterfront Project (SWP), from Bluffer's Park east to East Point Park in the City of Toronto. This section of the Scarborough waterfront has been the subject of many studies seeking to understand stressors on the ecosystem, public access issues, and the nature of public safety and property risks posed by shoreline erosion. While the Scarborough Bluffs are an iconic feature of the Lake Ontario shoreline, due to limited public access and existing public safety hazards, the water's edge along this section of the waterfront (or shoreline)[1] is not formally accessible to the public. Ultimately, the SWP has the potential to provide formal public access along a currently inaccessible area of the Scarborough waterfront between Bluffer's Park and East Point Park, while comprehensively addressing the risks to public safety and public property and enhancing the natural heritage system.

The City of Toronto's Official Plan and TRCA's Living City Policies are guiding planning documents for the SWP, which recognize the need to balance waterfront revitalization and public access with natural heritage and natural hazard protection and management. There is no formal public access along the shoreline between Bluffer's Park and East Point Park (approximately 11 km), as a result of the steep grades, public safety risks due to ongoing shoreline erosion and crest migration, private property, and restricted access associated with critical public infrastructure. TRCA's Living City Policies recognize that public ownership of waterfront lands is a key means of managing natural hazards while providing accessible open space integrated with opportunities for public enjoyment, and aquatic and terrestrial enhancements. The City of Toronto Official Plan recognizes that over time, lands along the water's edge should become part of a network of publicly accessible open spaces offering a range of leisure activities connected by a contiguous Waterfront Trail. Policies in the Official Plan support actions that will improve, preserve and enhance these lands by improving public access and enjoyment of lands under public ownership; maintaining and increasing public access to privately owned lands, where appropriate; and restoring, creating and protecting a variety of landscapes (Section 2.3.2 and Policy 2.3.2.1). TRCA's Living City Policies further supports this framework, and lays out a strategic direction for "*preventing, eliminating, or reducing the risk of flood and erosion hazards to life and property (Section 7.2.4, Policy a)"* and "*promoting an integrated approach to revitalization of the waterfront (Section 7.2.4, Policy b)"* through "*increased public access, recreational opportunities and continuous trail system (Section 7.2.4, Policy b.i)";* while enhancing the terrestrial and aquatic natural habitats of the shoreline.

The SWP is being planned using a rational comprehensive planning approach to resolve the remaining access, safety and habitat integrity issues between Bluffer's Park and East Point Park in an integrated manner such that the needs of the ecosystem and the residents of the City of Toronto may be met. Project planning is being undertaken in accordance with the requirements of the Ontario

1. Note that the terms "waterfront" and "shoreline" are used interchangeably in this report and include both the top and toe of the Bluff. The term "water's edge" refers to the area along the toe of the bluff only.

Environmental Assessment Act as an Individual Environmental Assessment (EA). This report is an Appendix to the EA and informs the planning and decision making documented in the EA.

1.2 Project Areas

For the purposes of the Project, three Project Areas were considered: the Project Area; the Project Study Area; and Regional Project Areas.

1.2.1 Project Area

Project works (e.g. development of Alternatives, or physical works) were focused along the shoreline area, including both the toe and top of the Bluffs, and include any identified access routes. This area is referred to as the Project Area (**Figure 1**). To help facilitate the Alternatives development and evaluation process, the Project Area has been divided into three Shoreline Segments, recognizing the distinct characteristics along each Shoreline Segment:

1. **West Segment: Bluffer's Park to Meadowcliffe**: Bluffer's Park is located at the foot of Brimley Road and provides a range of active and passive recreational opportunities. A sand beach extends along the eastern portion of the Segment, almost to the Meadowcliffe Drive Erosion Control Project to the east.

2. **Central Segment: Meadowcliffe to Grey Abbey**: Shoreline protection works exist along the length of this Segment. There is no formal public access along the base of the Bluffs.

3. **East Segment: Grey Abbey to East Point Park/Highland Creek**: While some shoreline protection works exist, the majority of the shoreline consists of a sandy shoreline, a cohesive profile overlain by a veneer of sand. East Point Park is located along the tablelands near the eastern portion of the Segment and provides a range of active and passive recreational opportunities.

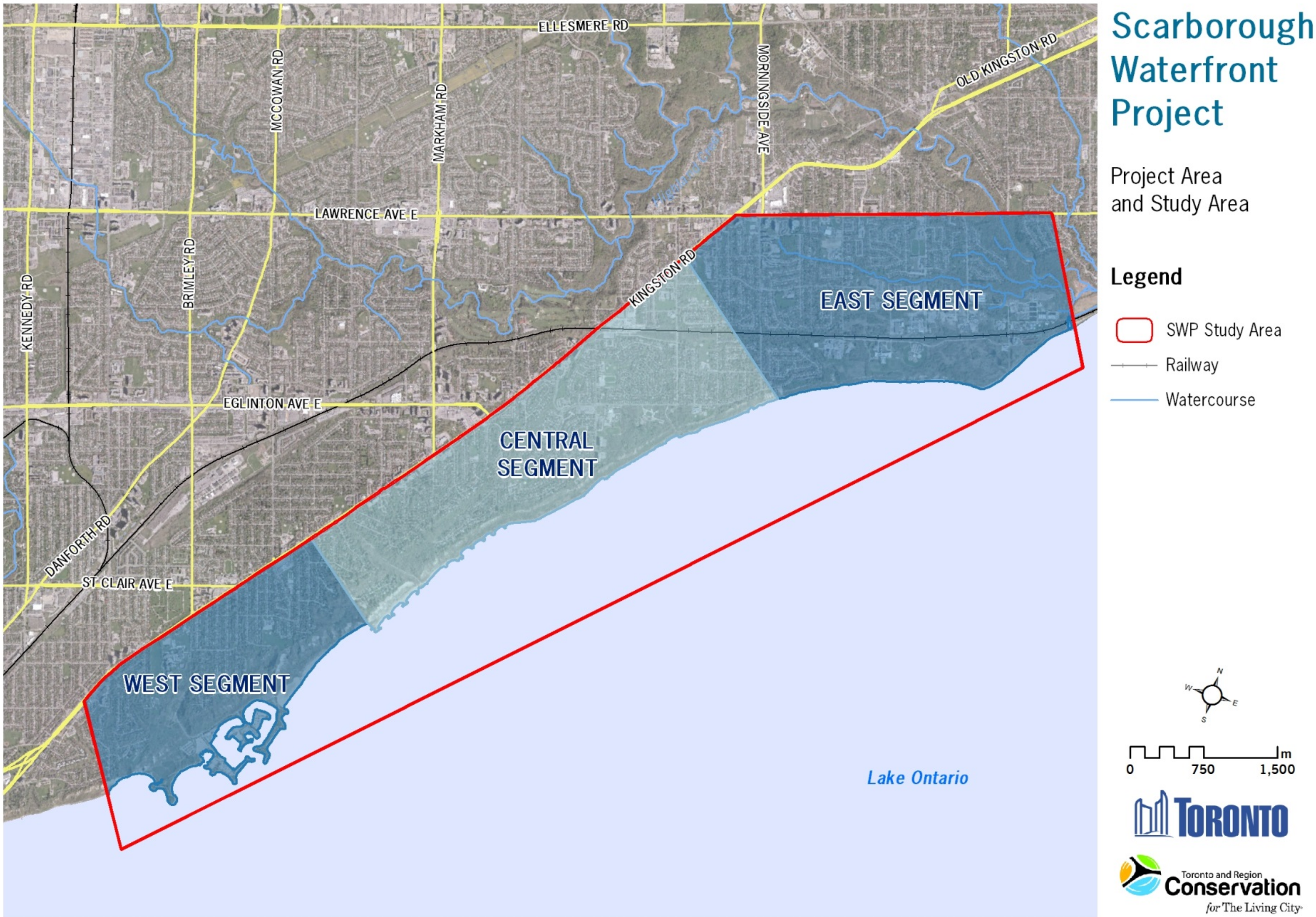
1.2.2 Project Study Area

The Project Study Area (**Figure 1**) denotes the area where potential project effects have been assessed for many of the technical disciplines. The Project Study Area extends along the Lake Ontario shoreline from Bluffer's Park in the west to the mouth of the Highland Creek in the east (approximately 11 km in length). The northerly boundary is Kingston Road/Lawrence Avenue and the southern boundary is Lake Ontario to a maximum of 1 km offshore. This Project Study Area includes the access routes and any potential effects to adjacent communities.

1.2.3 Regional Project Areas

For certain technical disciplines, larger "Regional Project Areas" were used to identify and assess potential effects at the appropriate scale (i.e. sediment transport and coastal processes, water quality modelling, socio-economic assessment, archaeology).

Figure 1: Project Area and Study Area



2. Baseline Environmental Conditions

2.1 Historical Context

This section describes some key human induced historic activities that occurred in the 19th and 20th centuries and how they influenced the diversity and character of aquatic and terrestrial natural communities. A brief summary and timeline, based on a variety of sources, are presented below. Please note that the dates/date periods are approximate and not all information could be verified.

First half of 19th Century (1800 - 1850)	▪ The area now known as Scarborough is beginning to receive European settlers. Though settlements are sparse, saw- and grist-mills are fairly abundant, indicating availability of suitable timber stands. White pine was considered particularly commercially valuable for its use as ship masts, and later, sawn timber. ▪ Stonehooking ships are built at mouths of Highland Creek and other streams in the area. Stone, gravel and shale are gathered from the nearshore waters of the lake and traded. ▪ Goods such as ashes, potash, grain, cordwood and apples are produced and traded, indicating rural agricultural community development (associated with clearing of forests etc.).
Second half of 19th Century (1850s - 1900s)	▪ Saw- and grist-mills decline – few significant stands of timber are left. ▪ Stonehooking still ongoing. ▪ Beginning of Scarborough shoreline conversion to summer residences and private parks in the late 19th Century.
Early 20th Century (Pre-World War II)	▪ More cottages and private parks appear. Some private parks include pavilions, trails, manicured grounds and entertainment (dance halls, concert stages) ▪ Suburbanization is taking place, but at a pace much slower than that of Toronto's downtown. Though much of the land is subdivided into lots, development is sporadic.
Post-World War II (1950s - 1970s)	▪ Post-war conditions (population increase, housing shortage) result in intensified development. Over the course of a decade (1950s – 1960s), population increases almost four-fold from approximately 56,000 to approximately 217,000. Farm fields and some natural areas are converted into subdivisions. ▪ Steep conditions restricted development along some shoreline areas, much like steep ravines did in the inner parts of the city. These areas remain natural, though still well-used, today.
1970s - Present Day	▪ Urbanization is largely complete. ▪ First major shoreline project – Bluffer's Park – is completed between 1975 and 1985. ▪ Early protection works (1990s) – South Marine and Guildwood Parkway – are linear and consist of rubble and construction debris. ▪ Subsequent protection works (2000s) – Sylvan and Meadowcliffe – were designed as headland beach systems, which provide excellent fish habitat restoration opportunities.

2.2 Terrestrial Habitat

2.2.1 Study Methodology

To assess and monitor the condition of the natural system the TRCA gathers information about the region through two main survey methods: remote-sensing (patch level data collected from the air by plane or satellite and interpreted on desk top) and field data collection (vegetation community and species data collected from the ground). Field data collection occurs in two ways, through systematic inventories and through fixed sites (TRCA, 2007a).

A biological inventory of the Project Area was conducted at the levels of habitat patch (landscape analysis), vegetation community, and species (flora and fauna) according to the TRCA methodologies for landscape evaluation and field data collection. Habitat patch mapping was excerpted from the regional 2007/08 mapping of broadly-defined patch categories (forest, wetland, meadow and coastal) and digitized using ArcView GIS software (TRCA, 2007a).

2.2.1.1 Desktop Study

Natural cover data in the TRCA jurisdiction is captured using digital ortho-rectified aerial photography at a scale of 1:4000. This data is collected as a shape file using Geographical Information System (GIS) software 'on screen'. All natural cover is characterized into discreet polygons of habitat patches of beach/bluff, forest, meadow, successional, and wetland; and anthropogenic cover is categorized into urban or agricultural uses. Patches are generally defined by obvious changes in habitat or land use. Main roads and wide trails are considered as boundaries to habitat patches, and a width of 25 m was used to define breaks in habitat patches, or if an obvious split in the canopy could be detected at a scale of 1:2000 on the aerial photos. Wide rivers were also considered to be separate habitat patches; where rivers or creeks created an obvious break in the canopy, polygons were divided (TRCA, 2007a).

The first step in evaluating a natural system or an individual habitat patch is to interpret and map land cover using aerial photographs. The basic unit for the evaluation at all scales is the habitat patch in the region, which are then combined and evaluated as a system at any scale. A habitat patch is a continuous piece of habitat, as determined from aerial photo interpretation. The TRCA maps habitat according to four broad categories: forest, wetland, meadow, and coastal (beach, dune, or bluff). At the regional level, the TRCA jurisdiction is made up of thousands of habitat patches. This mapping of habitat patches in broad categories is conducted through remote-sensing and is used in the evaluation of quality, distribution and quantity of natural cover. It should not be confused with the more detailed mapping of vegetation communities obtained through field surveys and that is used to ground-truth the desktop interpretation (TRCA, 2007a).

A key component of data collection and analysis is the scoring and ranking of vegetation communities and flora and fauna species to generate local "L" ranks (L1 to L5); this process was undertaken in 1996-2000 and ranks are reviewed regularly. Vegetation community scores and ranks are based on two criteria: local occurrence and the number of geophysical requirements or factors on which they depend. Flora species are scored using four criteria: local occurrence, population trend, habitat dependence, and sensitivity to impacts associated with development. Fauna species are scored based on seven criteria: local occurrence, local population trend, continent-wide population trend, habitat dependence, sensitivity to development, area-sensitivity, and patch isolation sensitivity. With the use of this ranking system, communities or species of regional concern, ranked L1 to L3, now replace the idea of rare communities or species. Rarity (local occurrence) is still considered, but is now one of many criteria that make up the L-ranks, making it possible to recognize communities or species of regional concern before they have become rare. In addition to the L1 to L3 ranked species, a large number of currently common or secure species at the regional level are considered of concern in the urban context. These are the species identified with an L-rank of L4. Although L4 species are widespread and frequently occur in relatively intact urban sites, they are vulnerable to long-term declines. Communities and species that are ranked L5 are considered to be generally secure, while a sixth rank exists – L+ – which denotes vegetation communities dominated by non-native species, or indicates a species non-native in origin (TRCA, 2007a; TRCA, 2007b).

A summary of the L-ranks and their associated definition are summarized in the table below (**Table 1**).

Table 1: L-ranks and Their Associated Level of Conservation Concern in the TRCA's Jurisdiction

Rank	Level of Conservation Concern in the TRCA Region
L1	Of regional concern.
L2	
L3	
L4	Generally secure in a rural matrix, but is of conservation concern in the urban matrix.
L5	Generally secure; may be of conservation concern in a few specific situations.
L+	A non-native species, or a community defined by non-native species.

2.2.1.2 Field Study

The system used to delineate the vegetation communities contained within the Project Area was a modified version of the Ecological Land Classification (ELC) for Southern Ontario (Lee. et al., 1998). A full ELC survey to the level of vegetation type is a very detailed and time-consuming process. The TRCA protocol for surveying vegetation communities strikes a balance between giving enough detail to provide meaningful descriptions of vegetation communities and the constraints of time and funding. For example, resources are unlikely to be available to pursue detailed soil analysis (as outlined in the ELC field guide) in every patch surveyed in the TRCA jurisdiction. Gathering detailed vegetation community data using the ELC protocol for Southern Ontario provides the information needed in order to track community diversity throughout the region, to assess community sensitivity to development and ecological needs, and to determine what that means to the health of the region. Species data are used to determine how species needs are being met in the region relative to their sensitivity to development, mobility (fauna), area-sensitivity (fauna), and habitat requirements (TRCA, 2007a).

Vegetation community and flora and fauna species data were collected through field surveys.

These surveys were done during the appropriate times of year to capture breeding status in the case of amphibians and birds, and during the optimal growing period of the various plant species and communities. Vegetation communities and flora species were surveyed concurrently (TRCA, 2007a).

Vegetation community designations were based on the ELC and determined to the level of vegetation type (Lee et al., 1998). Community boundaries were outlined onto printouts of 2007 digital ortho-rectified photographs (ortho-photos) to a scale of 1:2000 and then digitized in ArcView. Flora species of regional and urban concern (species ranked L1 to L4) were mapped as point data with the approximate number of individuals seen. A list of all other species observed was documented for the site (TRCA, 2007a).

The majority of records are drawn from the 2011 field season, augmented by flora species data collected by TRCA in fall 2000 for the City of Toronto Natural Heritage Study (City of Toronto, 2001). In addition, the flora data include incidental reports submitted by TRCA staff since 1997 and from a long-term forest vegetation monitoring plot initiated in 2008 at Cudia Park.

The most complete fauna survey of the site was conducted by the TRCA in May, June and July of 2011. The 41 ha Guild Inn site was inventoried in 2002, and any additional records from this earlier survey have been incorporated into the results for this document. Other reports have also been included from the results of the annual long-term monitoring surveys, conducted since 2008 at two stations in the Project Area (East Point Park and Cudia Park). Surveys in 2011 were concerned primarily with the mapping of breeding bird species of regional and urban concern, i.e. those ranked as L1 to L4. As per the TRCA data collection protocol, breeding bird surveys were carried out by visiting all parts of the site at least twice during the breeding season (last week of May to mid-July) to determine the breeding status of each mapped point. The methodology for identifying confirmed and possible breeding birds follows Cadman et al. (2007). All initial visits were completed by the end of the third week of June. The field-season is to be organized so that by late June only repeat visits are being conducted. It is imperative that any visit made in the first half of June is subsequently validated by a second visit later in the season. Fauna regional species of concern (species ranked L1 to L3) were mapped as point data with each point representing a possible breeding bird.

2.2.2 Project Area Terrestrial Habitat

This section focuses on characterization of the terrestrial habitat in the Project Area. Terrestrial habitat found within a few kilometres of the Lake Ontario shoreline serves an important role in supporting both resident and migratory species. With the limited natural cover that exists along the Lake Ontario shoreline, even small habitat patches in urban and urbanizing areas are of value and associated losses and/or gains have a much greater relative impact to overall ecosystem functions. Overall habitat quality within the Project Area is considered to be “fair” to “poor” (TRCA, 2012).

2.2.2.1 Terrestrial Habitat Types

Five broad groupings of natural terrestrial habitat types have been identified within the Project Area, and include: forests, wetlands, successional, meadows, and beach/bluff. Forest communities dominate the Project Area. Successional and beach/bluff communities are well represented, while wetland communities and meadow communities are present, but are not as common as the other types.

Forests

TRCA defines forest as coniferous, mixed, and deciduous forest communities including plantations and treed-swamps.

Wetlands

Wetlands are areas of land that are seasonally or permanently covered by shallow water, or lands where the water table is close to or at the surface (MNR, 2010). TRCA defines wetland communities as shallow marsh, meadow marsh, shallow aquatic ponds (where water is known to be less than 2 m deep), thicket swamps, and treed-swamps.

Successional

Successional ecosystems signify those that are undergoing a change in species structure over time, in response to a natural (e.g. wind or erosion) or anthropogenic activity (e.g. land clearing for urban development or land creation) that removed, or allowed for the establishment of, some or all of the woody vegetation from the community.

Successional communities include cultural woodlands and thickets and for the purposes of this report savannahs, given their successional characteristics in the Project Area.

Meadow

TRCA characterizes meadows as old field habitat or cultural meadows, natural tallgrass prairie, sand and/or clay barren and sometimes meadow marsh (due to remote sensing challenges) are included in this category.

Beach/Bluff

Beach or bluff communities are natural barren coastal habitats not corresponding to other habitat types. They include beach/sand shorelines, coastal dunes and bluffs.

2.2.2.2 Vegetation Communities

Vegetation communities are identified and delineated according to a modified version of the ELC for Southern Ontario (Lee et al., 1998). TRCA's Terrestrial Natural Heritage System Strategy (TRCA, 2007b) provides a ranking system consisting of five ranks – L1 to L5 – where each rank reflects a level of conservation concern and status of a given vegetation community, flora or fauna species in TRCA's jurisdiction. Vegetation communities and species ranked L1 to L3 are considered to be of regional conservation concern and, if present, are noted below. Vegetation communities and species that are ranked L4 are considered to be of urban concern, while vegetation communities and species that are ranked L5 are considered to be generally secure. A sixth rank exists – L+ – which denotes vegetation communities dominated by non-native species, or indicates a species non-native in origin. The distribution of L+ vegetation communities is indicated in **Figure 3, Figure 5,** and **Figure 7**, but is not included the summary table (**Table 2**) or discussion below.

2.2.2.2.1 Project Area

A total of 98 distinct vegetation communities have been recorded in the Project Area as of 2011 (**Appendix A**). **Figure 2** to **Figure 7** illustrate their distribution across the Project Area and into the Project Study Area. This is considered to be a fairly high number for an urban area; however, approximately 30% of these communities are dominated by invasive and/or exotic (non-native) species that are anthropogenic in origin. All land receives an ELC classification, therefore land-units, such as manicured lawns and hedgerows, can also be included as part of the overall vegetation community count.

Broad community types recorded include forest (including plantations), wetland, successional (savannahs, thickets, woodlands, and hedgerows), meadow (including prairies and barren) and dynamic (bluff, beach and dune).

Table 2: Summary of Vegetation Communities, Ranked L1 to L5, Within the Project Area Segments

Vegetation Community Class	West Segment		Central Segment		East Segment	
	Number of Types	Area (ha)	Number of Types	Area (ha)	Number of Types	Area (ha)
Forest	26	46.5	25	41.5	9	17.2
Wetlands	4	6.0	7	10.8	14	4.8
Successional	6	11.1	11	19.0	10	14.5
Meadow	3	1.6	2	1.6	8	15.8
Beach/Bluff	11	31.3	8	22.5	10	14.5
Total	**50**	**96.5**	**53**	**95.4**	**51**	**66.8**

2.2.2.2.2 Forests Communities

Forest ELC community types are the most dominant vegetation type within the Project Area occupying a total area of approximately 105.2 ha. Forest cover here is connected along an often very narrow corridor via the Lake Ontario shoreline. The forests in the Project Area are similar to those in other urbanized areas in that they contain a significant component of non-native vegetation. Exotic species are extremely abundant in the Project Study Area as a whole, comprising up to 45% of recorded plant species (TRCA, 2012). Vegetation communities that are dominated by ash trees (*Fraxinus* sp.) are notably in decline due to the invasion of the Emerald Ash Borer (*Agrilus planipennis)*, which kills all species of this genus.

Figure 2: Vegetation Community Types within West Segment

Figure 3: Vegetation Community by L-Rank within West Segment

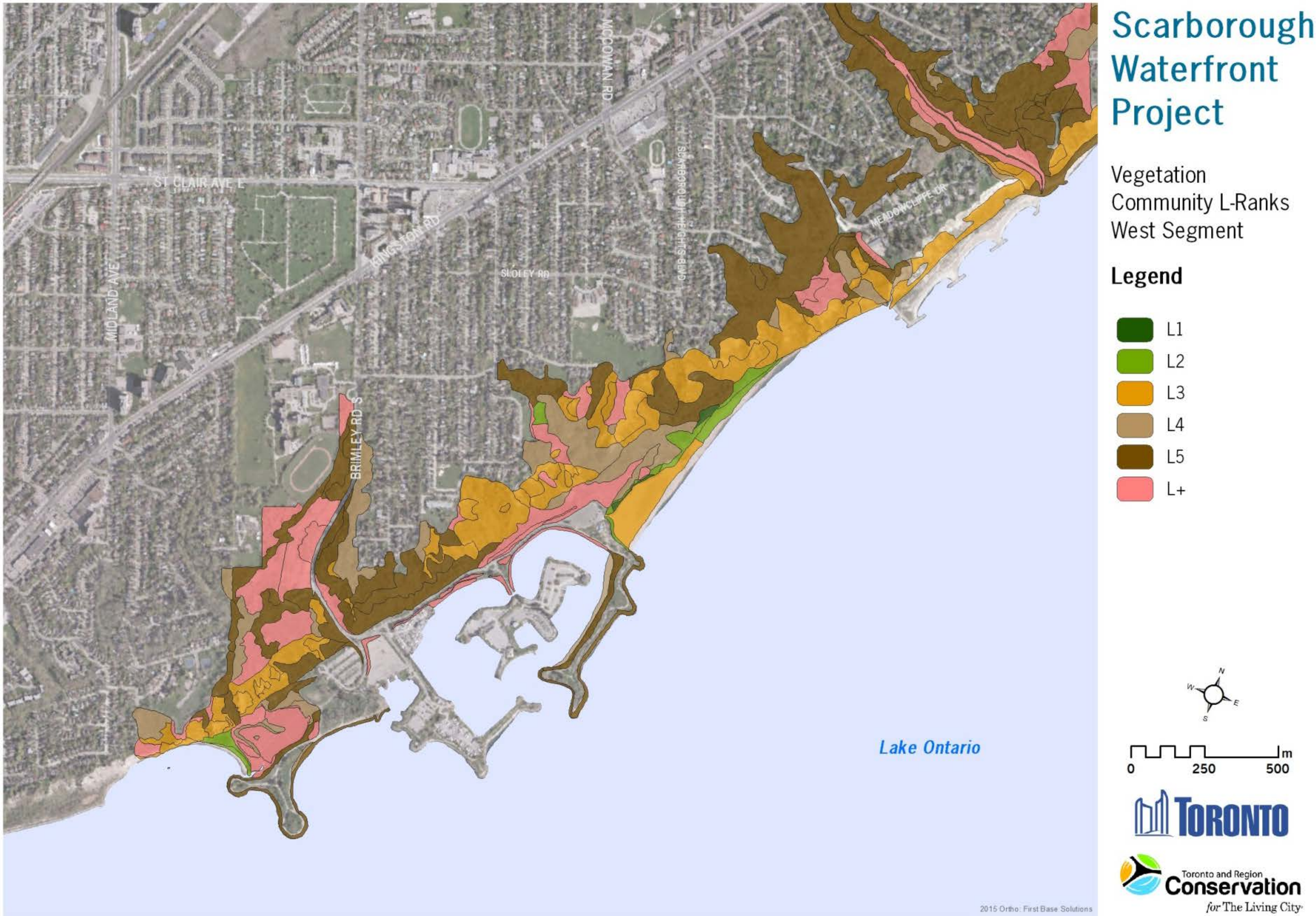


Figure 4: Vegetation Community Types within Central Segment

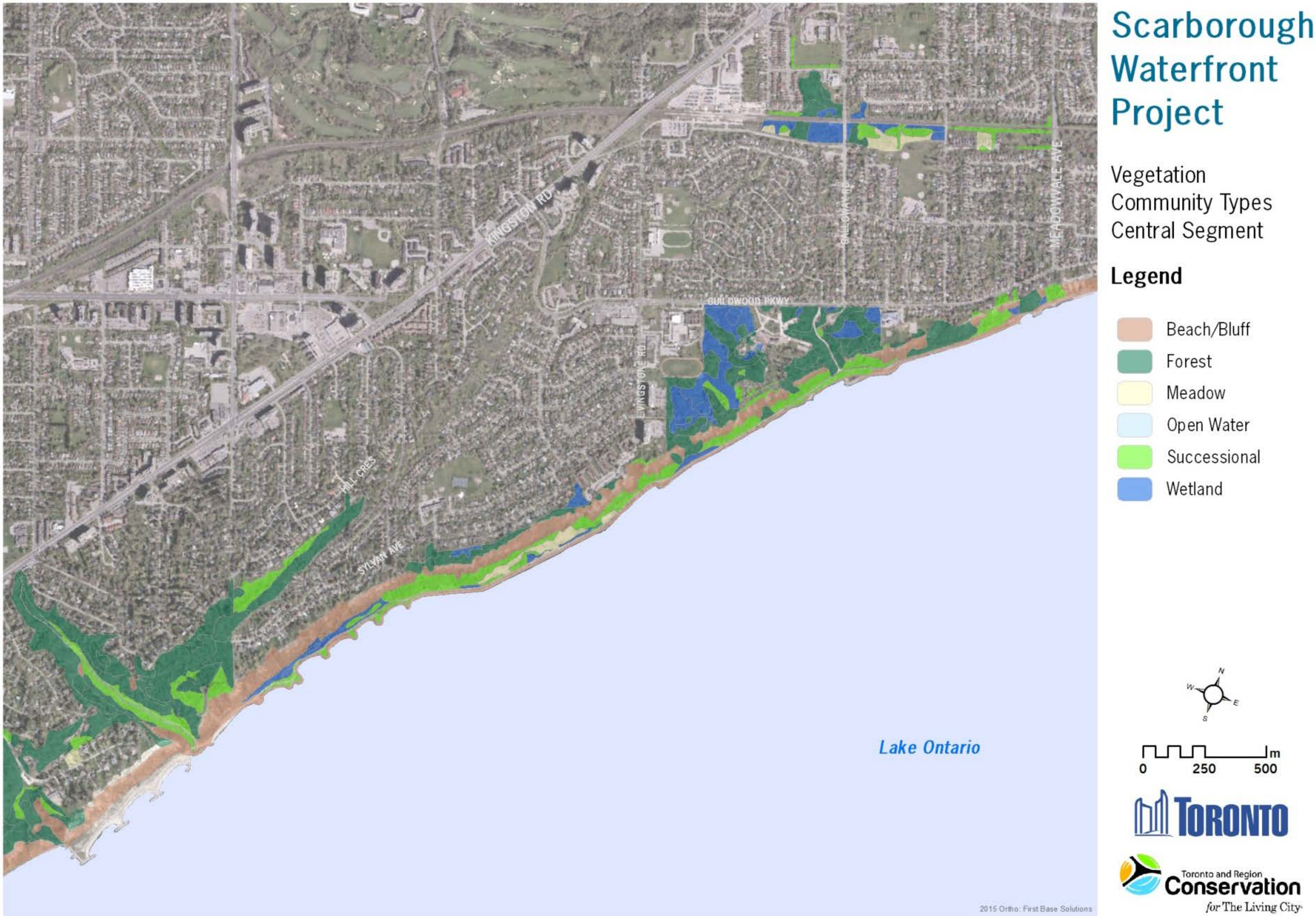


Figure 5: Vegetation Community by L-Rank within Central Segment

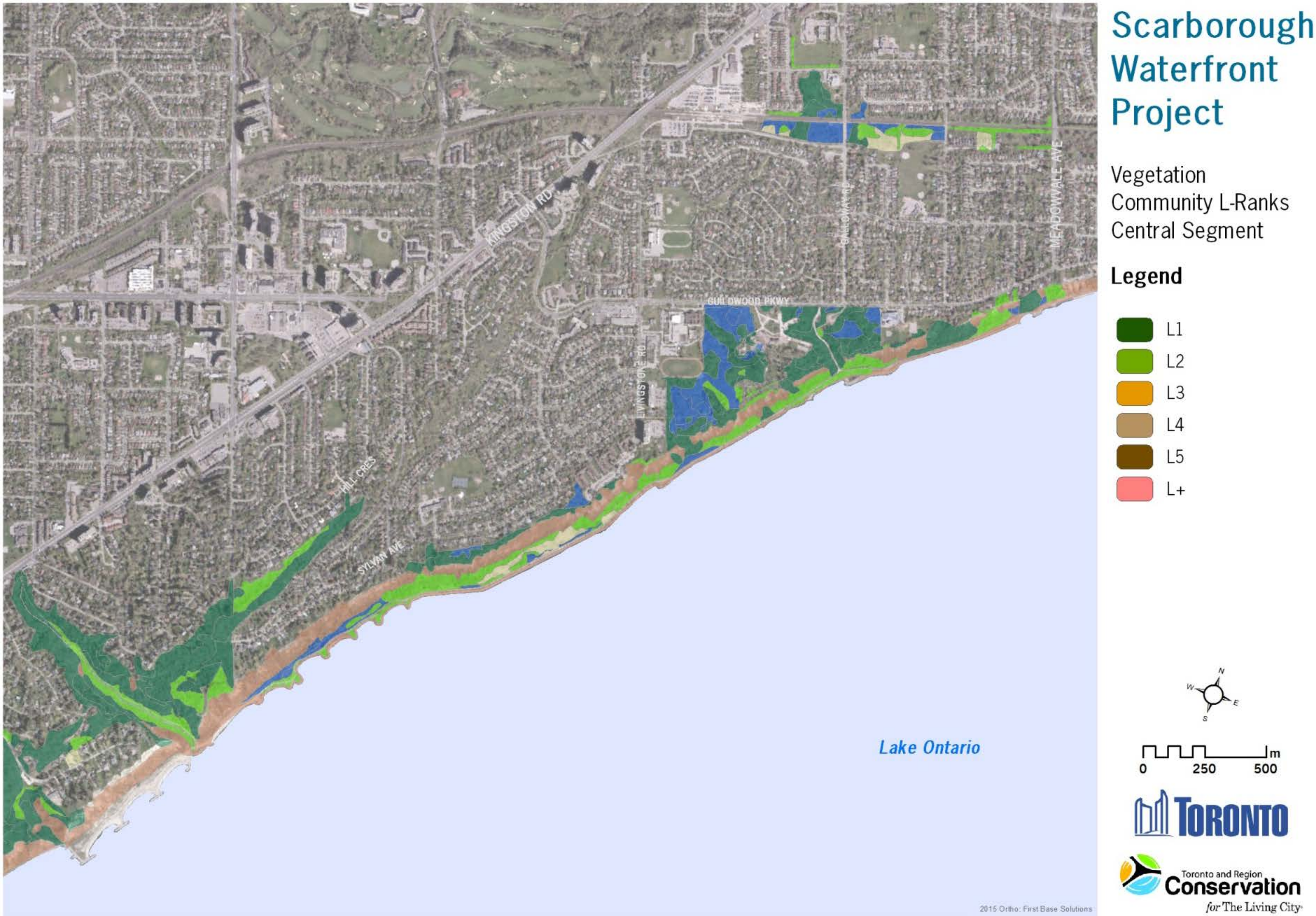


Figure 6: Vegetation Community Types within East Segment

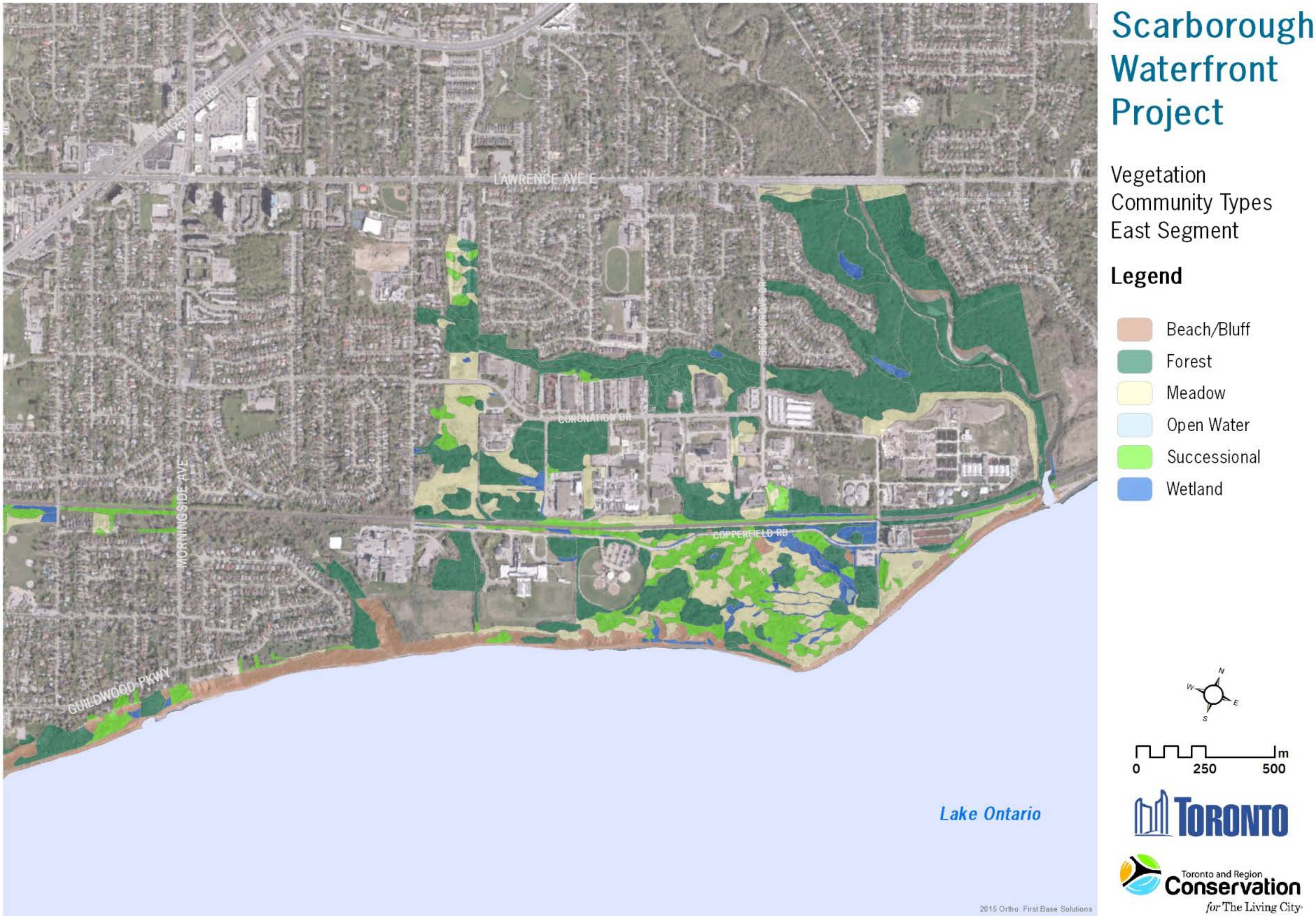
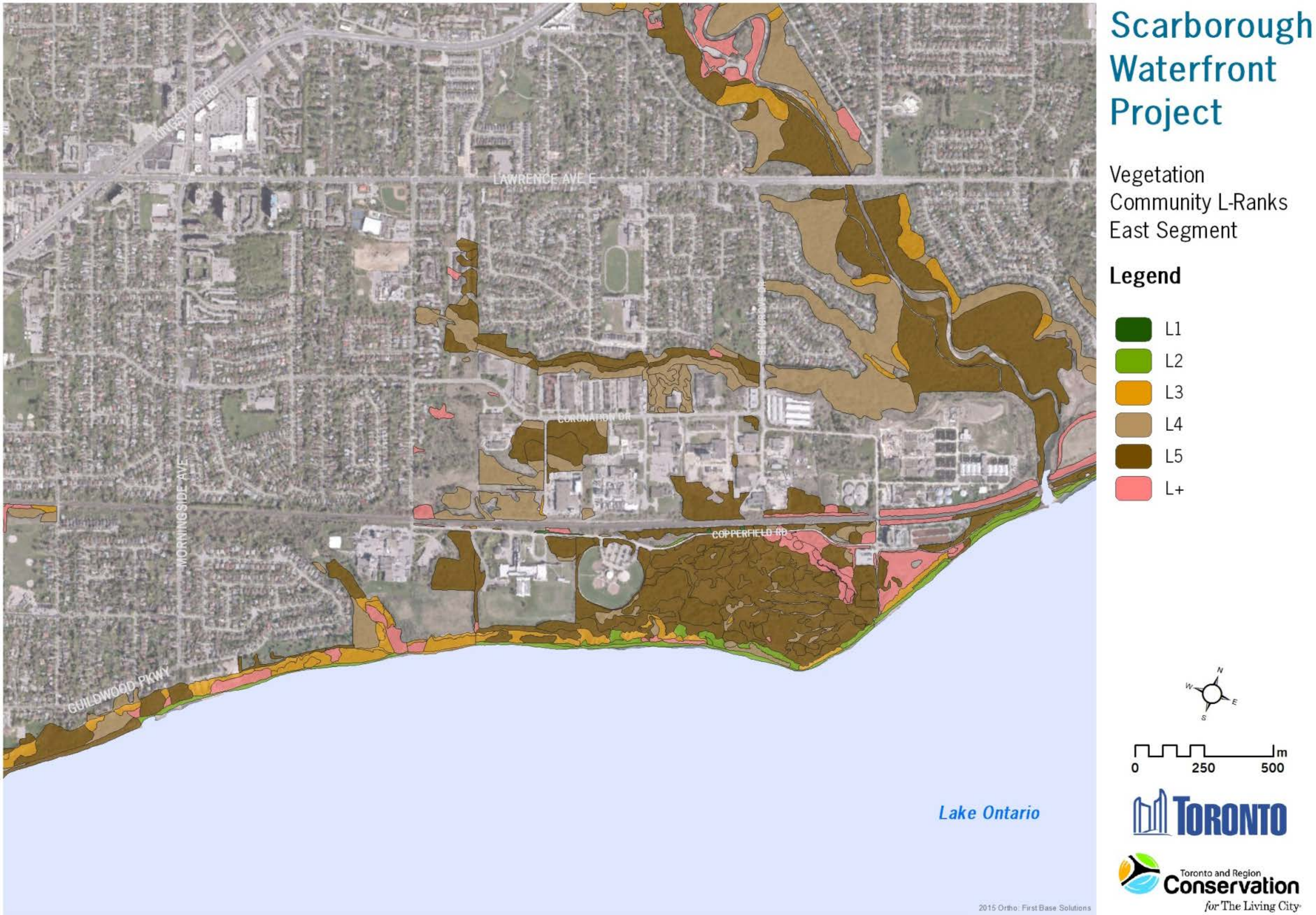


Figure 7: Vegetation Community by L-Rank within East Segment



Human disturbances related to off-trail uses are evident where there is reduced regeneration and forest understory structure. Informal trails lead to vegetation trampling, increase native communities' susceptibility to invasive species spread, and damage sensitive soils through compaction and erosion. Soil compaction and erosion is especially pronounced in those areas along the Bluffs which are informally used by the public to access the base of the Bluffs/shoreline from the tablelands and vice versa. Bluffer's Park and East Point Park exhibit the highest levels of trampling, while areas with access limitations such as fencing (e.g., at Guild Park and Gardens) have no to low levels of trampling.

West Segment

The West Segment is dominated by forest ELC community types, of which the most prevalent type is Dry-Fresh Sugar Maple-Beech Deciduous Forest (FOD5-2) (L5), a secure community type in terms of conservation concern. This mature forest is associated with stable slopes and in the ravines of Cudia Park and Brimley Road at approximately 18 ha. In addition to this community, a combined total of 25 other forest communities are present in the West Segment including the regionally significant Dry-Fresh Hickory Deciduous Forest (FOD2-3) (L3) at approximately 0.29 ha and the provincially notable Dry-Fresh Oak-Hardwood Deciduous Forest (FOD2-4) (L4) at approximately 0.43 ha, present at Cudia Park and Sylvan Park.

Central Segment

The Central Segment is also dominated by Dry-Fresh Sugar Maple-Beech Deciduous Forest (FOD5-2) (L5) at approximately 6.7 ha. A total of 24 other forest ELC community types are present in the Central Segment including one community of regional conservation concern, Fresh-Moist Ash Mixed Forest (FOM8-B) (L3) at approximately 0.44 ha, which is located within the Guild Park and Gardens area and is in decline due to the Emerald Ash Borer invasion.

East Segment

In contrast to the other Segments, the East Segment only contains nine forest ELC community types occupying a total of 17.2 ha. The Fresh-Moist Poplar Deciduous Forest (FOD8-1) (L5) is the largest community type with a total of 12.1 ha. Three L4 communities are present within this Segment and include Dry-Fresh Oak-Hardwood Deciduous Forest (FOD2-4) (L4), Fresh-Moist Paper Birch Deciduous Forest (FOD8-B) and Silver Maple-Conifer Mixed Plantation, occupying a combined total of 2.7 ha. No other forest communities of regional conservation concern are located within this Segment.

2.2.2.2.3 Wetland Communities

Wetland communities occupy a total area of 21.6 ha within the Project Area and are dominated by swamps and marshes. Wetlands in the Project Area are typical of those in urban areas, threatened by invasive species such as common reed (*Phragmites australis*) and fragmentation due to human disturbance.

West Segment

The dominant wetland ELC community type within the West Segment is the Common Reed Mineral Meadow Marsh (MAM2-a) (L4), an exotic community occupying 2.7 ha. Three other wetland communities are also found within this Segment, and are primarily situated along the backshore area of Bluffer's Park Beach totalling an area of 3.3 ha. These communities were restored by TRCA between 2008 and 2009, and contribute in part to the improvement in water quality at the Bluffer's Park Blue Flag Beach. No wetlands in this Segment are of regional conservation concern.

Heavy informal use has been observed through this backshore area, subjecting the flora within these communities to trampling. This may ultimately result in the loss of sensitive wetland flora species or in the reduction of overall wetland vegetation community quality.

Central Segment

The Central Segment contains seven wetland ELC community types that occupy 10.8 ha and includes tableland swamps that are rare in the City of Toronto. The dominant community within this category is the rare tableland Red (Green) Ash Mineral Deciduous Swamp (SWD2-2) (L4), a community of urban conservation concern that is found in several locations, including the Guild Park and Gardens area, and occupies a total of 6.0 ha. This community includes the only known example of Red Ash-Hemlock Mineral Mixed Swamp in TRCA jurisdiction. Unfortunately, it is rapidly declining due to the Emerald Ash Borer invasion. An artificially-created wetland at the base of the Guild construction access route was present at the time of the biological inventory, in association with previous shoreline works. In subsequent years, wetland vegetation began to colonize the feature. No wetland communities of regional conservation concern are located within the Central Segment.

East Segment

A total of 14 wetland ELC community types occupying a total area of 4.8 ha have been recorded in the East Segment on the tablelands. The wetland community is dominated by Narrow-leaved Cattail Mineral Shallow Marsh (MAS2-1b) (L5), an exotic community composing a total land area of 1.2 ha. Two fen and two marsh communities of regional concern are found here, and include Willow Shrub Mineral Fen (FES2-A) (L2), Mineral Fen Meadow Marsh (MAM5-1) (L2), Horsetail Mineral Meadow Marsh (MAM2-7) (L3), and Bur-reed Mineral Shallow Marsh (MAS2-7) (L3).

2.2.2.2.4 Successional Communities

Successional communities within the Project Area are the second most dominant type of vegetation cover (44.6 ha) and include thicket, woodland, savannah, and hedgerow community types. Similar to forest and wetland ELC community types within the Project Area, successional communities are threatened by unmanaged public use that fragments habitats and exacerbates invasive species problems.

West Segment

In the West Segment successional ELC community types are represented by a total of six communities ranging from savannah communities (1.3 ha) to thickets (5.8 ha) and woodlands (4.0 ha). The most dominant community within this broader category is the Native Deciduous Successional Woodland (CUW1-A3) (L5), occupying 4.0 ha. No successional communities of regional concern are present in this Segment.

Central Segment

A total of 11 successional ELC community types are present in the Central Segment, dominated by woodland communities (9.1 ha), followed by thicket (7.5 ha) and savannah communities (2.2 ha), as well as a small hedgerow community (0.1 ha). The Native Deciduous Successional Woodland (CUW1-A3) is the largest of these communities, totalling 4.8 ha. No successional communities of regional concern are present in this Segment.

East Segment

Six thicket communities occupy the largest area (11.7 ha) of successional ELC community types in the East Segment, including a small 0.05 ha community of regional conservation concern, Ninebark Planted Deciduous Thicket (CUT1-H) (L3). The dominant community is the Red Osier Dogwood Deciduous Thicket (CUT1-E) (L5), a generally secure community, which is found in multiple locations and totals 9.8 ha. The balance of successional vegetation communities are woodland (1.3 ha), savannah (1.0 ha) and hedgerow (0.4 ha).

2.2.2.2.5 Meadow Communities

Meadow ELC community types within the Project Area occupy the least amount of area at 18.8 ha. Since most of the Project Area has had several decades of natural succession since urbanization eliminated agriculture, meadow communities are decreasing as woody species take hold. Most meadow communities in the Project Area have a high proportion of native species; however, these communities are threatened by non-native species invasion.

West Segment

Three meadow ELC community types are present in the West Segment, totalling 1.6 ha. The Exotic Forb Meadow (CUM1-c) (L5) dominates this category at 0.7 ha. There are no meadow communities of regional conservation concern located in this Segment.

Central Segment

Two generally secure meadow ELC community types are present within this Segment: a Native Forb Meadow (CUM1-A) (L5) occupies 1.4 ha, while an Exotic Cool-season Grass Graminoid Meadow (CUM1-b) (L5) totals 0.2 ha.

East Segment

Meadow communities are the second most dominant ELC community type in the East Segment representing a total area of 15.8 ha and being composed of eight communities, including barren communities. The Native Forb Meadow (CUM1-A) (L5) occupies the largest area within the East Segment and is found in numerous locations throughout the Segment, with a total area of 12.1 ha. Local meadow and prairie communities, particularly one jurisdictionally rare prairie community, Fresh-Moist Tallgrass Prairie (TPO2-1) (L1) (found north of Copperfield Road), support a small number of prairie species that are unusual for TRCA jurisdiction. Many of the meadow communities in the East Segment are fragmented by a network of informal trails, resulting in the degradation of the vegetation quality.

East Point Park contains the only barren ELC community types found within the Project Area; the three barren communities make up a total land area of 0.3 ha. Two of the barren communities are considered of regional conservation concern: Shrub Clay Barren (CBS1) (L2) and White Cedar Low Treed Clay Barren (CBT1-A) (L2).

2.2.2.2.6 Beach/Bluff Communities

The beach, shoreline and bluff ELC community types are among the most notable within the Project Area. Communities range from actively eroding and/or influenced by coastal processes with sparse vegetation to partly stabilized with varying amounts of native and exotic vegetation.

It should be noted that both dynamic sand beach and cohesive shorelines, as defined in the Coastal Report (Appendix C of the EA) and in Section 3.1.8.4 of Chapter 3 of the EA, are encompassed within the broader beach/bar (BBO) ELC community land-unit. Using the ELC system, community types are defined by a variety of characteristics, including surficial geology and soil depth, texture, moisture regime, nutrient regime, and drainage patterns, along with the structure (e.g., degree of cover) and species composition of the vegetation community (Lee et al., 1998).

West Segment

Within the West Segment, bluff ELC community types are the second most dominant vegetation community type overall, totalling 24.5 ha. Four of the five bluff communities are considered of regional conservation concern. Sumac-Willow-Cherry Shrub Bluff (BLS1-A) (L3) is the largest bluff ELC community type found, totalling 10.2 ha. The greatest proportion of this community has been observed along the vegetated section of the Bluffs protected by Bluffer's Park Beach, with smaller patches situated on the Bluffs below Cudia Park. The other communities of regional conservation concern are Deciduous Treed Bluff (BLT1-B) (L3), Mineral Shrub Bluff (BLS1) (L3) and Serviceberry-Buffaloberry Shrub Bluff (BLS1-B) (L2). One bluff community of urban conservation concern also exists in this Segment – Mineral Open Bluff (L4).

A total of six beach and dune ELC community types occupy an area of 6.8 ha within this Segment, largely at or near the shoreline at Bluffer's Park. As noted in the Coastal Report (Appendix C of the EA) and in Section 8.1.8.4 of the EA, the Bluffer's Park Beach is the only fully developed dynamic sand beach along the shoreline within the Project Area. This is due to a deep enough sand profile that is not all fully mobilized during storm conditions, and there is no erosion of the substrate below the overlying sand. Bluffer's Park Beach consists of several beach and dune ELC community types, the largest being the Mineral Open Beach (BBO-1) (L3), a community of regional concern at 3.0 ha. The Switchgrass - Beachgrass - (Little Bluestem) Open Sand Dune (SDO1-1) (L1) and Sea Rocket Open Sand Beach (BBO1-1) (L2) are considered provincially rare and of regional conservation concern, and were established as part of TRCA's restoration efforts in 2009 to 2010. Willow Shrub Beach (BBS1-2A) (L2) and Willow Shrub Sand Dune (SDS1-A) (L3) are also considered of regional conservation concern. The dune habitats on the east side of Bluffer's Park Beach, in particular, have been bisected by informal trails resulting from unmanaged public use.

Central Segment

The Central Segment contains four bluff ELC community types, including the Sumac-Willow-Cherry Shrub Bluff (BLS1-A) (L3), a community of regional conservation concern, which dominates this Segment at 10.9 ha. Two other bluff communities of regional conservation concern are present, Deciduous Treed Bluff (BLT1-B) (L3) and Exotic Treed Bluff (BLT1-c) (L3), along with one community of urban conservation of concern, Mineral Open Bluff (L4).

Four beach ELC community types are present, totalling 5.8 ha. Rubble Open Shoreline (BBO2-A) (L4), created as a result of the past shoreline erosion control efforts, occupies the largest area (4.0 ha) along the existing South Marine Drive, Guild Park and Gardens and Guildwood Parkway shoreline in the form of an armourstone revetment. Willow Shrub Beach (BBS1-2A) (L2) and Mineral Treed Beach (BBT1-A) (L3) are two communities of regional conservation concern found near the south-western end of the Segment.

East Segment

Five bluff ELC community types occupy a total land area of 10.0 ha in East Segment; the regionally rare Sumac-Willow-Cherry Shrub Bluff community remains the most dominant, although in much smaller proportions relative to the West and Central Segments at 4.4 ha. Three other bluff communities of regional concern are also found in the East Segment – Serviceberry-Buffaloberry Shrub Bluff (BLS1-B) (L2), Deciduous Treed Bluff (BLT1-B) (L3), and Exotic Treed Bluff (BLT1-C) (L3) – as well as one bluff community of urban conservation concern, Open Mineral Bluff (L4).

Five beach and dune ELC community types are present, totalling 4.5 ha along the existing cohesive sand shoreline in the East Segment. The greatest proportion (3.3 ha) of the provincially rare community of regional conservation concern, Sea Rocket Open Sand Beach (BBO1-1) (L2), is found between Grey Abbey Park and East Point. Balsam Poplar Treed Sand Dune (SDT1-2) (L2) is another provincially rare community of regional conservation concern occupying approximately 0.5 ha located at the mouth of Highland Creek. Mineral Open Beach (BBO1) (L3) and Willow Shrub Beach (BBS1-2A) (L2) are communities of regional conservation concern located within the coastal zone of Lake Ontario, while a small (0.09 ha) Rubble Open Shoreline (BBO2-A) (L4) community is located at the west end of the Segment where past shoreline erosion control efforts have been implemented.

2.2.2.3 Vascular Plants

A total of 256 vascular plant species have been recorded in the Project Area. The vast majority of species are either considered secure or are invasive species that are ubiquitous and abundant throughout the Project Area; therefore, they have been excluded from the plant dataset presented in order to more clearly evaluate the presence of more sensitive species. A complete list of the flora species detected can be found in **Appendix B**. Quantities of individual plant species of conservation concern, based on regional or urban concern levels, per Segment, are provided in **Table 3**.

Table 3: Individual Species of Vascular Plants Observed in the Project Area Based on Level of Conservation Concern*

Level of Conservation Concern	Project Area Segment		
	West	Central	East
Regional Conservation Concern (L1-L3)	33	38	53
Concern in an Urban Environment (L4)	63	71	66

*Note: * Generally secure species are not included.*

The relatively high number of plant species found in the Project Area can be attributed to a range of habitats and regimes, diverse topography and variety of soil conditions. At the same time, up to 45% of the vegetated area contains non-native or invasive species (TRCA, 2012). Plant species of conservation concern within the Project Area are currently threatened by exotic invasive species, White-Tailed Deer (*Odocoileus virginianus*) browse (especially spring ephemeral species) and public use through trampling and removal, enabled by a network of informal trails through many sensitive areas, such as several ravines and East Point Park.

Two vascular plant Species at Risk (SAR) have been located within the Project Area. Butternut (*Juglans cinerea*) (L3), which has been listed as Endangered in Ontario, has been encountered in all three Segments in the forested tablelands, while the provincially Threatened spike blazing-star (*Liatris spicata*) (L2), has only been observed on the tablelands in the East Segment. Spike blazing-star populations are particularly susceptible to habitat loss and/or alteration through activities such as fragmentation, which reduce habitat patch size and enable the establishment of invasive species, as well as natural succession.

West Segment

In the West Segment, 33 species of regional concern and 63 species of concern in urban environments were recorded.

Notable observations include presence of jurisdictionally rare Oakes' evening-primrose (*Oenothera oakesiana*) (L3) in the Bluffer's Park area. As well, five of the 38 regionally rare species in this Segment are associated with the beach (Bluffer's Park Beach northern extent, in particular) and wetland communities, and include: russet buffalo-berry (*Shepherdia canadensis*) (L3), sea-rocket (*Cakile edentula*) (L2), seaside spurge (*Euphorbia polygonifolia)* (L2), Schweinitz's umbrella-sedge (*Cyperus schweinitzii*) (L2), and marram grass (*Ammophila breviligulata*) (L2).

Central Segment

In Central Segment, 38 species of regional conservation concern were observed, in addition to 71 species of urban conservation concern.

One of the two most jurisdictionally rare species found within the Project Area is found in this Segment: wood betony (*Pedicularis canadensis*) (L1), an upland forest species associated with forested tablelands. Many regionally rare species appear to be concentrated near Guild Park and Gardens, an area often frequented by informal trail users. Notable species within the Central Segment also include the spring ephemerals wild leek (*Allium tricoccum*) (L4) and broad-leaved spring beauty (*Claytonia caroliniana*) (L3).

One SAR, butternut, has been observed in this Segment, but not in proximity to proposed Project works.

East Segment

The East Segment contains the greatest proportion of regional species of concern at 53 species, with another 66 species of conservation concern in urban environments.

The second most jurisdictionally rare species within the Project Area, the ragged fringed orchis (*Platanthera lacera*) (L1), has been detected here. Other rare species include pasture thistle (*Cirsium discolor*) (L2), and the white form of bottle gentian (*Gentiana andrewsii f. alba*) (L2), as well as golden Alexanders (*Zizia aurea*) (L3).

Butternut has also been observed in this Segment, but is not in proximity to proposed Project works.

2.2.3 Wildlife and Wildlife Habitat

In general, the number of terrestrial vertebrate species potentially breeding in the Project Area is considered high for an urban area. However, it is important to note that a list of potential species does not indicate the significance of a site. The presence and representation of species associated with specific habitats is a better indicator of significance. Under-representation of habitat dependent species within the Project Study Area indicates that the quality of local habitat is not high enough to support a large number of species with specific habitat requirements. For example, the majority of well-represented breeding birds in the area nest at levels considerably higher than ground-level, indicating persistent disturbance likely resulting from informal trails and frequent public use, as well as other factors associated with urbanized environment.

2.2.3.1 Wildlife Corridors

Wildlife corridors are areas that are functionally or ecologically connected and provide important habitat while allowing wildlife movement. Corridors can help to preserve populations of wildlife over the long-term within a heavily urbanized landscape where natural communities are fragmented and dispersed, as within the Project Study Area.

Generally, wildlife movement corridors within the Project Area are limited to the shoreline, ravines and naturalized tableland areas. The matrix of residential and commercial/industrial land between natural areas also contributes to the natural ecology of the area, but is not characterized here.

Ravines and valley lands provide important habitat for the movement of songbirds which rely on vegetated areas when in need of rest, food or shelter from adverse weather conditions during migration. These areas also offer important cover for the movement of mammalian species such as White-Tailed Deer. Additionally, ravines and valley lands provide a connection between the shoreline lands and natural areas within the watersheds of various streams draining into Lake Ontario (Highland Creek within the Project Area).

The Lake Ontario shoreline provides an important east-west corridor linkage for urban wildlife movement, as well as a connection between the lake and terrestrial habitats at the land-water interface. It also serves as stopover and staging habitat for migratory wildlife. Though some areas along the shoreline offer a limited east-west connection and a limited land-water interface (e.g., narrow, easily overtopped sections of the sand deposits adjacent to Cudia Park in the West Segment), others (e.g., well-vegetated backshore areas along the Sylvan Avenue shoreline and the cobble beaches at Meadowcliffe) can easily serve as movement corridors and land-water interface connections for multiple species.

Tableland corridor connections are poor to fair given that they are often very narrow, or are interrupted by residential properties. The naturalized areas within the Project Study Area provide a measure of connectivity east-west, as well as north-south via the ravines.

Unfortunately, many corridors within the Project Study Area experience direct and indirect impacts from human use. Ravines are impacted by increased overland flow and storm sewer discharges associated with extensive urbanization. In combination with trampling from informal public use, ravine ecosystems are becoming degraded through vegetation loss and subsequent slope erosion. Informal public use also impacts the shoreline corridors and tablelands.

2.2.4 Birds

To date, wildlife observations for the Project Area include 69 bird species (**Appendix C**).

The ecological needs of bird species differ depending on their behaviour and life history characteristics. For many groups of birds, the specific habitat requirements can be readily identified and conserved based on these differences.

Of these, 10 birds were confirmed breeders, and the rest are considered probably or possible breeders. Anecdotal wildlife sightings reported by the local community support the argument that the Project Area in general supports migratory and resident bird species. Overwintering waterfowl, especially within the sheltered Bluffer’s Park are also documented to occur, as well as several gull and raptor species.

Most of the existing breeding bird community utilize sheltered forest habitat as opposed to open shoreline habitat. Of the regionally rare species, Black-and-White Warbler (*Mniotilta varia*) utilizes forest habitat, and Bobolink (*Dolichonyx oryzivorus*) is associated with large expanses of grassland habitat. Many others rely on woodland habitats (Sharp-shinned Hawk (*Accipiter striatus*), Pileated Woodpecker (*Dryocopus pileatus*), Wood Thrush (*Hylocichla mustelina*), Pine Warbler (*Setophaga pinus*), Winter Wren (*Troglodytes troglodytes*), and Wild Turkey (*Meleagris gallopavo*) and several have specific habitat requirements within the woodland habitat such as coniferous trees for Pine Warbler, cavity trees for Pileated Woodpecker and tall trees for roosting Wild Turkey. Early successional habitat and scrubland birds include Black-billed Cuckoo (*Coccyzus erythropthalmus*), Mourning Warbler (*Geothlypis philadelphia*), Eastern Towhee (*Piplio erythrophthalmus*) and Brown Thrasher (*Toxostoma rufum*). One regionally rare waterfowl species was recorded, Red-necked Grebe (*Podiceps grisegena*).

It has been noted that habitat loss is the single biggest threat to bird populations worldwide (City of Toronto, 2011). Habitat loss can occur for a variety of reasons, but the majority results from human activities, such as habitat removal for development or fragmentation through continued informal use. Constant habitat disturbance and/or degradation has the potential to reduce bird populations or result in local extirpation, particularly for bird species that have specific habitat requirements.

West Segment

Twenty-nine bird species have been observed in this Segment.

Significant wildlife habitat within this Segment includes the bluff formations that support Bank Swallow (*Riparia riparia*) colonies, a provincially Threatened species. As a threatened species under the *Endangered Species Act*, both the swallows and their habitat are protected. Approximately 800 cavities have been observed within this Study Segment; however occupancy may be much lower (TRCA, 2012). Nevertheless, the apparent size, as well as the current condition of most of the bluff face, makes this a regionally significant colony. Slope failures and erosion may help to maintain the current colony, but over time a stable slope will form naturally, which may allow vegetation to grow and provide easier access for predators, thereby making it potentially less suitable for nesting Bank Swallows. However, based on the evidence of the Bluffer's Park Bank Swallow colony, the colonies that occupy areas with silt to sand substrate (not till), such as this area, are likely to persist over the long-term.

Habitat within this segment supports two species of nesting raptors: Eastern Screech-Owl (*Otus asio*; a confirmed breeder), and American Kestrel (*Falco sparverius*; a possible nester). As of 2011, Eastern Screech-Owl has consistently raised young since at least 2009. It is likely that additional owl species may use the area for overwintering, though no winter data is available.

One area-sensitive species was recorded within the West Segment: Pileated Woodpecker, which was observed as possibly breeding. Several slightly less area-sensitive species were also recorded: Winter Wren (an uncommon bird for the area); Red-breasted Nuthatch (*Sitta canadensis*; observed as possibly breeding); and a number of Great-crested Flycatchers (*Myiarchus crinitus*; observed with breeding status ranging from status uncertain to possible and probable). Hairy Woodpecker was recorded as possible and confirmed breeding and White-breasted Nuthatch was recorded as probable and confirmed nesters. The number of confirmed, probable and possible cavity nesting species illustrates the number of natural nest cavities that appear to be available within this area.

Given its location along a highly urbanized area of the Lake Ontario shoreline, Cathedral Bluffs Park and Cudia Park likely provides migratory bird habitat; however data is not available to support this statement. The area, especially Cudia Park when viewed with the continuous Gates Gully and Sylvan Park natural areas, contain a diversity of forest types that support migrating birds. Citizen science data via eBird for Bluffer's Park helps to support the assertion regarding suitable migratory bird stopover habitat availability (ebird, 2015).

Barn Swallow (*Hirundo rustica*), a provincially Threatened is considered a possible breeding species, with nesting associated with human infrastructure (e.g. boats, buildings, docks.) at Bluffer's Park, while a single Wood Thrush, a provincial species of special concern, was recorded during standardized surveys at the beginning of the nesting season; however, its breeding status was uncertain.

The confirmed breeding of cavity nesters such as Hairy Woodpecker (*Picoides villosus*), Northern Flicker (*Picoides villosus*), White-breasted Nuthatch (*Sitta carolinensis*), and Carolina Wren (*Thryothorus ludovicianus*) also demonstrates the richness of available tree cavities within the segment. Northern Rough-winged Swallow (*Stelgidopteryx serripennis*) likely uses the excavated burrows of Bank Swallows (*Riparia riparia*) along the bluff faces. Rose-breasted Grosbeak (*Pheucticus ludovicianus*) and Red-eyed Vireo (*Vireo olivaceus*) find nesting habitat within the relatively large forested area of Cudia Park.

Central Segment

Thirty-two bird species have been observed in the Central Segment. More than 140 Bank Swallow holes were counted within the Segment; however, occupancy may be much lower. The Bluffs provide significant nesting opportunities for this species, although vegetation that is slowly colonizing the slopes has reduced nesting opportunities over time. Areas farther east within this Segment where Bank Swallows occupy cohesive soils may become unsuitable for Bank Swallow nesting in approximately 5 to 20 years, depending on how quickly natural succession occurs.

Confirmed breeding raptors include Great Horned Owl (*Bubo virginianus*), Eastern Screech-Owl and Sharp-shinned Hawk. It is likely that the area also supports overwintering owls, and possibly other raptors. Raptor nesting use of the study segment appears to be fairly consistent. Eastern Screech-Owl nesting records date back to 2002, along with Great Horned Owl that was also recorded during 2011 standardized surveys. Sharp-shinned Hawk was also confirmed nesting during the 2002 and 2011 surveys, while Cooper's Hawk (*Accipiter cooperii*) was a possible breeding species. No data is available to describe winter use of the area by raptors; however it is likely that the nesting Great Horned Owl pair used the site for courtship before nesting. Unfortunately, the invasive Emerald Ash Borer has decimated areas of ash dominated forest that are common within the Study Segment, which may have affected raptor habitat.

Four area sensitive species were recorded within the Project Area. Sharp-shinned Hawk and Cooper's Hawk are able to take advantage of the forested areas of Sylvan Park and Guild Park, while Pine Warbler and Pileated Woodpecker also found suitable forested habitats within these areas. An additional 11 slightly less area sensitive species with various breeding status were also found within the Study Segment. All of the bird species were accommodated by forested and thicket habitats, with the exception of the Red-necked Grebe, which requires aquatic and wetland habitats. Cavity nesting bird species confirmed as nesting are White-breasted Nuthatch, Red-breasted Nuthatch, Great-crested Flycatcher, Carolina Wren, and Hairy Woodpecker. The diversity of cavity nesting bird species demonstrates the availability of various natural cavities in this area.

While no standardized data are available for migratory bird stopover use, it is reasonable to assume that this Study Segment represents suitable habitat. The forested areas of Gates Gully/Sylvan Park, especially when taken together with Cudia Park in the West Segment, represent a fairly large area with various forest cover types suitable for migrating birds. Citizen science data via eBird for Guild Park helps to support the assertion regarding suitable migratory bird stopover habitat availability (eBird, 2015).

East Segment

Forty-three bird species have been recorded in East Segment, including the provincially Threatened Bank Swallow. However, small amount of suitable bluff habitat likely limits the number of Bank Swallow nests, as the dominant substrate in this area lacks cohesion, which is required for burrowing. Northern Rough-winged Swallows were a probable breeding species taking advantage of excavated Bank Swallow burrows.

No raptor species were recorded within East Segment, and no data on overwintering raptor species are available, however it is possible that East Point Park provides suitable habitat for overwintering owls.

No area-sensitive species were found within this Segment; however, several slightly less area sensitive species were recorded. The provincially Threatened Eastern Meadowlark (*Sturnella magna*) has not been recorded during breeding bird surveys in more than a decade, and the Threatened Bobolink was only recently observed during breeding season after an 11-year absence, but both require large grassland areas that are generally not present in the Project Area. They have likely disappeared from the area due to natural succession, and human related disturbance associated with the high number of informal trails through the East Point Park meadow community. The remaining species depend on mature forested or semi-forested-thicket type habitats, with cavity nesting opportunities available: American Redstart (*Setophaga ruticilla*), Black-billed Cuckoo, Blue-grey Gnatcatcher (*Polioptila caerulea*), Great Crested Flycatcher, Hairy Woodpecker, Red-breasted Nuthatch, Winter Wren, and Wood Duck (*Aix sponsa*).

East Point Park is known to be locally significant as a migratory bird stopover location, and its significance for migrating birds has been confirmed by citizen science data collected from eBird (eBird, 2015).

A number of regional conservation concern species were present within this segment: they favour woodland thicket type habitats found at East Point Park and include Winter Wren and Brown Thrasher (probably nesting in the area), and Black-billed Cuckoo, Mourning Warbler and Wild Turkey (possible breeders). Notably, Mourning Warbler records date back to 2003.

2.2.5 Mammals

A total of 16 mammal species have been recorded within the Project Area. All species observations, except bats (see **Appendix D** for survey information), are incidental and were made as part of breeding bird and vegetation surveys.

This relatively small number of mammals is typical of urban areas and includes species commonly encountered in the urban landscape, such as Grey Squirrel (*Sciurus carolinensis*), Red Squirrel (*Tamiasciurus hudsonicus*), Eastern Cottontail (*Sylvilagus floridanus*), and Eastern Chipmunk (*Tamias striatus*).

Most mammal species encountered are relatively ubiquitous throughout the Project Study Area. All of the species, with the possible exception of some bat species, are considered quite adaptable to urban situations.

Notable mammals include the six bat species detected, as only eight species of bats are known in all of Ontario. Two of the bat species detected, Little Brown Bat (*Myotis lucifugus*) and Tri-Colored Bat (*Perimyotis subflavus*), are currently considered both provincially and federally Endangered. Residency and roosting activity was not assessed for any bat species in the Project Area; however, based on their habitat preferences it is unlikely that any of the species use the Bluffs for roosting or nesting activity, and instead are likely using the surrounding forest habitats, or even residential properties (e.g., attics) (B. Lim to K. McDonald, personal communication, May 17, 2016). Maintaining and expanding the amount of suitable habitat within existing natural areas, such as leaving cavity trees standing and planting species that will result in cavities and/or loose bark once mature, would help to preserve and promote opportunities for bats.

2.2.6 Herpetofauna

Six reptile and five amphibian species have been detected within the Project Area (**Table 4**).

Table 4: Herpetofauna Species Detected within the Project Area

Reptiles	
Snakes	**Turtles**
▪ Eastern Gartersnake (*Thamnophis sirtalis sirtalis*) ▪ Dekay's Brownsnake (*Storeria dekayi*)	▪ Common Musk Turtle (*Sternotherus odoratus*)* ▪ Midland Painted Turtle (*Chrysemys picta marginata*) ▪ Red-Eared Slider (*Trachemys scripta elegans*)** ▪ Snapping Turtle (*Chelydra serpentina*)
Amphibians	
Frogs and Toads	**Salamanders**
▪ Northern Leopard Frog (*Lithobates pipiens*) ▪ American Toad (*Bufo americanus*) ▪ Green Frog (*Rana clamitans*)	▪ Spotted Salamander (*Ambystoma maculatum*) ▪ Eastern Red-Backed Salamander (*Plethodon cinereus*)

Notes: * *SAR*
** *Non-native species*

Amphibians in particular are key ecological indicators as most spend a portion of their life in both aquatic and terrestrial habitats. Human disturbance, pollution, and climate change can have an impact on population size and health. Some amphibian species, such as the two frog and one toad species found in the Project Study Area, are more resilient than others when faced with urban stresses. American Toad has been detected within all three Segments of the Project Area. Green Frogs were detected in the Central and East Segments, and Northern Leopard Frog was only observed within the East Segment.

Populations of Eastern Red-Backed Salamanders, an important forest indicator (TRCA, 2012), were discovered in the Central Segment and were present in the Highland Creek ravine system. Spotted Salamander were also observed in the East Segment within the Highland Creek ravine system.

Eastern Gartersnake is one of the most widely distributed snakes in Ontario and has been observed in all Segments of the Project Area. In contrast, Dekay's Brownsnake was only observed within the East Segment. This species is fairly common and abundant throughout Ontario, and is often found in or near human habitat in suburban and urban areas (MacCulloch, 2002). However, they are not often seen due to their elusive habits and small size.

Four turtle species have been observed within the Project Area, three of which have been encountered in the West Segment, including the Common Musk Turtle, a provincially Threatened SAR. However, due to the isolated nature of this observation (one individual was captured in 2003 and the species has not been detected in subsequent years), its current status in the Project Area is uncertain. Citizen science has reported a Snapping Turtle observation within the Central Segment.

2.2.7 Significant Natural Areas

This section describes the significant natural areas found in the Project Study Area and individual Segments. Significant natural areas considered include Areas of Natural and Scientific Interest (ANSIs), Environmentally Significant Areas (ESAs), and Provincially Significant Wetlands (PSWs). Although ANSIs and ESAs are a conservation designation, proposed works can occur within them, if the appropriate studies have been undertaken.

2.2.7.1 Areas of Natural and Scientific Interest (ANSIs)

ANSIs are areas of land and water containing unique natural landscapes or features. These features have been scientifically identified as having life or earth science values related to protection, scientific study or education. ANSIs complement provincial parks and conservation reserves by conserving significant features through means other than regulation (Government of Ontario, 2014).

ANSIs include Life Science ANSIs and Earth Science ANSIs. The Project Study Area contains two Life Science ANSIs and one Earth Science ANSI.

Life Science ANSIs are significant representative segments of Ontario's biodiversity and natural landscapes including specific types of forests, valleys, prairies and wetlands, their native plants and animals, and their supportive environments (Government of Ontario, 2014).

Earth Science ANSIs are geological in nature and consist of some of the most significant representative examples of the bedrock, fossil and landforms in Ontario and include examples of on-going geological processes (Government of Ontario, 2014).

ANSIs are categorized as Provincially Significant, Regionally Significant or Locally Significant by the MNRF.

The significant natural features which led to these areas being designated as ANSIs are currently under pressure from a variety of factors. In particular, unmanaged public use (an approximately 14 km long network of informal trails measured along the top and bottom of the Bluffs via orthophotography interpretation and ground-truthing using GPS technology) results in habitat fragmentation, trampling of plants, spread of invasive species, and disturbance of wildlife.

Three ANSIs are located in the Project Study Area:

1. **Scarborough Bluffs Provincially Significant Life Science ANSI** (155.4 ha):
   At the time of evaluation in 1980, the major features included a variety of vegetation communities associated with the Bluffs and ravine systems, particularly the regionally rare Sumac-Willow-Cherry Shrub Bluff community and a number of remnant forest communities classified as either regionally rare or of urban concern. Informal trails fragment several sections of this ANSI, particularly within Bellamy Ravine and Sylvan Park.
2. **Scarborough Bluffs Provincially Significant Earth Science ANSI** (93.3 ha):
   The Bluffs were identified as the major feature at the time of evaluation in 1980. This particular 93.3 ha section exhibits the most complete record of Pleistocene geology in North America, and contains a number of notable sections to the west of the Project Study Area (e.g., the Dutch Church Section [including the Needles] and Seminary Section) and within the Project Study Area (e.g., Cathedral Bluffs, Cudia Park Section, and portions of the Iroquois Section). At present, the Cathedral Bluffs section of Bluffs are considered to be in the middle to late stages of stabilization and are well vegetated due to the creation of Bluffer's Park Beach, which protects the slope toe from wave action (**Appendix B**).

3. **East Point Bluffs Regionally Significant Life Science ANSI** (71.7 ha):
   The major features at the time of evaluation in 1980 included a unique grassland meadow that is interspersed with small woodlots, wetlands and small ravines. A small remnant prairie community still exists within this ANSI, and contains a number of rare prairie plant species, including the largest and healthiest spiked blazing-star population in Ontario, along with significant prairie grasses (e.g., bluestem [*Anthropogon gerardii*], little bluestem [*Schizachyrium scoparium*], dropseed grass [*Sporobolus heterolepis*]) and wildflowers (e.g., white bottled gentian, fringed gentian [*Gentiana crinita*]). The largest network of informal trails in the Project Study Area is also located within this ANSI through East Point Park (approximately 8 km in length), fragmenting and threatening the aforementioned vegetation communities.

Scarborough Bluffs Life Science and Earth Science ANSIs overlap with West and Central Segments, and East Point Life Science ANSI overlaps with East Segment (**Figure 8** to **Figure 10**).

2.2.7.2 Environmentally Significant Areas (ESAs)

City of Toronto designated ESAs are natural areas within the City of Toronto's natural heritage system that, at the time of designation, have been found to be particularly significant or sensitive and require protection to preserve the unique or rare flora and fauna features within (North-South Environmental Inc., 2012a). ESAs are protected under the City of Toronto Official Plan Policy 3.4.13 (City of Toronto, 2015; Amendment No. 262), which states that "*development or site alterations with the exception of trails, where appropriate, and conservation, flood and erosion control projects is not permitted on lands within the natural heritage system that exhibit any of these characteristics. Activities will be limited to those that are compatible with the preservation of the natural features and ecological functions attributed to the areas."* Similar to the designated ANSIs discussed above, each ESA identified within the Project Study Area is currently under pressure from unmanaged increases in public use, with networks of informal trails observed to bisect portions of each.

Five ESAs overlap with/are located within the Project Study Area:

1. **Scarborough Bluffs Sequence** (**Figure 8**):
   This ESA overlaps with the West Segment and occupies an area of 73.6 ha. It was designated as environmentally significant due to biologically and geologically significant areas surrounded by deciduous forest, successional and beach communities found at the time of evaluation (North-South Environmental Inc., 2012a). A total of 30 significant flora species and nine significant vegetation communities were detected amongst a total of 43 vegetation communities. A total of 68 flora and 11 fauna species ranked L1 to L4 also contribute to the designation. Over 100 Bank Swallow colony nesting holes were recorded, and swamps and marshes provide upwards of 4.5 ha of water storage (North-South Environmental Inc., 2012b). The City of Toronto has identified the protection of the landform and vegetation within this area as a management need for this ESA. Many areas of the existing vegetation are dominated by patches of non-native flora species (e.g. dog strangling vine, Norway maple, giant reed grass, cow vetch), and evidence of considerable human disturbance has been observed, including

Figure 8: ANSIs and ESAs Overlapping West Segment with the Locations of Existing and Informal Trails Identified

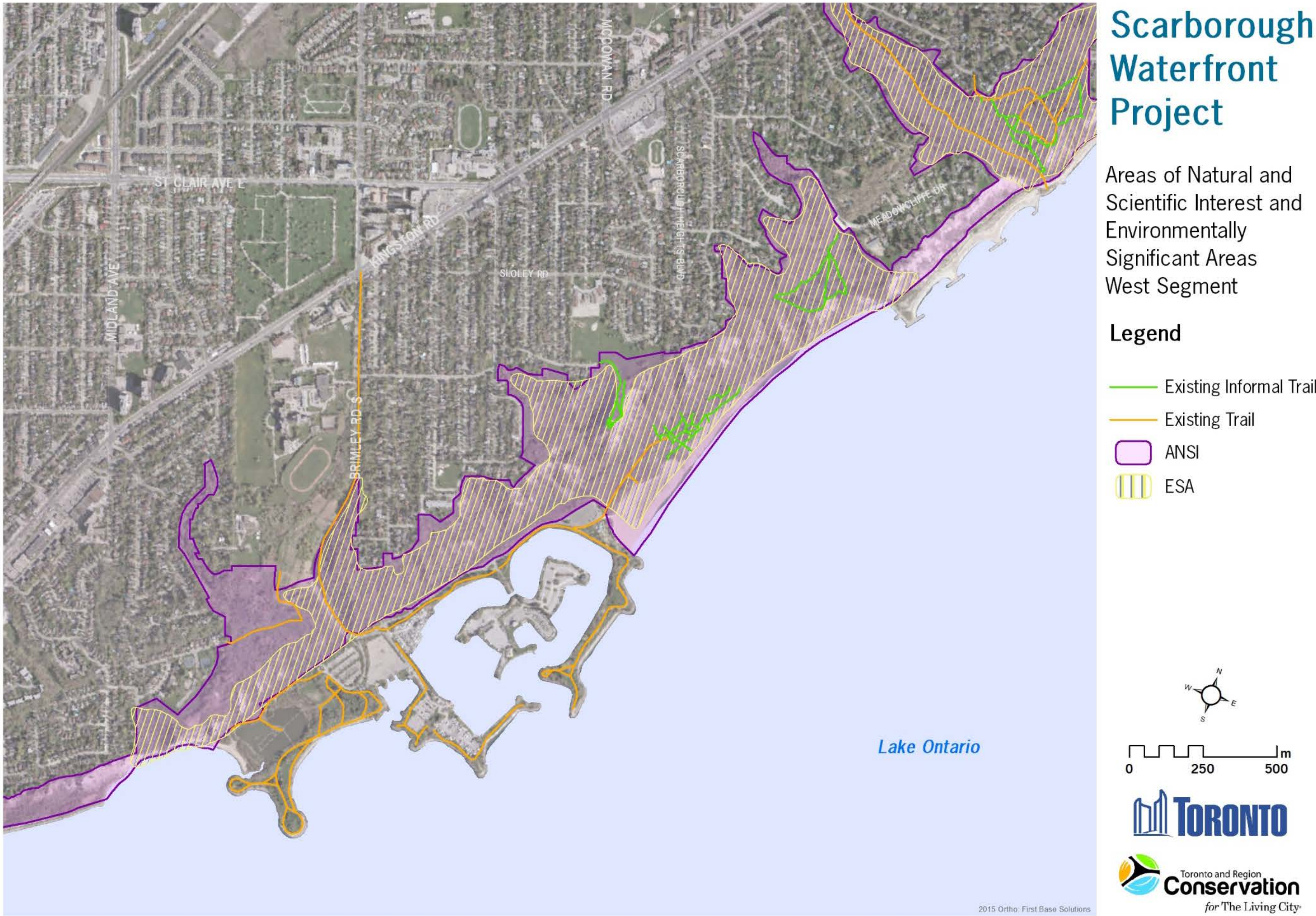


Figure 9: ANSIs and ESAs Overlapping Central Segment with the Locations of Existing and Informal Trails Identified

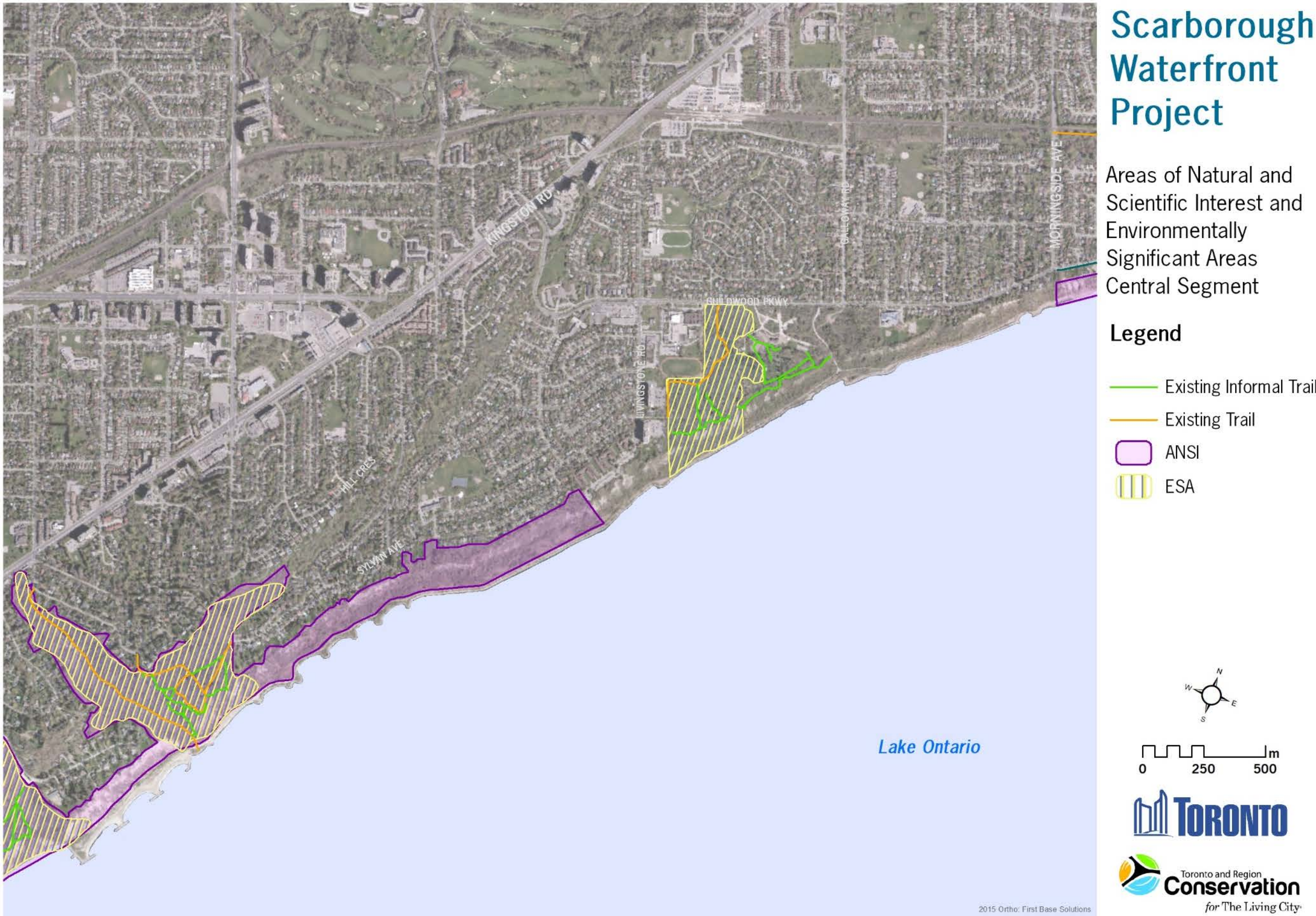
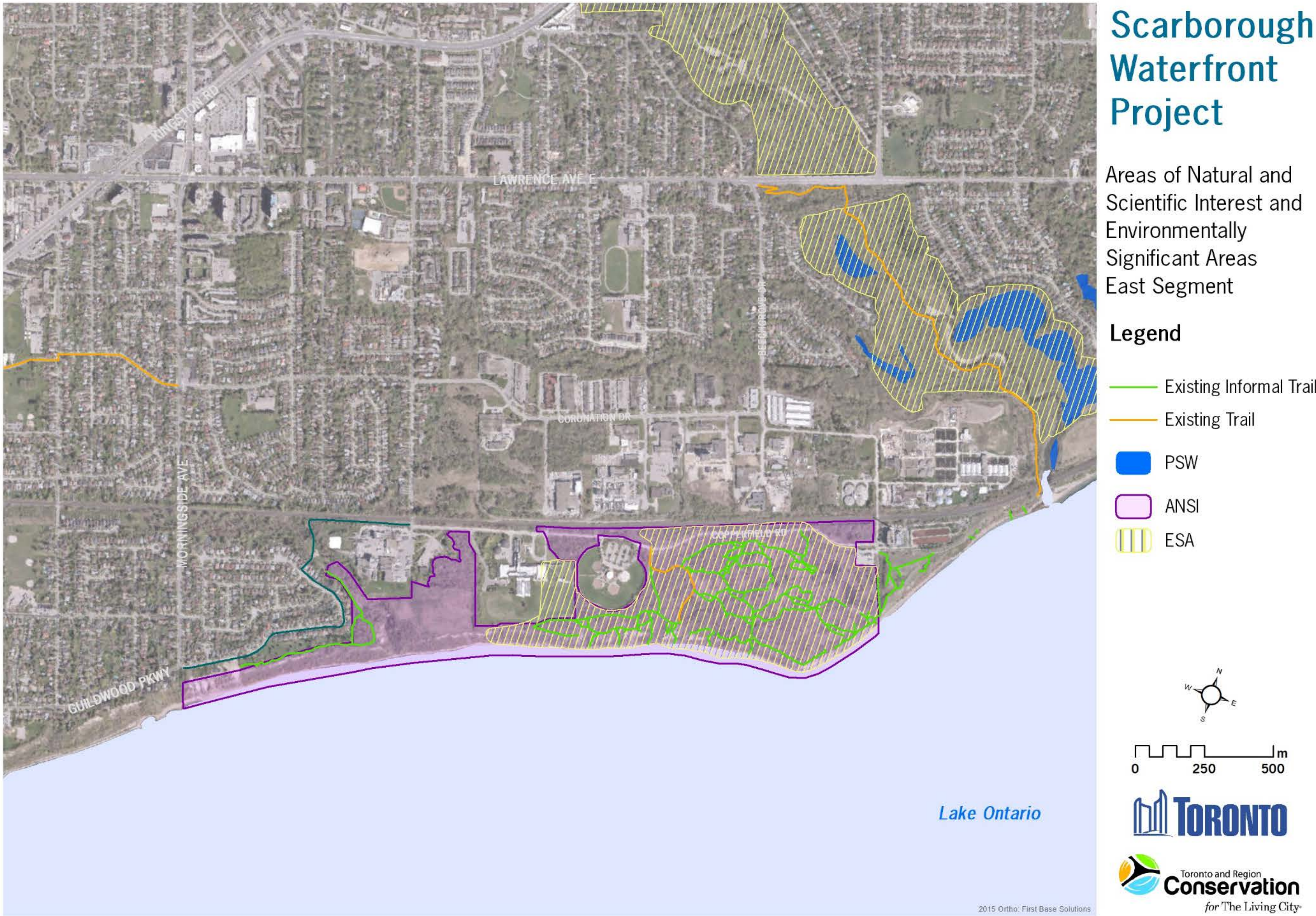


Figure 10: ANSIs and ESAs Overlapping East Segment with the Locations of Existing and Informal Trails Identified



camping, informal trails and yard waste dumping (North-South Environmental Inc., 2012b). Intensive residential development along the landward edge of the Bluffs in this area is also heavily impacting the landform along these edges (North-South Environmental Inc., 2012b).

2. **Bellamy Ravine/Sylvan Park** (**Figure 9**):
This ESA overlaps with the Central Segment and occupies an area of 28 ha. When evaluated, it was found to include nine significant flora species and three significant vegetation communities across a total of 17 vegetation communities, and supported over 300 Bank Swallow nests (North-South Environmental Inc., 2012c). A total of 31 flora and 14 fauna species ranked L1 to L4 were also recorded. A number of informal trails has been observed to intersect this ESA and provide shortcuts between stretches of the existing trail, increasing the potential for habitat fragmentation and human disturbance along the east side of Bellamy Ravine and Sylvan Park, in particular. Protection and enhancement of the vegetation along the ravine slopes and on the tableland has been identified as a management need by the City as these communities are affected by high proportions of non-native flora species (e.g., dog strangling vine and black locust) along with informal trails primarily at the bottom of the ravine (North-South Environmental Inc., 2012c).

3. **Guild Woods** (**Figure 9**):
This ESA also overlaps with the Central Segment. It covers an area of 14.8 ha, and, at the time of designation, was characterized by the presence of rare flora or vegetation communities, including 11 significant flora species and four significant vegetation communities across a total of 18 vegetation communities, along with 3.9 ha of water storage area provided by marsh and swamp communities (North-South Environmental, 2012d). This site was found to contain many areas of high quality vegetation; however, similar to the Bellamy Ravine/Sylvan Park ESA (but to a lesser extent), a series of informal trails has been observed, intersecting the natural area to provide shortcuts from the existing trail to the edge of the Bluffs (North-South Environmental Inc., 2012d). Resultantly, protection of the landform and vegetation from informal trails within this area has been recommended as a management need by the City, along with removal/control of invasive flora species, such as garlic mustard, which has been found in high concentrations in several areas (North-South Environmental Inc., 2012d).

4. **East Point** (**Figure 10**):
This ESA overlaps with the East Segment, and covers an area of 46.6 ha. At the time of evaluation, it was found to contain 37 significant flora species, 9 significant vegetation communities and two significant fauna species, amongst a total of 30 vegetation communities (North-South Environmental Inc., 2012e). It was also found to contain 53 flora and 21 fauna species ranked L1 to L4. It represented an excellent example of bluff formation and maintenance, and contained a water storage area of approximately 7.2 ha through marsh and swamp communities (North-South Environmental Inc., 2012e). This area has a high diversity of successional vegetation, which supports a high diversity of wildlife species. However, East Point has also been found to contain the greatest concentration of informal trails within the Project Study Area (approximately 8 km). These include trails fragmenting the sensitive vegetation communities directly within and just west of the park, as well as those along the

bluff face (informal trails between the tablelands and shoreline have been noted within steep erosion gullies). Management needs identified by the City include maintenance of the landform and successional processes at this site, and maintenance of the connections with other natural areas (North-South Environmental Inc., 2012e). The trail system through the park needs to be managed with consideration of constructing paved trails in order to prevent erosion and the formation of more informal trails (North-South Environmental Inc., 2012e). Invasive species management should also be considered for the large patches of dog strangling vine observed (North-South Environmental Inc., 2012e).

5. **Stephenson's Swamp/Highland Creek East** (**Figure 10**):
   This ESA also overlaps with the East Segment and occupies an area of 44.8 ha. It was found to include steep valley slopes with mixed deciduous and coniferous forests that descend abruptly to a broad floodplain with lowland forest swamp, meadow marsh and riparian bars (North-South Environmental Inc., 2012a). A total of 56 significant flora species, 4 significant fauna species and 1 significant vegetation community were detected across 14 vegetation communities (North-South Environmental Inc., 2012f). A total of 136 flora and 34 fauna species ranked L1 to L4 also contribute to this areas ESA designation. This area was also identified as a major node in the Highland Creek corridor, providing linkage between foraging and breeding habitat for frogs, along with 6.4 ha of water storage provided by marsh and swamp communities (North-South Environmental Inc., 2012f). Similarly to the ESAs discussed above, the City has identified protection of the landform and vegetation in this area. Although the site has many areas of high-quality vegetation, high concentrations of non-native flora, specifically Norway maple, dog strangling vine and giant reed grass, have been found in certain areas (North-South Environmental Inc., 2012f). Additionally, informal paths have been frequently encountered and have been found to impact sites along the edge of Highland Creek (North-South Environmental Inc., 2012f).

2.2.7.3 Provincially Significant Wetlands (PSWs)

PSWs are identified by the MNRF as being the most ecologically valuable wetlands in Ontario based on four broad categories: biological, social, hydrological, and special features.

The Highland Creek Wetland complex, located in the north-east corner of the Study Area and away from the waterfront, is the only PSW and is composed of four individual wetlands totalling approximately 12.9 ha (**Figure 10**).

2.3 Aquatic Habitat and Fish Community

This section focuses on characterization of the aquatic habitat and fish community in the Project Area. Various aquatic habitat types present along the shoreline between Bluffer's Park and Highland Creek and their current state are described. The fish community is described using species richness, fish abundance and community structure trends over the last decade (2006-2016). In addition, the connection between the local habitat, fish community and the lake-wide ecosystem is examined.

2.3.1 Connected Lake Ontario Ecosystem Zones

It is important to recognize that the Project Area is a component of the Lake Ontario ecosystem, which, in turn, is comprised of the interacting physical, chemical and biological components. This interaction takes place within and between the watershed, nearshore and offshore zones. The nearshore zone includes the shallower exposed coastal zone and sheltered embayments, and the offshore zone is the main body of the Lake (Stewart et al., 2013).

The Project's direct potential impacts, both positive and negative, occur in the nearshore zone, as this is where the Project is located. However, as the system components are interconnected, the Project may potentially result in benefits and/or negative impacts to other zones. At the same time, significant impacts to either the offshore or watershed zones are unlikely as the Project is limited to a small area of the Lake Ontario nearshore zone.

2.3.1.1 Nearshore Zone

The lake nearshore zone is located parallel to the shoreline and is approximately < 15 m deep (Stewart et al., 2013). All aquatic habitat types present within the Project Area and discussed below (**Section 2.3.2**) – sheltered embayment and open coast – are associated with the nearshore zone.

As this is a relatively shallow zone, sunlight typically reaches all the way to the lake bottom, resulting in aquatic plants establishment where conditions allow (in sheltered embayments as opposed to along the non-engineered open coast). Many fish species (predominantly cool water) utilize the nearshore zone as a spawning area and to support various life stages. Spawning is subject to individual species' requirements with respect to substrate type, depth and availability of aquatic vegetation.

The nearshore is where many native warm and cool water fish species are found (e.g., Northern Pike [*Esox lucius*], Yellow Perch [*Perca flavescens*], Brown Bullhead [*Ameiurus nebulosus*], and Largemouth Bass [*Micropterus salmoides*]). Some of these, such as Northern Pike and Largemouth Bass, are part of an important recreational fishery. A number of cold water fish species considered offshore (e.g., Lake Trout [*Salvelinus namaycush*]) also utilize the nearshore zone: they use it as spawning and subsequently nursery and juvenile habitat. Important prey species such as Alewife (*Alosa pseudoharengus*) and Emerald Shiner (*Notropis atherinoides*) utilize the nearshore for spawning as well (Lane et al., 1996).

2.3.1.2 Offshore Zone

The offshore zone contains most of the water and living components of the Lake Ontario ecosystem (Stewart et al., 2013). It serves as habitat for the majority of native and stocked salmonids, prey fish such as Alewife and other cold water species. Due to its size, the offshore zone is not as well studied and understood as the nearshore zone. However, this does not diminish its importance.

One of the offshore zone's most remarkable features is its summertime organization into a warmer upper layer (epilimnion) and a deeper, cooler layer (metalimnion), which when combined can be considered the pelagic (open water) zone (Stewart et al., 2013). The epilimnion serves as a zone of primary production: it receives the most light and nutrients and produces algae and phytoplankton, which support all other forms of life in the lake. The deepest layer of water, below the metalimnion, is called the hypolimnion. It is located on top of a large offshore bottom area in which fish and other benthic organisms (e.g., mussels, worms and shrimp) reside. This deep area, including the bottom, is known as the benthic zone.

Offshore zone is used to support adult life stages of many fish species that spawn in the nearshore (e.g., Alewife, Lake Whitefish [*Coregonus clupeaformis*] and Lake Trout) (Lane et al., 1996). As well, it supports species residing exclusively offshore. Due to its sheer size, the offshore zone is also where most of the lake primary production takes place. Primary production is the basis of the entire lake food web.

2.3.1.3 Interconnectedness

Forces that shape aquatic habitat along the Scarborough waterfront and elsewhere (e.g., phosphorus levels in treated wastewater, coastal processes, and habitat loss or restoration as a result of direct human involvement) affect the local aquatic community composition and dynamics.

For example, historical stonehooking activities along the waterfront resulted in the loss of valuable fish spawning habitat for offshore species and degradation of habitat quality for the species inhabiting primarily the nearshore zone, and likely led to increased rates of coastal erosion. As illustrated by the introduction of Dreissenid mussels, changes in the lake biological properties through the introduction of invasive species may have profound effects on the lake food web and chemical properties, including the nearshore zone.

It is evident that the nearshore and offshore zones are dynamically interconnected and subject to changing coastal, weather and climate conditions, lake water levels, and human impact. All of these variables impact the lake-wide and local physical, chemical and biological properties.

According to the *Fish Community Objectives for Lake Ontario* (Stewart et al., 2013), continued efforts to protect and restore native species and invest in monitoring and science-based assessment to understand ecosystem change are the best management strategies to ensure the continuation of benefits provided by the Lake Ontario ecosystem.

2.3.2 Aquatic Habitat Types

In order to preserve, restore or benefit healthy, self-sustaining aquatic communities, it is necessary to protect, create or restore the appropriate habitat components that support a balanced aquatic community. In other words, aquatic habitat conditions play an important role in maintaining aquatic communities, including fish community.

Four major aquatic habitat types occur along the north shore of Lake Ontario: estuaries, sheltered embayments, coastal wetlands, and open coast. Sheltered embayments and open coast habitat is found within the Project Area.

1. **Sheltered Embayment**

   Sheltered embayment habitat is located at the Bluffer's Park boat basin at the western end of the Project Area.

   Sheltered embayments in harbour areas such as Bluffer's Park provide calm waters and thermal refuge to fish. Sheltered embayment water can be significantly warmer than the open coast. As such, cool or warm water fish species typically dominate the fish community within this habitat type. These areas are best described as having a variety of shoreline conditions and configurations where the substrates tend to be softer sediments that sustain significant amounts of aquatic vegetation. Sheltered embayments provide habitat for all life stages of fish species, including foraging and nursery habitat.

   Bluffer's Park boat basin habitat is characterized by soft, uniform substrate, an insufficient riparian vegetation buffer and general lack of shoreline profile complexity. In addition, the boat basin has had ongoing navigation issues due to nuisance aquatic vegetation, particularly in the late summer. Excessive amount of aquatic vegetation, in addition to interfering with safe navigation, may have a negative impact to the aquatic species utilizing the boat basin. In particular, excessive aquatic plant growth may reduce oxygen levels (at night, when oxygen is consumed by plants rather than generated) and thus reduce the value of the benefits that plants provide to aquatic organisms.

2. **Open Coast**

   Open coast habitat occurs across the rest of the Project Area.

   In sharp contrast to the sheltered embayments, coastal wetlands and estuaries, the open coast has much colder water, and is exposed to extensive wind and wave action, resulting in a relatively hostile environment for aquatic macrophytes and animals. Hypolimnetic upwellings of cold sub-surface waters are common, resulting in large temperature fluctuations that reduce survival of cool and warm water fish in these areas.

   However, while most of the shoreline within the Project Area is classified as cold water open coast habitat, it frequently functions as a warm/cool water corridor between warm water habitat areas such as estuaries and coastal marshes (e.g., Bluffer's Park boat basin embayment and Highland Creek estuary).

   Under calm summer conditions, the nearshore area of the lake reaches temperatures high enough that they are acceptable to warm water species such as Largemouth and Smallmouth Bass (*Micropterus dolomieu*) to travel along the otherwise cold or cool open coast. Though the availability of this corridor varies with the weather and lake conditions, it does provide for warm and cool water species movement along the shoreline and migration between various warm and cool water habitat areas. In other words, this corridor provides for thermal fish habitat connectivity. Connectivity enables fish movement to access resources (e.g., food or spawning habitat), seasonal migration, and movement in response to habitat disturbance or change in local conditions (e.g., increase in turbidity or decrease in water levels). Ultimately, connectivity results in species dispersal and continuous gene flow between otherwise isolated areas.

   Open coast habitat with bedrock or cobble/boulder/gravel substrates is particularly suited for cold water fish such as Lake Trout, Round Whitefish (*Prosopium cylindraceum*) and Lake

Whitefish, which rely on open coast substrates with nearby steep drop-offs for successful reproduction. The greatest aggregations of boulders in combination with optimal coastal conditions (currents and depths) provide the best quality cold water fish spawning habitat.

Open coast habitat with sand, gravel and cobble substrate is also suitable for reproduction of fish such as Emerald Shiner, Alewife and Rainbow Smelt (*Osmerus mordax*). These fish provide an important forage base for other species, including most sport fish. Many fish, such as salmon species, also use open coast as a corridor during seasonal movements.

As demonstrated by the Project Area fish community survey results , more structurally complex open coast habitat – headland-beach systems with diverse substrates, irregular shoreline and complex vertical profile of the shoreline – is able to support higher number of fish species (see **Section 2.3.3.2.1**) and higher abundance of fish (see **Section 2.3.3.3.2**).

Within the Project Area, three types of open coast habitat exist, and are defined by the degree and type of protection work implemented along the shoreline in response to toe erosion along the Scarborough Bluffs:

- **Non-engineered open coast**
  These are areas where no shoreline protection works have been previously implemented (below Cudia Park Bluffs in the west, and between Grey Abbey Ravine and Highland Creek in the east; see **Figure 11** and **Figure 13**), or areas of soft shoreline whose development and continued existence are dependent on adjacent existing shoreline protection works (i.e., Bluffer's Park Beach). The non-engineered open coast habitat in the Project Study Area is characterized by relatively linear shoreline profiles and primarily small-sized aggregate substrate. While these areas are primarily used as movement corridors, they can also be used for spawning under appropriate conditions by fish species that have a high affinity to small-sized aggregate as spawning substrate.
- **Open coast with revetment features**
  These are areas where a linear revetment has been placed along the shoreline for erosion protection (South Marine Drive, Guild Park and Gardens) (**Figure 12**). These engineered structures typically did not incorporate aquatic habitat into their design. The linear shoreline profile and lack of diverse substrate typically associated with these features result in lack of cover, shelter and foraging opportunities for fish. Therefore, they are primarily used as movement corridors. Though revetments can be designed or retrofitted to incorporate aquatic habitat enhancements, the benefits to aquatic habitat quality afforded by these structures are less than those provided by headland beach systems.
- **Open coast with headland features**
  These are areas where headland, headland beach and groyne features have been installed for shoreline protection and are found in all three Project Area Segments. While the main property of these features is to address shoreline erosion, incorporating aquatic habitat enhancements into their design benefits aquatic habitat and organisms, where the benefits provided are typically higher than those provided by enhanced linear revetments. As demonstrated by the Project Area fish community survey results, more structurally complex open coast habitat – headland beach systems with diverse substrates, irregular shoreline and complex vertical

Figure 11: Open Coast Aquatic Habitat in West Segment

Figure 12: Open Coast Aquatic Habitat in Central Segment

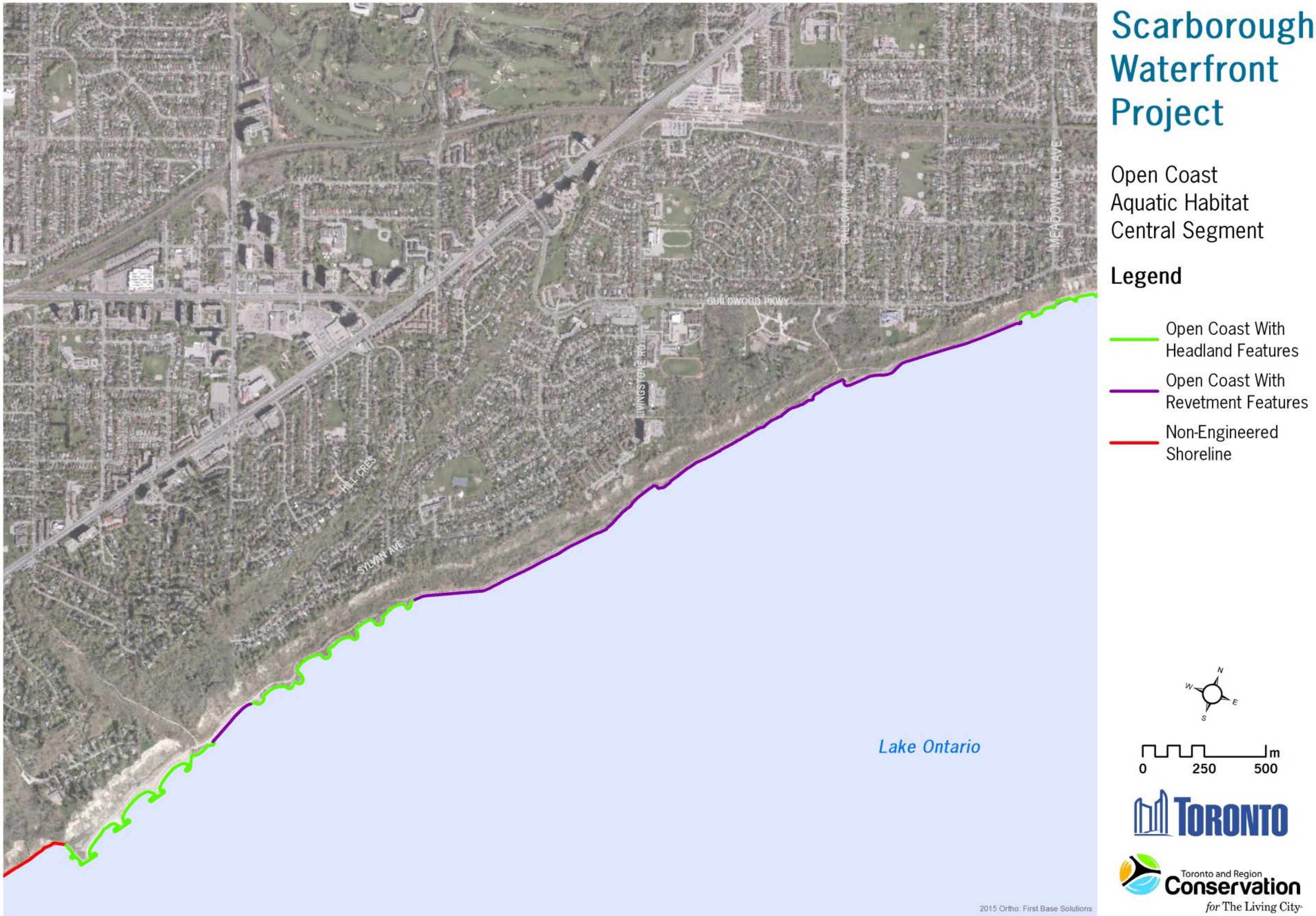
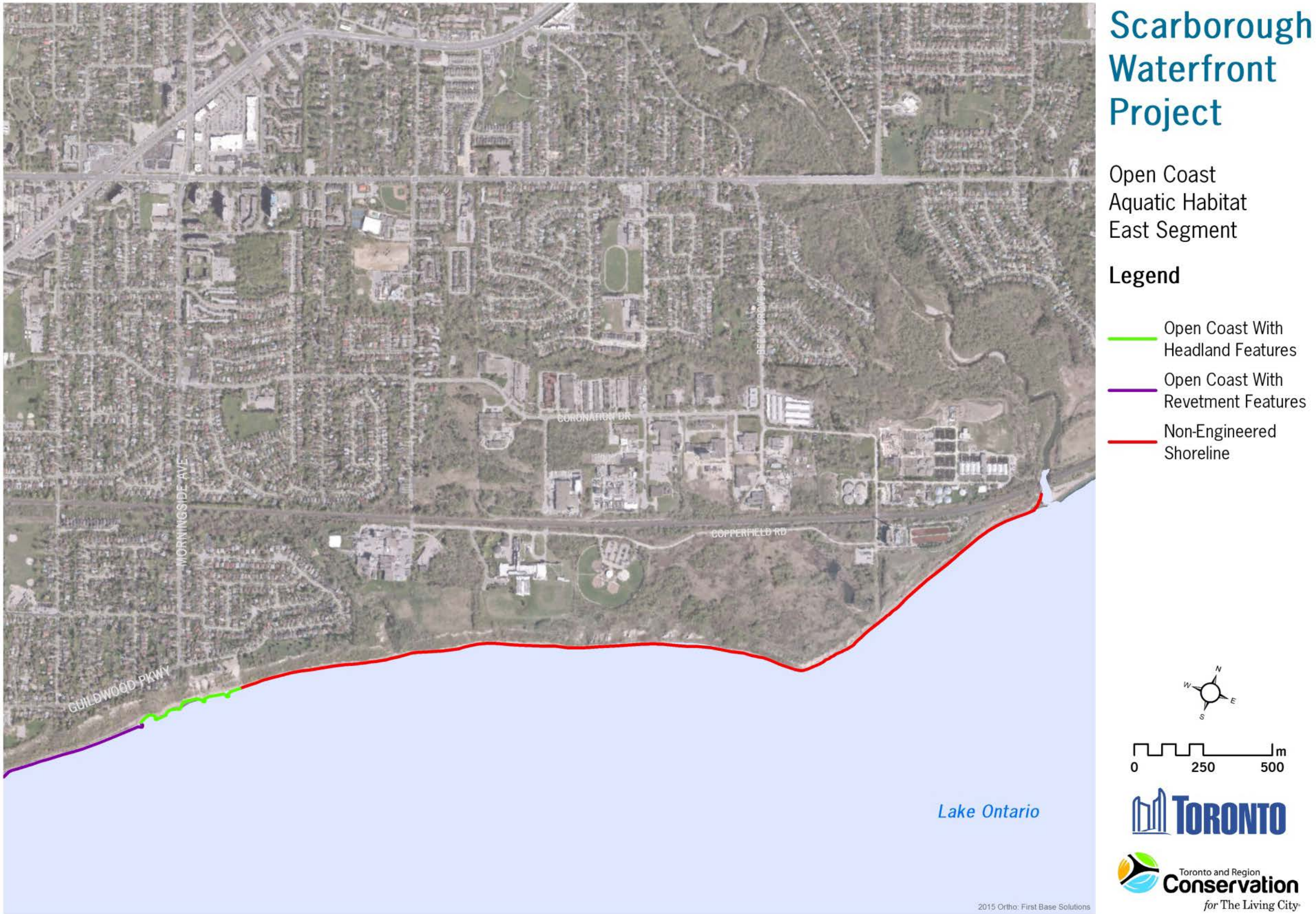


Figure 13: Open Coast Aquatic Habitat in East Segment



profile of the shoreline – is able to support a higher number of fish species and higher abundance of fish (see **Section 2.3.3.2.1** and **Section 2.3.3.2.2**).

These four main habitat types, along with the Lake Ontario tributaries, contain biophysical features that are essential for self-sustaining aquatic community. Whenever habitat is degraded or destroyed, more ecological damage occurs than just the loss of function at a specific site. For example, without adequate and sufficient habitat for reproduction, species and aquatic communities suffer because the transfer of genetic information is limited. When forage opportunities are affected, individuals do not grow and mature appropriately. As a result, energy transfers are reduced to recycling in large populations of very small, short-lived individuals usually associated with open water. The overall effect is a decrease in the self-regulatory and self-sustaining capacity of the biotic systems.

2.3.3 Fish Community

As previously stated, it is important to recognize that the Project Area is a component of the Lake Ontario ecosystem. Therefore, variables affecting the lake-wide fish community impact the local fish community.

The structure and overall health of the Lake Ontario fish community has undergone substantial changes through time in response to a variety of factors, such as habitat loss and/or degradation, overfishing, and interactions with invasive species (e.g., Alewife, Rainbow Smelt, Sea Lamprey [*Petromyzon marinus*]).

A fish community that was once dominated by native predatory pelagic fish (Atlantic Salmon [*Salmo salar*] and Lake Trout) and forage fish (Emerald Shiners and Spottail Shiners [*Notropus hudsonius*]) is now a mixture of both native and non-native. Currently, the most prevalent offshore predators include introduced Pacific and European salmonids (Chinook [*Oncorhynchus tshawytscha*] and Coho Salmon [*Oncorhynchus kisutch*], and Brown Trout [*Salmo trutta*] and Rainbow Trout [*Oncorhynchus mykiss*]), while the forage fish community is dominated by the non-native, invasive Alewife.

Efforts to rehabilitate the fish community have been on-going since the 1970s. Although increased management efforts targeting both the fish community and the overall quality of Lake Ontario have been implemented and improvements have been observed, a number of natural and human-induced factors, such as those previously discussed, still exist that continue to impact the fish community.

The Great Lakes Fishery Commission's Lake Ontario Committee believes that maintaining a modest approach to stocking a diversity of trout and salmon species, the implementation of regulations to sustain a diverse mix of fisheries, continued efforts to protect and restore native species, and investing in monitoring and science-based assessment to understand ecosystem change are the best management strategies to ensure the continuation of benefits (Stewart et al., 2013).

Locally, natural resource management agencies such as Conservation Authorities contribute to the continuation of benefits offered by the Lake Ontario ecosystem by supporting the *Fish Community Objectives for Lake Ontario* (Stewart et al., 2013) through restoration and enhancement of aquatic habitat historically destroyed or degraded, as well as continued long-term fish community monitoring.

TRCA has been monitoring the fish community along the Toronto waterfront, including the Project Area shoreline, since 1989. To characterize the local fish community, data collected in the last decade have been used. Trends in species richness, fish abundance and the community composition by trophic and thermal guilds have been evaluated by habitat type, and subsequently summarized by Project Area Segment, to provide an understating of the local fish community and the role of the various habitat types found in the Project Area.

2.3.3.1 Fish Community Data Collection Methodology

Fish community data were collected via a standardized electrofishing survey method conducted seasonally (spring through fall) each year at 14 sites shown in **Figure 14** to **Figure 16**.

Fish were sampled using an SR-18EH Smith-Root Electrofishing Boat equipped with a 7.5 kW pulsed DC electrofishing unit. Electrofishing crews were composed of four to five people: one certified operator, two netters and one to two support staff. Sampling time was 1,000 seconds per transect (site). Boat speed was kept as constant as possible depending on wind, current strength, and netting activity.

Netted fish were temporarily held in an onboard livewell to allow for recovery prior to processing. Fish processing included the identification of each individual to species, total length measurement to the nearest millimeter, and weight measurement to the nearest gram. Where the number of individuals of a given species exceeded 20, the remaining fish of that species were processed as a batch: smallest and largest individuals' lengths taken, number of individuals in a batch noted, and combined weight measured.

Collected fish data, in addition to air temperature (°C), water temperature (°C), current, water colour, bottom type, and aquatic vegetation, were recorded on Ministry of Natural Resources and Forestry Fish Collection Record forms. Fish were released immediately after processing.

Sampling effort (the number of times electrofishing surveys were conducted in a given year) was not consistent throughout the study period (**Table 5**). Sampling was dependent upon many factors including budget and weather.

Table 5: Summary of Annual Electrofishing Sampling Events by Project Area Habitat Type Between 2006 and 2016

Habitat Type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sheltered Embayment	4	4	2	2	5	4	6	5	2	6	9
Non-engineered Open Coast	1	1	0	0	1	0	1	0	6	6	11
Open Coast with Revetment Features	3	4	2	0	2	2	1	7	10	12	12
Open Coast with Headland Features	4	2	2	1	3	12	10	15	12	13	16

Figure 14: West Segment Electrofishing Runs

Figure 15: Central Segment Electrofishing Runs

Figure 16: East Segment Electrofishing Runs

2.3.3.2 Fish Community Data Analysis Methodology

2.3.3.2.1 Species Richness by Habitat Type

Species richness refers to the total number of fish species detected. Species richness was evaluated annually by habitat type.

Richness can be influenced by a number of factors, such as the provision of more diverse aquatic habitat for spawning and foraging or thermal refuge, and typically reflects the number of species in an area that are adapted to local environmental conditions.

2.3.3.2.2 Fish Abundance by Habitat Type

Average annual catch per 1,000 seconds of electrofishing effort (catch per unit effort, or CPUE) was calculated by dividing the total annual catch number for a given habitat type by the total number of electrofishing sampling events in a given year (see **Table 5** in **Section 2.3.3.1**). This calculation is done to correct for variability in the sampling effort during the monitoring period and standardize the results.

Changes in abundance over time within a given habitat type may signal a change to environmental conditions, which can be associated with a variety of factors, such as degradation, changes in the availability of a food source, or changes in habitat quality/availability. It is also important to note that abundance is not directly linked to species richness values.

2.3.3.2.3 Relative Fish Biomass Contributions by Feeding Group and Habitat Type

Three major feeding groups within the fish community were identified and evaluated across all habitat types in the Project Area: forage fish species, native piscivore (predator) species, and degradation-tolerant benthivore species.

The proportion of each group was assessed based on their relative biomass contribution to the annual total biomass per 1,000 seconds of electrofishing effort (% biomass per unit effort, or % BPUE).

The abundance of forage species, by mass, is important to acknowledge as forage species are the primary food source for larger open coast fish species such as salmon and trout, as well as the native piscivores utilizing the nearshore zone, such as Northern Pike, Largemouth and Smallmouth Bass.

Native piscivore populations are also important to examine, as healthy native piscivore populations create a “predation dominant” fish community (Regier et al., 1979), which is indicative of a healthy, balanced fish community (Fausch et al., 1990). The abundance of piscivores is a key factor in maintaining a balanced fish community in Lake Ontario, where environmental stresses, such as eutrophication, can inhibit the ability of piscivores to compete successfully (Hurley and Christie, 1977).

In the absence of piscivores due to potentially degraded environmental conditions that have inhibited their ability to compete successfully, degradation-tolerant benthivores (White Sucker [*Catostomus* *commersonii*] and Common Carp [*Cyprinus carpio*]) may dominate the fish community (Dietrich et al., 2008).

2.3.3.2.4 Relative Fish Community Abundance by Thermal Preference and Habitat Type

Fish species were grouped by their thermal guild (water temperature preference), and classified as cold, cool or warm water species. Thermal guilds proportions and distributions across all habitat types were compared using their relative contributions to the overall catch in a given year (i.e., % CPUE).

An understanding of the thermal guild distribution within the fish community helps guide the implementation of habitat enhancement techniques that are appropriate to the community and local conditions.

2.3.3.3 Fish Community Data Analysis Results

As discussed in **Section 2.3.1**, the Project Area is a component of the Lake Ontario ecosystem and is comprised of a series of interconnected zones containing multiple habitat types. Due to the mobile nature of fish, their tendency to concentrate within particular habitats, and the overlap of habitat types across each Project Area segment, fisheries data were evaluated at the habitat type level for the Project Area as a whole, and within each Project Area segment.

2.3.3.3.1 Species Richness by Habitat Type

Since 2006, a total of 44 individual fish species have been captured within the entire Project Area, of which 34 are considered native and 10 are considered non-native in origin (**Table 6**). It should be noted that this species list is not exhaustive and reflects the sampling bias resulting from sampling technique, frequency, and time of year. However, the techniques used to conduct the baseline surveys were appropriate for the species anticipated to be impacted by the Project.

Cold (preferred temperature <19^{0}C[2]), cool (preferred temperature 19-25^{0}C[2]) and warm (preferred temperature >25^{0}C[2]) thermal guild species were present within the Project Area, with the majority belonging to the cool water guild, followed by the warm water guild. Cold water species were least numerous.

Trophic group representation was variable across habitat types and throughout the study period. A total of 24 specialist species (generally high preference for specific diet, feeding method or locations), eight generalist species (generally low preference for specific diet, feeding method or locations) and 12 piscivore (fish-eating) species were observed.

As previously discussed, the Project Area contains two main types of habitat: 1) sheltered embayment; and 2) open coast, represented by the three subcategories: a) non-engineered; b) with revetment features; and c) with headland features.

2. *Preferred temperature ranges based on Coker et al. (2001).*

Table 6: Summary of Fish Species and Habitat Type Within the Project Area, Between 2006 and 2016

Origin	Common Name	Scientific Name	Thermal Guild	Trophic Guild	Project Area	Habitat Type			
						Sheltered Embayment	Open Coast		
							Unprotected	*Revetment Feature*	*Headland Feature*
	Atlantic Salmon	*Salmo salar*		Piscivore	x			x	x
	Longnose Sucker	*Catostomus catostomus*	Cold	Specialist	x				x
	Mottled Sculpin	*Cottus bairdii*		Specialist	x	x			x
	American Eel	*Anguilla rostrata*		Piscivore	x	x		x	x
	Blacknose Dace	*Rhinichthys atratulus*		Generalist	x		x		
	Brook Silverside	*Labidesthes sicculus*		Specialist	x	x		x	
	Brook Stickleback	*Culaea inconstans*		Specialist	x	x			
	Common Shiner	*Luxilus cornutus*		Specialist	x	x			
	Creek Chub	*Semotilus atromaculatus*		Generalist	x	x			
	Emerald Shiner	*Notropis atherinoides*		Specialist	x	x	x	x	x
	Golden Shiner	*Notemigonus crysoleucas*		Generalist	x	x			
	Lake Chub	*Couesius plumbeus*		Specialist	x				x
	Logperch	*Percina caprodes*	Cool	Specialist	x		x	x	x
	Longnose Dace	*Rhinichthys cataractae*		Specialist	x			x	x
	Northern Pike	*Esox lucius*		Piscivore	x	x			x
	Rainbow Darter	*Etheostoma caeruleum*		Specialist	x	x			
	Spotfin Shiner	*Cyprinella spiloptera*		Specialist	x		x		
Native	Spottail Shiner	*Notropis hudsonius*		Specialist	x	x	x	x	
	Threespine Stickleback	*Gasterosteus aculeatus*		Specialist	x	x	x	x	x
	Walleye	*Sander vitreus*		Piscivore	x	x			x
	White Sucker	*Catostomus commersonii*		Specialist	x	x	x	x	x
	Yellow Perch	*Perca flavescens*		Specialist	x	x	x	x	x
	Black Crappie	*Pomoxis nigromaculatus*		Specialist	x	x			
	Bluegill	*Lepomis macrochirus*		Specialist	x	x			
	Bluntnose Minnow	*Pimephales notatus*		Generalist	x	x			
	Bowfin	*Amia calva*		Piscivore	x	x			
	Brown Bullhead	*Ameiurus nebulosus*		Generalist	x	x	x	x	
	Fathead Minnow	*Pimephales promelas*	Warm	Generalist	x	x			
	Freshwater Drum	*Aplodinotus grunniens*		Specialist	x	x		x	x
	Gizzard Shad	*Dorosoma cepedianum*		Specialist	x	x	x	x	x
	Largemouth Bass	*Micropterus salmoides*		Piscivore	x	x		x	x
	Pumpkinseed	*Lepomis gibbosus*		Specialist	x	x			x
	Rock Bass	*Ambloplites rupestris*		Specialist	x	x		x	x
	Smallmouth Bass	*Micropterus dolomieu*		Piscivore	x	x	x	x	x

Table 6: Summary of Fish Species and Habitat Type Within the Project Area, Between 2006 and 2016

Origin	Common Name	Scientific Name	Thermal Guild	Trophic Guild	Project Area	Habitat Type			
						Sheltered Embayment	Open Coast		
							Unprotected	*Revetment Feature*	*Headland Feature*
Non-Native	Brown Trout	*Salmo trutta*	Cold	Piscivore	x	x	x	x	x
	Chinook Salmon	*Oncorhynchus tshawytscha*		Piscivore	x	x		x	x
	Coho Salmon	*Oncorhynchus kisutch*		Piscivore	x				x
	Rainbow Trout	*Oncorhynchus mykiss*		Piscivore	x		x	x	x
	Alewife	*Alosa pseudoharengus*	Cool	Specialist	x	x	x	x	x
	Rainbow Smelt	*Osmerus mordax*		Specialist	x	x	x	x	X
	Round Goby	*Neogobius melanostomus*		Specialist	x	x	x	x	x
	Sea Lamprey	*Petromyzon marinus*		Piscivore	x	x			x
	Common Carp	*Cyprinus carpio*	Warm	Generalist	x	x	x	x	x
	Goldfish	*Carassius auratus*		Generalist	x	x			
SPECIES RICHNESS					**44**	**35**	**17**	**23**	**28**

Species richness varied by habitat type. On average, the embayment contained the greatest number of fish species (**Table 7**). Embayment was followed by open coast with headland features and open coast with revetment features. Non-engineered open coast had the lowest number of species detected.

Table 7: Annual and Average Species Richness Values by Habitat Type Between 2006 and 2016

Habitat Type		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	*Annual Average*
Sheltered Embayment		16	14	12	13	14	11	20	13	18	17	19	***15***
Open Coast	*Revetment*	10	7	9	--	6	4	6	7	10	12	12	***8***
	Headland	18	6	5	6	8	8	15	18	15	18	16	***12***
	Non-engineered	3	6	--	--	4	--	0	--	5	4	7	***4***
Project Area		25	17	15	13	19	16	26	20	24	26	29	***21***

Note: "--" indicates years not fished.

Alewife (non-native forage fish), Emerald Shiner (native forage fish), White Sucker (native degradation-tolerant species), and Brown Bullhead (native) have been detected consistently over time. American Eel (*Anguilla rostrata*) and Atlantic Salmon (both also piscivores, and SAR) have been captured least frequently. In fact, until its capture in 2012, the last record of American Eel in the Project Area was in 1993; American Eel has since been consistently captured in the Project Area in the sheltered embayment habitat, with additional captures along the open coast with revetment (2014) and headland features (2013 to 2015). Atlantic Salmon was first detected in the Project Area in 2014, and two more captures were made in 2016.

Species not detected during the 2006-2016 period (and thus not included in the current analysis) include Lake Trout. Lake Trout were captured in the 1990's and early 2000's, mostly during the electrofishing surveys along the Bluffer's Park headland extending towards the Bluffer's Park Beach. Particularly notable was the capture of 39 mature individuals in Fall 1991. Lake Trout have not been captured in the Project Area since 2005, which is likely due to reduced Lake Trout stocking efforts.

An annual detection summary of the various species by habitat type during the 2006 to 2016 period is found in **Appendix E.**

The greater fish species richness associated with the embayment habitat (average of 15 species per year, and 35 species overall, of which 27 were native and 8 non-native) is likely due to calmer conditions (embayments are well-protected from the wave action), presence of in-water woody debris, and presence of abundant aquatic vegetation throughout the summer months. Additionally, significantly reduced wave action in the embayment area results in the development of a warm water thermal refuge, allowing for the establishment and persistence of a variety of fish species adapted to these conditions.

As mentioned above, species richness along the non-engineered sections of open coast was the lowest overall, with an annual average of 4 species, and an overall total of 17 species (11 native and

6 non-native). Species richness values along the open coast with revetment features were greater, with an annual average of 8 species and overall total of 23 species (16 native and 7 non-native) encountered, while an annual average of 12 species and overall total of 28 species (19 native and 9 non-native) were redetected along sections of the open coast with headland features.

The variation in species richness values across the three types of open coast habitat could be attributed to the differences in aquatic habitat complexity (morphology and substrate diversity), as thermal conditions remain consistent across all three. Within the Project Area, the non-engineered sections of open coast are predominantly fine aggregate (some large boulders are sparsely scattered farther offshore) with a fairly linear shoreline profile - conditions most suitable for a select group composed primarily of forage species. Similarly, the existing sections of open coast with revetment features provide uniform and relatively limited habitat due to their linear armourstone/rip-rap structure and a small amount of coarse substrate along the shoreline.

In contrast, higher species richness values were found along portions of the coast with headland features as these systems are designed to increase the complexity of aquatic habitat available through an irregular shoreline profile and increases in substrate diversity (via cobble, rubble and/or boulder inclusion). The resulting increase in habitat complexity provides enhanced cover, spawning and foraging opportunities for a greater variety of species along the open coast with headland features relative to the non-engineered open coast or open coast with revetment features. T-shaped headland features create backwater refuge areas that provide additional cover and shelter opportunities for fish.

The creation of the Meadowcliffe headland beach system, or open coast with headland features (located at the western-most end of Central Segment), illustrates this in detail. A change in species richness was observed following the construction of the system (**Table 8**). When this section of shoreline was a non-engineered section of open coast (2006 to 2010), species richness values ranged between 2 and 4. After construction was completed, richness values increased to a maximum of 13 species. Notable species detected after the headland-beach system was implemented include native piscivores such as Northern Pike, Largemouth Bass, Smallmouth Bass, and the SAR American Eel.

Table 8: Annual Species Richness at the Meadowcliffe Headland Beach System, Pre- and Post- Headland Beach System Construction

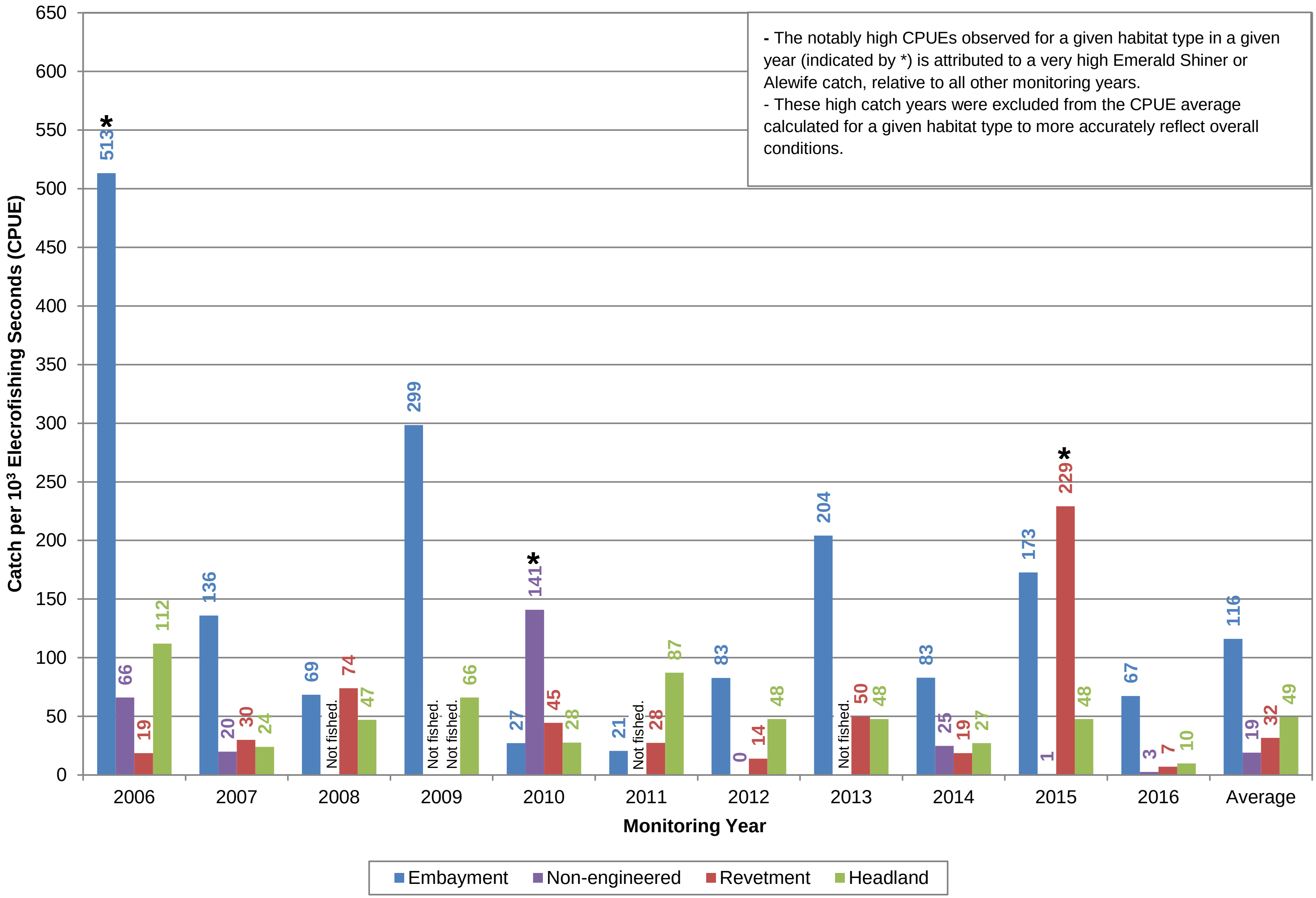
2006	2007	2008-2009	2010	2011*	2012*	2013	2014	2015	2016
3	2	Not surveyed	4	6	10	10	12	13	8

*Note: * Construction years.*

2.3.3.3.2 Fish Abundance by Habitat Type

Fish were most abundant within the sheltered embayment of Bluffer's Park boat basin, with an annual average catch of 116 fish (**Figure 17**). Alewife was the most abundant species captured within the embayment, comprising 18.6% of the total average annual catch between 2006 and 2016. Alewife is a highly reproductive schooling species that is prone to dramatic population changes, which can result

Figure 17: Average Annual Catch per Unit Effort (CPUE) for Each Project Area Habitat Type between 2006 and 2016



from environmental conditions, excess predatory pressures, inadequate food supply, or a combination of these (Dietrich et al., 2008; Stewart et al., 2013). The second-most abundant species was Yellow Perch at 11% of the total average annual catch, followed by Pumpkinseed (*Lepomis gibbosus;* 5.2%), White Sucker (2.8%) and Northern Pike (2.8%).

Sections of open coast with headland features had the second highest CPUE values, with an annual average of 49 fish. Alewife or Emerald Shiner were the most abundant species, making up 49.8% and 35.5% of the total average annual catch, respectively.

The open coast with revetments had second-lowest CPUE values, with an annual average of 32 fish Alewife was the most abundant species in this habitat type, with average annual Alewife catch making up 33.4% of the overall average annual catch between 2006 and 2016. Emerald Shiner was the second most abundant species at 7.8% of the total average annual catch, followed by White Sucker at 6%. Given the fairly low quality of aquatic habitat associated with revetment features, as is typical of their design, the generally low CPUE associated with this habitat type is an expected result.

CPUE values along sections of non-engineered open coast were the lowest, with an annual average catch of 19 fish. A high Emerald Shiner catch (138 fish) relative to all other monitoring years was observed in 2010. Similarly to the other two open coast sites, Alewife was the most abundant species at 33.5% of the total average annual catch, followed by Emerald Shiner at 7.4%.

Low average annual CPUE values associated with the open coast are expected as the open coast is generally considered a lower productivity zone, relative to the sheltered embayment. Due to the often hostile conditions (e.g. wave action, rapid changes in temperature) and the currently low availability of diverse and complex habitat along revetments and non-engineered open coast, fewer fish species utilize these areas.

2.3.3.3.3 Relative Fish Biomass Contributions by Feeding Group and Habitat Type

Forage Fish

As discussed in **Section 2.3.3.2.3**, abundance of forage species, by mass, is important to acknowledge as forage fish are the primary food source for piscivores utilizing the nearshore zone such as American Eel, Northern Pike, and Largemouth and Smallmouth Bass, and salmonids. Historically, the key forage species in Lake Ontario were native Emerald Shiner and Spottail Shiner (Stewart et al., 2013). However, non-native Alewife and Rainbow Smelt became more abundant forage species over time.

Within the Project Area fish community, the forage fish community is primarily composed of the non-native Alewife and native Emerald Shiner. While the non-native Rainbow Smelt and native Spottail Shiner are also considered forage species, they were excluded from the forage fish community analysis given their low proportion by biomass.

It should also be noted that within the warm waters of the sheltered embayment, fry and juvenile fish of a number of other species such as Pumpkinseed, Bluntnose Minnow (*Pimephales notatus*), White

Sucker and Yellow Perch provide a forage base for piscivores. However, they were not included in the analysis given their low proportion by biomass.

Overall, Alewife make up the greatest proportion of the Project Area forage fish community, though variations in forage fish community composition by mass were observed across habitat types (**Figure 18**).

In the sheltered embayment, Alewife and Emerald Shiner proportion of the total average annual fish biomass was lowest (2.4% and 0.5%, respectively).

In the open coast habitat, Alewife and Emerald Shiner biomass proportion was higher, with the highest values associated with the non-engineered open coast habitat. Here, Alewife constituted approximately 17.7% of the total average annual fish community biomass, and Emerald Shiner made up 9.9%. Non-native Alewife remained the dominant forage species along sections of open coast with both revetment and headland features, at 14.9% and 9.6% of the total average annual fish community biomass, respectively. However, native Emerald Shiner contributed a greater proportion of biomass to the open coast headland habitat fish community, at 1.3%, while approximately 0.6% of the open coast revetment habitat fish community consisted of Emerald Shiner.

Native Piscivores

As discussed in **Section 2.3.3.2.3**, healthy native piscivore populations create a “predation dominant” fish community (Regier et al., 1979), which is indicative of a healthy, balanced fish community (Fausch et al., 1990).

Native piscivores within the Project Area include Atlantic Salmon, American Eel, Northern Pike, Walleye (*Sander vitreus*), Bowfin (*Amia calva*), Largemouth Bass, and Smallmouth Bass.

Native piscivore biomass contributions across the Project Area habitat types varied by habitat type as well as species.

The sheltered embayment was the only habitat type where native piscivores have been detected on an annual basis, and have provided the greatest contributions, on average, to fish community biomass (**Figure 19**). Northern Pike was the most dominant native piscivore within the sheltered embayment fish community, composing approximately 16.9% of total average annual fish community biomass. Bowfin (1.3%), American Eel (1.1%), Largemouth Bass (0.9%), Walleye (0.1%), and Smallmouth Bass (0.1%) constituted smaller average annual biomass contributions.

Along the open coast, native piscivores were not captured on an annual basis. . In the open coast with headland features, Northern Pike was the most abundant native piscivore species by biomass, composing 17.4% of the total average annual fish community biomass. Atlantic Salmon (0.7%), American Eel (0.3%), Smallmouth Bass (0.2%), and Largemouth Bass (0.3%) constituted smaller average annual biomass contributions.

Native piscivore contributions along the open coast with revetment features were limited, with these species only being detected in 2006, 2014 and 2016 (**Figure 19**). Smallmouth Bass and Atlantic

Figure 18: **Percent Contribution of Forage Species (Alewife and Emerald Shiner) Biomass to Total Average Annual Fish Community Biomass by Habitat Type (% Biomass per Unit Effort, or % BPUE)**

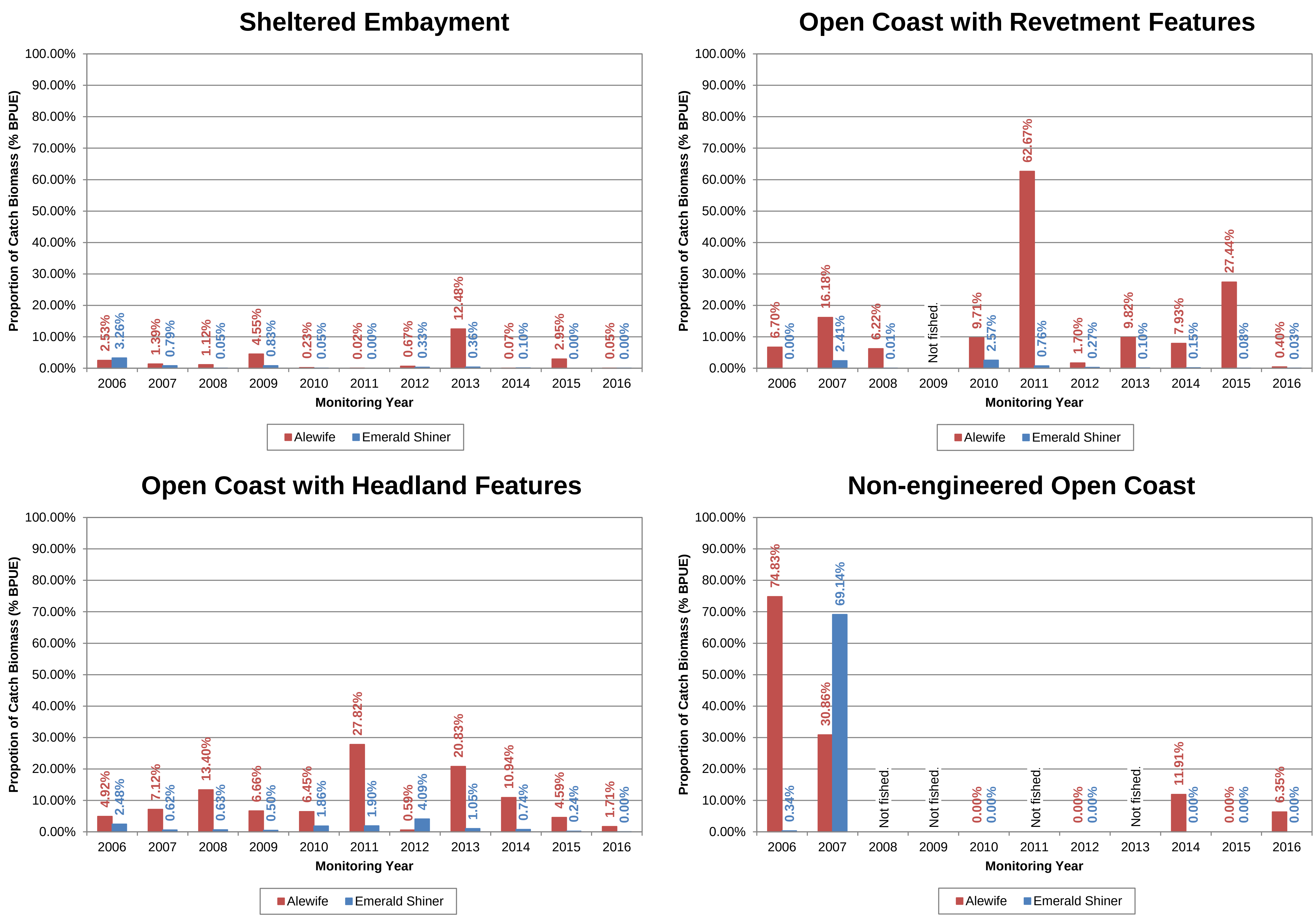
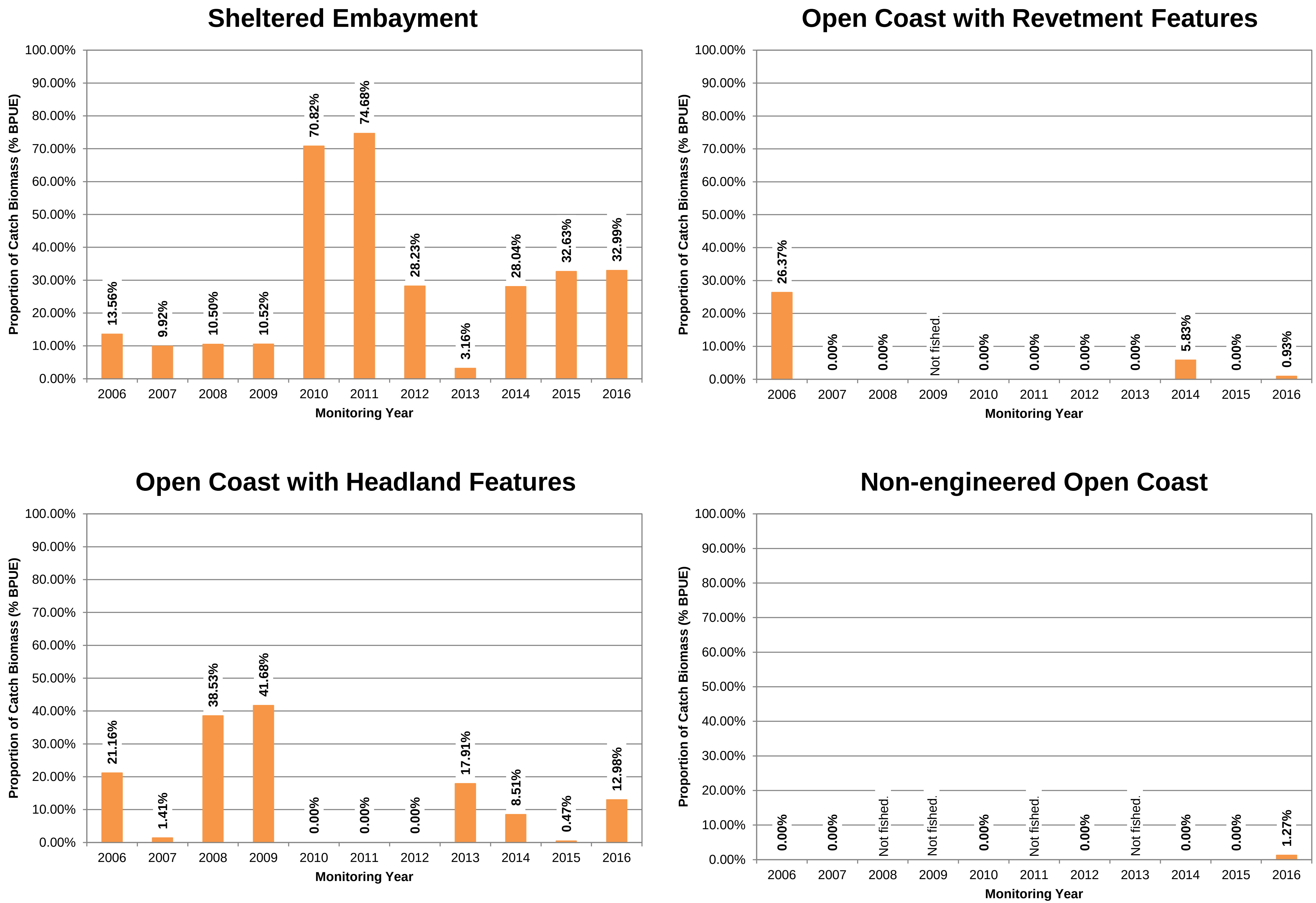


Figure 19: **Percent Contribution of Native Piscivore Species (American Eel, Atlantic Salmon, Bowfin, Largemouth Bass, Northern Pike, Smallmouth Bass, and Walleye) Biomass to Total Average Annual Fish Community Biomass by Habitat Type (% Biomass per Unit Effort, or % BPUE)**



Salmon comprised 0.4% and 0.3% of total average annual community biomass, respectively. American Eel and Largemouth Bass contributed in very small proportions.

Along the non-engineered open coast, native piscivores were detected only once between 2006 and 2016, with Smallmouth Bass, the only native piscivore captured in this habitat type, contributing 1.3% to the total average annual fish community biomass that year.

Degradation-Tolerant Benthivores

In the absence of piscivores, degradation-tolerant benthivores (White Sucker and Common Carp) may dominate the fish community in response to potentially degraded environmental conditions (Dietrich et al., 2008).

White Sucker and Common Carp proportions by biomass varied by habitat type and year.

Within the sheltered embayment, degradation-tolerant benthivores contributed 28.4% to the total average annual fish community biomass (**Figure 20**).

Along the open coast with headland and revetment features, benthivores' contribution to the fish community biomass was generally higher, at 47.2% and 49.7% of the total average annual fish community biomass, respectively, for all years.

Along the non-engineered open coast, benthivores' contribution to the fish community biomass was generally lower, at 15.0% of the total average annual community biomass for all years.

Although a greater proportion of benthivores by mass may indicate environmental degradation, it is important to note that their distribution also reflects the habitat types they are most adapted to. In particular, a higher proportion of Common Carp in the sheltered embayment is expected given their preference for calm warm water, dense aquatic vegetation, and soft substrate for consumption of macroinvertebrates, algae and aquatic plants (Holm et al., 2010). The bottom-feeding species White Sucker also has a propensity for macroinvertebrate and aquatic vegetation consumption, but is slightly more versatile in terms of thermal requirements, although it does prefer cool waters (Holm et al., 2010).

2.3.3.3.4 Relative Fish Abundance by Thermal Preference and Habitat Type

Warm, cool and cold water habitats have all been identified within the Project Area:

- Warm water: sheltered embayment;
- Cool/cold water: non-engineered open coast, open coast with revetment features, and open coast with headland features.

Fish species from all three thermal guilds have been observed throughout the Project Area (see **Table 6**).

Cool water species were most abundant, on average, across all habitat types for the Project Area (**Figure 21**).

Figure 20: **Percent Contribution of Degradation-Tolerant Benthivores (White Sucker and Common Carp) Biomass to Total Average Annual Fish Community Biomass by Habitat Type (% Biomass per Unit Effort, or % BPUE)**

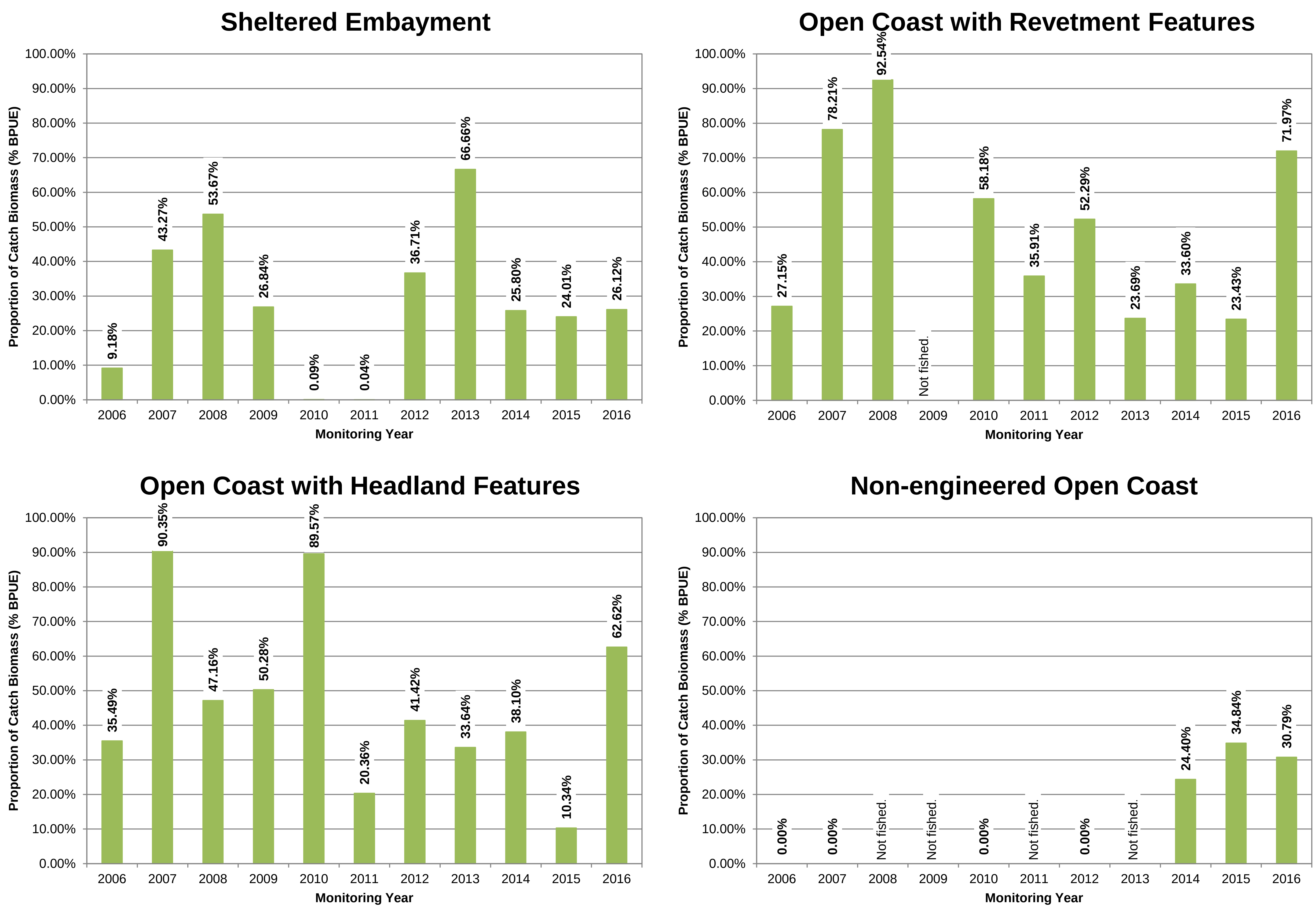
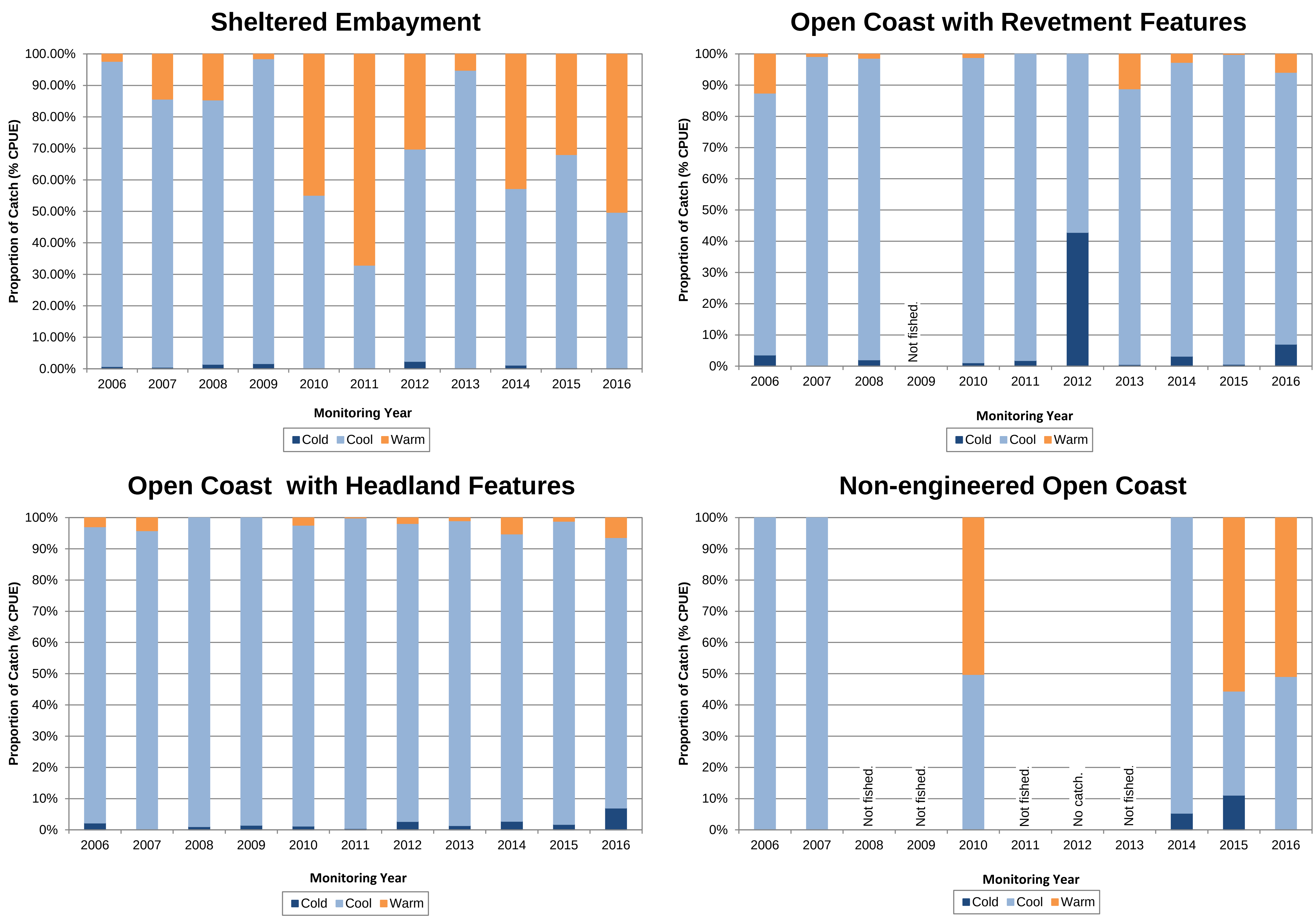


Figure 21: **Percent Contribution of Cold, Cool and Warm Water Species Catch to Total Average Annual Fish Community Catch by Habitat Type (% Catch per Unit Effort, or % CPUE)**



Warm water species were generally the second-most abundant in the sheltered embayment and along the non-engineered open coast. In some years, average annual warm water fish were as abundant as average annual cool water fish for both habitat types. Average annual warm water fish were marginally greater than average annual cold water fish along the open coast with headland features.

The relatively high abundance of warm water fish along the non-engineered open coast may be due to the fact that the fish community sampling is seasonal and typically restricted from late Spring to early Fall, with most sampling events having been conducted in the Summer. In other words, fish community sampling takes place when the temperature conditions along the open coast enable its utilization by the warm water fish species.

The open coast with revetment features is the only habitat type within the Project Area where cold water species were found in greater average annual catch proportions overall, relative to warm water species.

Consideration of fish distribution by thermal guild throughout the Project Area will aid in the design of habitat enhancements by employing enhancement techniques specific to a given habitat type.

2.3.3.3.5 Fish Community by Project Area Segment - Summary

West

Three aquatic habitat types have been identified within the West Segment (see **Figure 11**):

- Sheltered embayment (Bluffer’s Park boat basin)
- Open coast with headland features (Bluffer’s Park headland)
- Non-engineered open coast (Bluffer’s Park Beach)

Both fish species richness values and abundance are greatest within Bluffer’s Park boat basin, followed by the open coast around the Bluffer’s Park headland, then the non-engineered open coast of Bluffer’s Park Beach. Alewife is the most abundant species across all three habitat types, while Emerald Shiner is the next most abundant along the open coast and Yellow Perch the next most abundant in the embayment (Bluffer’s Park boat basin).

In Bluffer’s Park boat basin, Alewife and Emerald Shiner provide relatively small contributions by mass to the overall forage base relative to their contributions along the open coast. Additional forage species within the sheltered embayment include species such as Pumpkinseed and Bluntnose Minnow.

Northern Pike is the most dominant native piscivore, by mass, in the sheltered embayment habitat and along the open coast with headland features. American Eel, Largemouth and Smallmouth Bass utilize these habitats as well, though their proportion by biomass is smaller. Bowfin and Walleye also contribute to the native piscivore population within the sheltered embayment of the boat basin, while Atlantic Salmon have been recently captured along the headland feature outside the boat basin.

Degradation-tolerant benthivores Common Carp and White Sucker constitute the greatest proportion of the fish community biomass in both Bluffer's Park boat basin and around the Bluffer's Park headland. However, both species are infrequently detected along the non-engineered coast of Bluffer's Park Beach.

Generally, cool water species are most abundant in the West Segment. At the same time, warm water fish in the embayment habitat were as abundant as cool water fish in some years. Cold water fish are least abundant in all habitat types of the West Segment.

Central

Two aquatic habitat types have been identified within the Central Segment (see **Figure 12**):

- Open coast with headland features (headland beach systems of Meadowcliffe Drive and Sylvan Avenue)
- Open coast with revetment features (informal revetment between Meadowcliffe and Sylvan and along Guild Park and Gardens, and the formal revetments along South Marine Drive and Guildwood Parkway)

Both fish species richness and abundance are greater along the sections of open coast with headland beach systems relative to the sections with revetments. However, overall richness and abundance values are lower than the West Segment, which is likely due to the fact that embayments, the habitat type associated with the highest species richness and abundance, are absent from Central Segment.

A notable change in species richness was observed at Meadowcliffe following construction of the headland beach system between 2011 and 2012 (see **Table 7** in **Section 2.3.3.3.1**). Prior to shoreline modification, when the shoreline was a non-engineered open coast, species richness values were low, ranging from 2 to 4. After construction, an increase in richness values was observed, with a maximum of 13 species detected.

Forage fish Alewife and Emerald Shiner are most abundant in the open coast fish community within the Central Segment, followed by White Sucker.

Alewife is also the most dominant forage species by biomass along both open coast habitat types of Central Segment. Along the Meadowcliffe and Sylvan headland beach systems, Northern Pike are the greatest contributor to the native piscivore community by biomass, with additional contributions from American Eel, Largemouth Bass and Smallmouth Bass. In contrast, only two native piscivore species – Atlantic Salmon and Smallmouth Bass – have been detected along the South Marine Drive and Guild revetment features. Degradation-tolerant benthivores constitute a greater proportion of the total fish community's biomass around the headland beach systems, and make up a smaller proportion of the total fish community biomass along the South Marine Drive and Guild revetments.

As in the West Segment, cool water species are most abundant in the Central Segment. Along the open coast with headland features (Meadowcliffe and Sylvan), cool water species are followed by warm water species in terms of fish abundance. Along the open coast with revetment features (South

Marine Drive and the Guild), cold water fish are second-most abundant. Overall, fish abundance is lower along the open coast with revetment features compared to open coast with headland features.

East

Two aquatic habitat types have been identified within the East Segment (see **Figure 13**):

- Open coast with headland features (groynes immediately west of Grey Abbey Park)
- Non-engineered open coast (from Grey Abbey Park to the Highland Creek mouth)

Less than 15% of the shoreline length within the East Segment is classified as open coast with headland features.

Species richness and fish abundance are the lowest in this Segment compared to the West and Central Segments. This may be attributed to the predominance of the non-engineered open coast habitat type along the Grey Abbey and East Point Park shorelines which constitute over 80% of the East Segment shoreline length. As in the open coast habitat of the West and Central Segments, Alewife is the most abundant species, followed by Emerald Shiner. Alewife also provides the greatest contribution to the forage fish community biomass.

Native piscivore biomass proportion is low compared to values observed in West and Central Segments. Only one native piscivore species – Smallmouth Bass – was detected in the East Segment, once (in 2016) in four years of sampling.

Degradation-tolerant benthivores Common Carp and White Sucker are fairly common, having been captured in three of the four years of sampling in this Segment.

As in the West and Central Segments, cool water fish are most abundant. Cool water fish abundance values are followed by warm water fish abundance values, and cold water fish are least abundant.

2.4 Species at Risk (SAR)

SAR include plants and animals identified in provincial and federal SAR legislation that have been detected within the Project Area.

2.4.1 SAR Recognition and Protection

There are several levels of SAR recognition and protection, based on authority and jurisdictional boundaries. Each level is identified and described in **Table 9**. Not every proposed activity that occurs within or near protected habitat will damage or destroy SAR habitat (Government of Ontario, 2015). The following will be considered as they apply to SWP Alternatives development, evaluation and selection of the Preferred Alternative:

- details of the activity (i.e., type and degree of the Alternatives' impact on a given SAR and its habitat);

Table 9: SAR Levels of Recognition and Protection

Authority	Details
Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[3]	▪ COSEWIC is the nation-wide authority for assessing the conservation status of wildlife species that may be at risk of Extinction in Canada. ▪ COSEWIC's assessment informs SARA and is considered to be the first step in wildlife protection.
Federal Species at Risk Act (SARA), enforced by Environment Canada[4]	▪ SARA is a federal law designed to prevent wildlife species from becoming Extinct and to help facilitate the recovery of these species. ▪ The federal list of SAR is determined by the federal government, and is based on the recommendations made by the COSEWIC. Not all species status recommended by COSEWIC is listed under SARA. ▪ The Act establishes Schedule 1 as the official list of wildlife SAR. It classifies those species as being Extirpated, Endangered, Threatened or a Special Concern. Once listed, appropriate agencies work together to lay out a Recovery Strategy that outlines a plan to recover the species. ▪ Extirpated, Endangered or Threatened species[5] on the SARA list receive protection (i.e., illegal to kill, harass, capture or harm in any way) and recovery planning under SARA. Recovery planning results in the development of recovery strategies and action plans. ▪ Special Concern species benefit from management planning.
Endangered Species Act, enforced by Ontario Ministry of Natural Resources and Forestry (MNRF)[6]	▪ The *Endangered Species Act* aims to identify, protect and facilitate the recovery of Ontario SAR. ▪ Each species is classified into one of four categories: 1. Extirpated: lives somewhere in the world, and at one time lived in the wild in Ontario, but no longer lives in the wild in Ontario 2. Endangered: lives in the wild in Ontario but is facing imminent Extinction or Extirpation 3. Threatened: lives in the wild in Ontario, is not Endangered, but is likely to become Endangered if steps are not taken to address factors threatening it 4. Special Concern: lives in the wild in Ontario, is not Endangered or Threatened, but may become Threatened or Endangered due to a combination of biological characteristics and identified threats ▪ Endangered, Threatened or Extirpated species are automatically protected from being harmed or harassed. Special Concern species are not included in this protection. ▪ General habitat of Endangered or Threatened species is automatically protected. Specific habitat is regulated based on species recovery strategy. ▪ Recovery strategies are completed for Endangered, Threatened and Extirpated species, while management plans are completed for species listed as Special Concern.

3. *Source: Government of Canada, 2013.*
4. *Source: Government of Canada, 2002.*
5. *Automatic protection of species applies to migratory birds, aquatic species, and species on federal lands. In many cases protection of terrestrial species on non-federal lands is the responsibility of the provinces/territories where they are found.*
6. *Source: Government of Ontario, 2015.*

- which parts of habitat are likely to be altered by the activity (e.g., location of the Alternatives in the context of SAR habitat, including potential habitat); and,
- how habitat changes will affect the species' ability to carry out its life processes.

Likewise, not every activity that occurs near a member of a protected species will kill, harm or harass that member (Government of Ontario, 2015). To help determine if a given Alternative or work associated with a given Alternative's implementation could kill, harm or harass a member of a protected species, the following will be considered:

- the biology and behaviour of the species;
- details of the activity (i.e., type and degree of Alternatives' impact on SAR); and,
- how the activity may affect the species' ability to carry out its life processes.

2.4.2 Plant SAR

Only two vascular plant species currently included in provincial and federal (Schedule 1) SAR lists were observed in the Project Area:

1. **Butternut**: Endangered status under both the Ontario *Endangered Species Act* and federal *Species at Risk Act*
2. **Spike Blazing-Star**: Threatened status under both the Ontario *Endangered Species Act* and federal *Species at Risk Act*

Butternut was observed in all three Segments of the Project Area, while spike blazing-star was observed in one (East Segment). Due to these species' sensitivity, specific location information is not discussed in this report, but will be considered in Project planning, design, and implementation, as applicable.

Should any of the project activities impact SAR, MNRF will be consulted, and all efforts will be made to avoid negative impacts.

2.4.3 Terrestrial SAR

Twelve terrestrial SAR designated provincially and/or federally have been detected in the Project Area. These species and their current provincial and federal status are listed in **Table 10**.

MNRF, as well as other appropriate agencies, will be consulted throughout the Project. All efforts will be made to avoid negative impacts to SAR.

Bank Swallows are among a group of aerial insectivores with declining populations. The reasons for their population decline are not well understood and evaluation of threats to the population is incomplete. In Ontario threats include loss of nest site habitat; loss or degradation of foraging habitat; environmental contaminants, pesticides and pollutants; reduced nest productivity due to human activities and persecution; habitat loss, disturbance and persecution at roost sites; and climate change (Falconer et al., 2016).

Table 10: Wildlife SAR Found in the Project Area[7]

Species	Status		Year Detected *(most recent observation)*	Breeding Status*
	Provincial (*Endangered Species Act*)	**Federal** (*Species at Risk Act,* Schedule 1)		
Birds				
Bank Swallow	Threatened	--	2015	Confirmed
Barn Swallow	Threatened	--	2011	Possible
Bobolink	Threatened	--	2014	Probable
Chimney Swift	Threatened	Threatened	2011	Probable
Eastern Meadowlark	Threatened	--	2003	Possible
Wood Thrush	Special Concern	-	2011	Confirmed
Mammals				
Little Brown Bat	Endangered	Endangered	2016	Unknown
Tricolored Bat	Endangered	Endangered	2016	Unknown
Herpetofauna				
Common Musk Turtle (Eastern Musk Turtle or Stinkpot)	Special Concern	Special Concern	2003	Possible

Sources: Government of Ontario, 2015; Government of Canada, 2016

Notes: * Confirmed Breeder = *Signs of confirmed breeding observed (e.g., nest with eggs or young, used nest, adults carrying food)*

Probable Breeder = *Signs of probably, but unconfirmed, breeding observed (e.g., nest building, pair observed in suitable habitat during breeding season, courtship displays)*

Possible Breeder = *Signs of possible, but unconfirmed, breeding (e.g., species observed in suitable habitat during breeding season, breeding calls or singing male heard in suitable nesting habitat) (Source: Ontario Breeding Bird Atlas, 2001)*

2.4.4 Fish SAR

Two fish species included in provincial and federal (Schedule 1) SAR lists were observed in the Project Area:

1. **Atlantic Salmon**: Extirpated under the federal *Species at Risk Act*
2. **American Eel,** Threatened under the Ontario *Endangered Species Act*

Since 1898, there has been no record of the Lake Ontario Atlantic Salmon population. The disappearance of the population has been attributed to habitat destruction and overexploitation associated with European settlement in the 1800s. As a result, Lake Ontario Atlantic Salmon is listed as Extirpated under the federal *Species at Risk Act*.

Some of the first returns of Atlantic Salmon adults in the TRCA jurisdiction, following initiation of the Bring Back the Salmon Program in 2006, have been captured along the Scarborough shoreline, with

7. *Sources: Government of Ontario, 2015; Government of Canada, 2016.*

the first individual captured in 2014 near the Guild shoreline. They have since been detected at the Bluffer's Park headland and Sylvan headland beach system in 2016.

Until its capture in 2012 in the Bluffer's Park boat basin, the last record of American Eel in the Project Area dates back to 1993. American Eel has since been consistently captured in the Project Area in both the embayment (Bluffer's Park boat basin) and open coast habitats (Meadowcliffe, Sylvan Avenue and the Guild).

Both Atlantic Salmon and American Eel utilize the local aquatic habitat to forage and move along the shoreline. Therefore, availability of adequate food resources (forage and juvenile fish for Atlantic Salmon, and insects, crayfish and/or small and large fish for American Eel), shelter and cover is essential.

3. Development of Alternatives

As the SWP Alternatives were not developed to create new habitat, terrestrial and aquatic habitat components were not considered as part of their development. Rather, terrestrial and aquatic habitat components were used as measures to compare and evaluate the SWP Alternatives against one another as part of the comparative evaluation (see **Section 4**), and as part of the Detailed Effects Assessment of the Refined Preferred Alternative (see **Section 5.2**).

4. Comparative Evaluation of Alternatives

The comparative evaluation of SWP Alternatives was based on specific Criteria which measured the potential impacts (both positive and negative) of the SWP Alternatives on the terrestrial and aquatic natural features and linkages in the Project Area. Criteria and Indicators were developed to measure how effectively each SWP Alternative met the natural environment Objective. Qualitative, and whenever possible quantitative, evaluations were undertaken for each Indicator.

The final Criteria and Indicators are:

1. Extent of aquatic habitat enhanced or diminished:
    a. Ability to increase shoreline morphology by increasing shoreline irregularity;
    b. Ability to increase shoreline substrate type diversity; and,
    c. Potential for aquatic habitat loss or modification.
2. Extent of terrestrial habitat attributes enhanced or diminished:
    a. Potential to create appropriate land-water interface; and,
    b. Impact to vegetation communities of concern.
3. Potential for impact on terrestrial SAR:
    a. Potential effects to habitat for Bank Swallow.

The Criteria and Indicators are discussed in greater detail in the following sections. A description of the measures used in the comparative evaluation is also provided.

4.1 Criteria: Extent of Aquatic Habitat Enhanced or Diminished

4.1.1 Indicator: Ability to Increase Shoreline Morphology by Increasing Shoreline Irregularity

In general, more irregular (longer) shoreline profiles provide more available and functional nearshore fish habitat. Increasing the length of shoreline habitat within a given area increases the opportunity for more shallow waters (littoral zone) to be present, which is important for improving fish foraging opportunities, cover and shelter (Kent and Wong, 1982). The MNR identifies a Shoreline Development Factor (S.D.F) in their *Manual of Instructions: Aquatic Habitat Inventory Surveys* (1987) as a way to describe the irregularity of a shoreline in relation to the overall area of a lake. For the purposes of the SWP EA, attempts to measure the differences in shoreline irregularity between the various SWP Alternatives in relation to the total area of Lake Ontario would effectively be inconsequential due to the small size of the area in question relative to the overall lake size. Instead, a more direct measure of irregularity was established by calculating the percent change in total length of existing shoreline relative to the shoreline proposed by a particular SWP Alternative (**Table 11**).

Table 11: Ability to Increase Shoreline Morphology by Increasing Shoreline Irregularity

Criteria	Indicator	Indicator Definition	Ranking Measures	Methodology
Extent of aquatic habitat enhanced or diminished	Ability to increase shoreline morphology by increasing shoreline irregularity	As supported by long-term monitoring data, open coast shorelines with more complex profiles result in increased species richness. Each Alternative results in an impact to shoreline morphology. Increasing the morphology via increasing irregularity improves essential aquatic habitat and benefits local resident and migratory fish (including SAR Atlantic Salmon and American Eel) while providing optimal functional open coast habitat. In particular, a complex shoreline profile provides for increased foraging opportunities, cover, and shelter.	▪ MP = Alternative that has the highest ability to increase shoreline morphology via increasing irregularity ▪ P = Alternative with second-highest ability ▪ IP = Alternative with second-lowest ability ▪ LP = Alternative with lowest or no ability	This measure will be calculated using ArcGIS to measure the length of shoreline proposed by a SWP Alternative (using the Alternative concept drawings), and the length of the existing length of shoreline (using geo-referenced aerial imagery), allowing the percent change in shoreline irregularity (length) for each SWP Alternative to be determined.

4.1.2 Indicator: Ability to Increase Shoreline Substrate Type Diversity

The indicator focuses on the "increase in shoreline substrate type diversity", whether created or lost. Specifically, "increase in shoreline substrate type diversity" measures the amount of sand shoreline created or lost, the amount of cobble shoreline created or lost, the amount of armourstone (boulder) shoreline created or lost, and the amount of change in all three shoreline substrate types compared to the existing shoreline. Long-term monitoring data (see **Section 2.3.3.3.1**) have shown that more diverse sections of open coast shoreline support increased species richness. Therefore, there is a desire for greater shoreline substrate type diversity, and SWP Alternatives that result in greater shoreline substrate type diversity are ranked higher, as they provide more foraging, cover and shelter opportunities for fish (**Table 12**).

Table 12: Ability to Increase Shoreline Substrate Type Diversity

Criteria	Indicator	Indicator Definition	Ranking Measures	Methodology
Extent of aquatic habitat enhanced or diminished	Ability to increase shoreline substrate type diversity	As supported by long-term monitoring data, more diverse open coast shorelines support increased species richness. Each Alternative results in an impact to shoreline substrate type composition. Increases in the relative amounts of cobble and boulder substrate, in relation to sand, brings the shoreline closer to historical conditions. This increased diversity improves essential aquatic habitat and benefits local resident and migratory fish, including SAR Atlantic Salmon and American Eel, while providing optimal functional open coast habitat. In particular, increased shoreline substrate diversity provides more foraging, cover and shelter opportunities for fish.	▪ MP = Alternative that has the highest ability to increase shoreline substrate type diversity ▪ P = Alternative with second-highest ability ▪ IP = Alternative with second-lowest ability ▪ LP = Alternative with lowest or no ability	This measure will be calculated using ArcGIS to measure the length of each shoreline substrate type gained or lost for each SWP Alternative.

4.1.3 Indicator: Potential for Aquatic Habitat Loss or Modification

For the SWP, the area of infill of each SWP Alternative was measured using GIS and AutoCAD to provide an indication of the overall footprint and ultimately the potential for aquatic habitat loss or modification (**Table 13**). Configurations that require less infill are ranked higher. The quality of the habitat lost was not considered as part of the rankings.

Table 13: Potential for Aquatic Habitat Loss or Modification

Criteria	Indicator	Indicator Definition	Ranking Measures	Methodology
Extent of aquatic habitat enhanced or diminished	Potential for aquatic habitat loss or modification	Alternatives differ in terms of their overall footprint, as indicated by their area of infill. Alternatives with the most infill have the potential to result in the highest amount of existing habitat lost or modified. As this does not consider the quality of the habitat, and as the Alternatives' conceptual designs can be refined to minimize the footprint overall, this indicator considers the potential for habitat loss only, as compared to the other Alternatives. Alternatives with a small amount of or no infill will be ranked higher.	▪ MP = Alternative does not involve infill ▪ P = Alternative involves a small amount of infill ▪ IP = Alternative involves a medium to high amount of infill ▪ LP = Alternative that involves the highest amount of infill	This measure will be calculated using GIS and AutoCAD to determine the above water infill area for each SWP Alternative.

4.2 Criteria: Extent of Terrestrial Habitat Attributes Enhanced or Diminished

4.2.1 Indicator: Potential to Create Appropriate Land-Water Interface

Some wildlife require easy and safe access to the water for different aspects of their lifecycle. Different shoreline treatments allow for or discourage easy access. This indicator focuses on how easy it is for herpetofauna and mammals to move between Lake Ontario and terrestrial habitats along the shoreline. Providing a more gently sloped shoreline for wildlife allows easy access to and from the water, while steeper sloped shorelines (e.g. revetments) can prevent important life processes such as mating and spawning (New York State Department of Environmental Conservation, 2010). SWP Alternatives with greater lengths of shoreline that provide greater ease of access between Lake Ontario and terrestrial habitats are ranked higher (**Table 14**).

Table 14: Ability to Create Appropriate Land-Water Interface

Criteria	Indicator	Indicator Definition	Ranking Measures	Methodology
Extent of terrestrial habitat attributes enhanced or diminished	Potential to create appropriate land-water interface	Potential exists to create land-water interface that benefits terrestrial species. Where the interface provides ease of access for wildlife and is always out of the water, the Alternative is preferred.	▪ MP = Highest quality land-water interface (highest ease of access and greatest length always out of water) ▪ P = Intermediate quality land water interface ▪ IP = Lower quality land-water interface ▪ LP = Least quality land-water interface	This measure will be calculated using GIS to determine the length of shoreline for each SWP Alternative that provides greater ease of access between Lake Ontario and terrestrial habitat wildlife.

4.2.2 Indicator: Impact to Vegetation Communities of Concern

Vegetation communities of concern are those that may be restricted in occurrence and/or require specific site conditions. These communities may be vulnerable to site alterations and human disturbance. SWP Alternatives that result in the smallest overall impact to vegetation communities of concern are ranked highest (**Table 15**).

Table 15: Impact to Vegetation Communities of Concern

Criteria	Indicator	Indicator Definition	Ranking Measures	Methodology
Extent of terrestrial habitat attributes enhanced or diminished	Impact to vegetation communities of concern (note: vegetation communities are key criteria for designation of ESAs and ANSIs)	Different Alternatives have varying levels of impact on vegetation communities of concern. Vegetation communities provide habitat for both flora and fauna species.	▪ MP = No negative impacts, potential for positive impacts on vegetation communities of conservation concern ▪ P = No negative impacts ▪ IP = Some negative impacts ▪ LP = Most negative impacts	This measure will be calculated using GIS to determine the area of vegetation communities of concern anticipated to be impacted or lost for each SWP Alternative.

4.3 Criteria: Potential for Impact on Terrestrial SAR

4.3.1 Indicator: Potential Effects to Habitat for Bank Swallow

Bank Swallows build nest burrows in a variety conditions, including riverbanks and eroding vertical banks (Falconer et al., 2016), such as the lakeshore Bluffs found within the Project Area. They can also be found in stockpiles created in aggregate pits and construction sites (Falconer et al., 2016). Ideal banks are composed of sandy-loam substrate where burrows are typically located in the top one-third of the bank. Natural erosion (or human-related excavation of material) refreshes the vertical profile and keeps the bank suitable for nesting (Falconer et al., 2016). If the vertical face of the bank is not maintained, it usually slumps and stabilizes, reducing the habitat available for Bank Swallow nesting and increasing opportunities for predators as vegetation increases (Falconer et al., 2016). A number of the SWP Alternatives propose shoreline protection works at the base of the Bluffs, which would immediately halt toe erosion and result in Bluff stabilization as crest migration would continue until a stable slope is reached.

Bank Swallows can be sensitive to sudden human disturbance, but are tolerant of disturbance as long as it is present and consistent in the nesting area before they arrive (e.g. aggregate pits and construction sites). Bluff height varies across the Project Area, with the highest points found in West Segment, and the lowest around East Point Park. With nests closer to the ground, a number of SWP Alternatives may have the potential to increase human disturbance by allowing greater public access along previously inaccessible stretches of shoreline, where Bank Swallow nesting would have originally occurred with minimal human interaction.

Alternative SWP Configurations that have less of an impact to Bank Swallows and Bank Swallow habitat are ranked highest (**Table 16**).

Table 16: Potential Effects to Habitat for Bank Swallow

Criteria	Indicator	Indicator Definition	Ranking Measures	Methodology
Potential for impact on terrestrial SAR	Potential effects to habitat for Bank Swallow	Potential terrestrial SAR present in the Study Area include Bank Swallows. Alternatives that benefit SAR and minimize negative impacts will be preferred.	▪ MP = Least degree of or no impacts on SAR ▪ P = Intermediate degree of impacts on SAR ▪ IP = Higher degree of impacts on SAR ▪ LP = Highest degree of impacts on SAR on SAR	This measure will be evaluated based on professional judgement (i.e. qualitative measurement) to determine the impacts of each SWP Alternative to Bank Swallow and their habitat.

4.4 Natural Environment Objective: Results for Comparative Evaluation

4.4.1 West Segment

The Criteria and Indicators for this Objective measure the ability of each Alternative to protect existing natural features and enhance or create new habitat and ecological linkages. For this Objective, the following Criteria were considered:

- Extent of Aquatic Habitat Enhanced or Diminished; and,
- Extent of Terrestrial Habitat Attributes Enhanced or Diminished.

Table 17 provides a Criteria-level summary of the Alternatives comparative evaluation for Objective 1.

Regarding the Criterion *Extent of Aquatic Habitat Enhanced or Diminished*, the Alternatives ranked Preferred included: Alternative 1 (Headland Beach), Alternative 3A (Short Span Island-Bridge), and Alternative 5B (Wide Beach). Alternative 1 provides the greatest increase to shoreline substrate type diversity through a moderate reduction in sand supplemented by a high increase in cobble and moderate increase in armourstone (boulder). Alternative 3A and Alternative 5B provide the greatest positive change to shoreline morphology through high increases in shoreline irregularity. The changes associated with Alternative 1, Alternative 3A and Alternative 5B provide the greatest opportunities for enhancement that will benefit both resident and migratory fish, relative to the other Alternatives. No Alternatives were ranked as Most Preferred with respect to this Criterion. Although the “Do Nothing”

Table 17: West Segment Criteria-Level Evaluation Summary

Objective	Criteria	Indicators	Do Nothing *(Existing Conditions)*	Alternative 1 *(Headland Beach)*	Alternative 2A *(Short Span Bridge)*	Alternative 2B *(Long Span Bridge)*	Alternative 3A *(Short Span Island-Bridge)*	Alternative 3B *(Long Span Island-Bridge)*	Alternative 4 *(Causeway)*	Alternative 5A *(Narrow Beach)*	Alternative 5B *(Wide Beach)*
Protect and Enhance Terrestrial and Aquatic Natural Features and Linkages	Extent of aquatic habitat enhanced or diminished	▪ Ability to increase shoreline morphology by increasing shoreline irregularity ▪ Ability to increase shoreline substrate type diversity ▪ Potential for aquatic habitat loss or modification	**Intermediate Preferred** No fill, but no improvement in morphology or substrate type diversity, relative to the other Alternatives.	**Preferred** High amount of fill (40,000 m^2). Increase in morphology through a 30% increase in shoreline irregularity. Greatest improvement to shoreline substrate type diversity through a high increase in cobble and a moderate increase in boulder proportions, relative to the previously existing sand-dominated substrate.	**Intermediate Preferred** Minor amount of fill. No increase in morphology as shoreline irregularity remains the same. No improvement to shoreline substrate type diversity.	**Intermediate Preferred** Minor amount of fill. No increase in morphology as shoreline irregularity remains the same. No improvement to shoreline substrate type diversity.	**Preferred** Moderate amount of fill (12,000 m^2). Highest increase in morphology through a 60% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity through a moderate increase in boulder proportions, relative to the previously existing sand-dominated substrate.	**Intermediate Preferred** Moderate amount of fill (9,000 m^2). Increase in morphology through a 40% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity through a moderate increase in boulder proportions, relative to the previously existing sand-dominated substrate.	**Intermediate Preferred** Moderate amount of fill (15,000 m^2). No increase in morphology, as shoreline irregularity remains the same. Some improvement to shoreline substrate type diversity through a moderate increase in boulder proportions, relative to the previously existing sand-dominated substrate.	**Intermediate Preferred** High amount of fill (49,000 m^2). Increase in morphology through a 30% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity through a moderate increase in boulder substrate, relative to the previously existing sand-dominated substrate.	**Preferred** Highest amount of fill (109,000 m^2). Second-highest increase in morphology through a 50% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity through a moderate increase in boulder substrate, relative to the previously existing sand-dominated substrate.
	Extent of terrestrial habitat attributes enhanced or diminished	▪ Potential to create appropriate land-water interface ▪ Impact to vegetation communities of concern	**Preferred** No improvement to land-water interface. No impacts to vegetation communities of concern.	**Preferred** Positive changes to land-water interface through a 15% increase in shoreline length that provides a land-water interface that is always out of the water. Moderate temporary impacts to ~3,500 m^2 of beach vegetation communities of concern.	**Intermediate Preferred** No improvement to land-water interface. Low temporary impacts to ~400 m^2 of beach vegetation communities of concern.	**Intermediate Preferred** No improvement to land-water interface. Low temporary impacts to ~400 m^2 beach vegetation communities of concern.	**Intermediate Preferred** No improvement to land-water interface. Low temporary impacts to ~300 m^2 beach vegetation communities of concern.	**Intermediate Preferred** No improvement to land-water interface. Low temporary impacts to ~200 m^2 beach vegetation communities of concern.	**Least Preferred** Negative change in land-water interface through a 20% reduction in shoreline length that provides a land-water interface that is always out of water. Greatest permanent negative impacts (i.e., loss) to ~2,300 m^2 of beach vegetation communities of concern.	**Most Preferred** Greatest improvement to land-water interface through a 30% increase in shoreline length that provides a land-water interface that is always out of the water. Alternative provides potential for expansion of existing sand dune communities (by enlarging existing sand beach).	**Most Preferred** Greatest improvement to land-water interface through a 30% increase in shoreline length that provides a land-water interface that is always out of water. Alternative provides potential for expansion of existing sand dune communities (by enlarging existing sand beach).
Objective-Level Ranking			**Intermediate Preferred**	**Preferred**	**Intermediate Preferred**	**Intermediate Preferred**	**Intermediate Preferred**	**Intermediate Preferred**	**Least Preferred**	**Preferred**	**Most Preferred**

Alternative results in no fill, this is the only Alternative that provides no improvement to shoreline morphology or shoreline substrate type diversity.

Concerning the Criterion *Extent of Terrestrial Habitat Attributes Enhanced or Diminished,* the Alternatives ranked Most Preferred included: Alternative 5A (Narrow Beach) and Alternative 5B (Wide Beach) as these Alternatives provide potential for the expansion of existing sand dune communities (by enlarging the existing sand beach) and result in enhancing the existing land-water interface to the greatest extent. Alternative 1 (Headland Beach) and the “Do Nothing” Alternative were ranked as Preferred. Alternative 1 (Headland Beach) provides the second-greatest enhancement to the existing land-water interface. The “Do Nothing” Alternative is not anticipated to have any negative impacts on vegetation communities of concern. However, with the “Do Nothing” Alternative, there are no opportunities for vegetation community of concern enhancement (i.e., sand dune expansion).

Considering the above Criteria-level rankings, the Most Preferred Alternative for Objective 1 was Alternative 5B (Wide Beach) as this Alternative provides one of the best opportunities for aquatic habitat enhancement through increases in shoreline profile morphology, some increase in shoreline substrate type diversity, and has the greatest potential to enhance the land-water interface. Alternative 5B also provides the opportunity for sand dune vegetation community expansion to the greatest extent.

4.4.2 Central Segment

The Criteria and Indicators for this Objective measure the ability of each Alternative to protect existing natural features and enhance or create new habitat and linkages. For this Objective, the following Criteria were considered:

- Extent of Aquatic Habitat Enhanced or Diminished; and,
- Extent of Terrestrial Habitat Attributes Enhanced or Diminished.

Table 18 provides a Criteria-level summary of the Alternatives comparative evaluation for Objective 1.

Regarding the Criterion *Extent of Aquatic Habitat Enhanced or Diminished*, Alternative 1 (Headland Beach) was ranked Most Preferred and ahead of Alternative 2 (Revetment). Although Alternative 1 has the highest amount of infill and corresponding loss or modification of existing habitat, this Alternative provides the highest potential for habitat enhancement opportunities through an increase in shoreline substrate type diversity with the addition of cobble beaches, along with an increase in shoreline morphology associated with a more irregular shoreline. These improvements benefit fish communities, both resident and migratory.

Concerning the criterion *Extent of Terrestrial Habitat Attributes Enhanced or Diminished,* Alternative 1 (Headland Beach) was ranked Most Preferred as it provides the greatest length of land-water interface, relative to the existing and proposed (Alternative 2) revetment features, and is not anticipated to have any permanent negative impacts on existing vegetation communities of concern.

Table 18: Central Segment Criteria Level Evaluation Summary

Objective	Criteria	Indicators	Do Nothing *(Existing Conditions)*	Alternative 1 *(Headland Beach)*	Alternative 2 *(Revetment)*
Protect and Enhance Terrestrial and Aquatic Natural Features and Linkages	Extent of aquatic habitat enhanced or diminished	▪ Ability to increase shoreline morphology by increasing shoreline irregularity ▪ Ability to increase shoreline substrate type diversity ▪ Potential for aquatic habitat loss or modification	**Least Preferred** No fill, but no increase in morphology. No improvement in shoreline substrate type diversity.	**Most Preferred** High amount of fill (65,000 m^2). Highest increase in morphology through a 15% increase in shoreline irregularity. Greatest improvement in shoreline substrate type diversity through a moderate increase in cobble substrate.	**Intermediate Preferred** High amount of fill (42,000 m^2). Virtually no change to shoreline morphology and no change to shoreline substrate type diversity.
	Extent of terrestrial habitat attributes enhanced or diminished	▪ Potential to create appropriate land-water interface ▪ Impact to vegetation communities of concern	**Intermediate Preferred** No improvement to land-water interface. No impacts to vegetation communities of concern.	**Most Preferred** Greatest positive change to land-water interface through a 50% increase in shoreline length that provides a land-water interface that is always out of water. No anticipated impacts to vegetation communities of concern.	**Intermediate Preferred** No improvement to land-water interface. No anticipated impacts to vegetation communities of concern.
Objective-Level Ranking			**Least Preferred**	**Most Preferred**	**Intermediate Preferred**

Considering the above Criteria rankings, the preferred Central Segment Alternative for Objective 1 was Alternative 1 (Headland Beach) as it was ranked Most Preferred for both criteria. Its key advantage is that it provides a greater benefit for the enhancement of aquatic and terrestrial habitat than Alternative 2 (Revetment).

4.4.3 East Segment

The Criteria and Indicators for this Objective measure the ability of each Alternative to protect existing natural features and enhance or create new habitat and linkages. For this Objective, the following Criteria were considered:

- Extent of Aquatic Habitat Enhanced or Diminished;
- Extent of Terrestrial Habitat Attributes Enhanced or Diminished; and,
- Potential for Impact on Terrestrial Species at Risk.

Table 19 provides a Criteria-level summary of the Alternatives comparative evaluation for Objective 1.

Regarding the Criterion *Extent of Aquatic Habitat Enhanced or Diminished*, the Most Preferred Alternative was Alternative 4B (Headland Beach to East Point Park) as, despite a fairly high amount of fill to be used, this Alternative increases the shoreline morphology through the greatest increase in shoreline irregularity relative to all other Alternatives. Shoreline substrate type diversity is also increased to the greatest extent, with a decrease in sand supplemented by high increases in cobble and moderate increases in armourstone (boulder). The added complexity associated with increased shoreline irregularity and substrate type diversity provides more habitat to be utilized by a greater number of fish species.

Concerning the Criterion *Extent of Terrestrial Habitat Attributes Enhanced or Diminished,* Alternative 4B (Headland Beach to East Point Park) was ranked as Preferred. Alternative 4B provides the most positive changes to land-water interface through the greatest increase in an interface that is always out of water, with minor impacts to beach vegetation communities of concern and moderate impacts to bluff vegetation communities of concern. Alternative 4B will reduce existing impacts on vegetation communities of concern associated with informal trail use and trampling by creating a formal trail network to and along the water's edge. All of the Alternatives that include the revetment features result in significant impacts to beach vegetation communities of concern, while Alternative 5 (Top of Bluffs Connection Over Grey Abbey Ravine) will result in significant impacts to bluff vegetation communities of concern, as well as a mid-aged paper birch forest community, through construction. The Alternatives with revetment features will also result in an overall reduction in the existing land-water interface. While the "Do Nothing" Alternative has no direct impact, it also provides no habitat enhancement opportunity and no opportunity to decommission informal trails currently degrading vegetation communities.

Table 19: East Segment Criteria Level Evaluation Summary

Objective	Criteria	Indicators	Do Nothing *(Existing Conditions)*	Alternative 1A *(Headland Beach with Top of Bluffs Connection)*	Alternative 1B *(Headland Beach with Base of Bluffs Connection)*	Alternative 2A *(Bridge & Headlands with Top of Bluffs Connection)*	Alternative 2B *(Bridge & Headlands with Base of Bluffs Connection)*	Alternative 3A *(Island-Bridge & Headlands with Top of Bluffs Connection)*	Alternative 3B *(Island-Bridge & Headlands with Base of Bluffs Connection)*	Alternative 4A *(Headland Beach with Revetment to East Point Park)*	Alternative 4B *(Headland Beach to East Point Park)*	Alternative 5 *(Top of Bluffs Connection Over Grey Abbey Ravine)*
Protect and Enhance Terrestrial and Aquatic Natural Features and Linkages	Extent of aquatic habitat enhanced or diminished	▪ Ability to increase shoreline morphology by increasing shoreline irregularity ▪ Ability to increase shoreline substrate type diversity ▪ Potential for aquatic habitat loss or modification	**Intermediate Preferred** No fill, but no improvements to morphology or substrate type diversity.	**Intermediate Preferred** Medium amount of fill (48,000 m^2). Increase in morphology through a 20% increase in shoreline irregularity. Some improvement in shoreline substrate type diversity with moderate increases in cobble and boulder proportions, relative to the previously existing sand-dominated substrate.	**Intermediate Preferred** Highest amount of fill (94,000 m^2). Increase in morphology through a 20% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity with moderate increases in cobble proportions. However, high increases in boulder proportions result in a high reduction in sand proportions.	**Intermediate Preferred** Low-medium amount of fill (26,000 m^2). Minor increase in morphology through a 10% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity with moderate increases in cobble and boulder proportions, relative to the previously existing sand-dominated substrate.	**Least Preferred** High amount of fill (71,000 m^2). Minor increase in morphology through a 10% increase in shoreline irregularity. Some improvement to shoreline substrate type diversity through moderate increases in cobble proportions. However, high increases in boulder proportions result in a high reduction in sand proportions.	**Intermediate Preferred** Medium amount of fill (48,000 m^2). Increase through a 20% increase in shoreline irregularity. Some improvement in shoreline substrate type diversity with moderate increases in cobble and boulder proportions, relative to the previously existing sand-dominated substrate.	**Intermediate Preferred** Highest amount of fill (94,000 m^2). Increase in morphology through a 20% increase in shoreline irregularity. Some improvement in shoreline substrate type diversity through moderate increases in cobble proportions. However, high increases in boulder proportions result in a high reduction in sand proportions.	**Preferred** High amount of fill (59,000 m^2). Increase in morphology through a 20% increase in shoreline irregularity. Improvement in shoreline substrate type diversity with moderate increases in cobble and boulder proportions, relative to the previously existing sand-dominated substrate.	**Most Preferred** High amount of fill (86,000 m^2). Greatest increase in morphology through a 30% increase in shoreline irregularity. Greatest improvement in shoreline substrate type diversity through high increases in cobble proportions, and moderate increases in boulder proportions, relative to the existing sand-dominated substrate.	**Intermediate Preferred** No fill, but no improvements to morphology or substrate type diversity.
	Extent of terrestrial habitat attributes enhanced or diminished	▪ Potential to create appropriate land-water interface ▪ Impact to vegetation communities of concern	**Intermediate Preferred** No improvement to land-water interface (100% of the shoreline provides a land-water interface that is sometimes out of the water). No additional impacts to vegetation communities of concern beyond existing conditions (trampling through informal trail use).	**Intermediate Preferred** Overall gain to land-water interface through the addition of shoreline that is always out of the water (approximately half that provided by Alternative 4B). Land-water interface that is sometimes out of water is reduced by ~30%. Moderate impact to ~1,300 m^2 of vegetation communities of concern. However, there is potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Least Preferred** Overall loss to land-water interface through a reduction in shoreline length that provides a land-water interface that is sometimes out of water by ~80%. Addition of land-water interface that is always out of water is equivalent to 1A. High degree of impact to ~18,800 m^2 of vegetation communities of concern. However, there is potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Intermediate Preferred** Overall gain to land-water interface through the addition of shoreline that is always out of the water (approximately 30% of what is provided by Alternative 4B). Land-water interface that is sometimes out of water is reduced by ~20%. Moderate impact to ~1,300 m^2 of vegetation communities of concern. However, there is potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Least Preferred** Overall loss to land-water interface through a reduction in shoreline length that provides a land-water interface that is sometimes out of water by ~60%. Addition of land-water interface that is always out of water is equivalent to 2A. High degree of impact to ~18,800 m^2 vegetation communities of concern. However, there is potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Intermediate Preferred** Overall gain to land-water interface through the addition of shoreline that is always out of the water (approximately 40% of what is provided by Alternative 4B). Land-water interface that is sometimes out of water is reduced by ~20%. Moderate impact to ~1,300 m^2 of vegetation communities of concern. However, there is potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Least Preferred** Overall loss to land-water interface through a reduction in shoreline length that provides a land-water interface that is sometimes out of water by ~60%. Addition of a land-water interface that is always out of water is equivalent to 3A. High degree of impact to ~18,800 m^2 vegetation communities of concern. However, there is potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Intermediate Preferred** Overall gain to land-water interface through the addition of shoreline that is always out of the water (approximately half that provided by Alternative 4B). Land-water interface that is sometimes out of water is reduced by ~50%. High degree of impact to 11,100 m^2 of vegetation communities of concern. However, there is also the potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Preferred** Greatest gain to land-water interface with the addition of approximately 1,400 m of shoreline that provides a land-water interface that is always out of the water. Land-water interface that is sometimes out of water is reduced by ~50%. Moderate impacts to ~5,300 m^2 of vegetation communities of concern. However, there is also the potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.	**Least Preferred** No improvement to land-water interface. Bridge construction would likely require vegetation clearing on both sides of Grey Abbey Ravine, and potentially down within the ravine, with additional changes to bluff vegetation community composition anticipated due to the shading effects of the bridge. Significant impacts to three bluff vegetation communities of concern (BLO1, BLS1-A and BLT1-B) are anticipated. Permanent loss of ~950 m^2 of a mid-aged paper birch forest (FOD8-B) would be required for the trail on the west side of the ravine. However, there is the potential to reduce impacts on vegetation communities of concern by redirecting public access along formal trails.

Table 19: East Segment Criteria Level Evaluation Summary

Objective	Criteria	Indicators	Do Nothing *(Existing Conditions)*	Alternative 1A *(Headland Beach with Top of Bluffs Connection)*	Alternative 1B *(Headland Beach with Base of Bluffs Connection)*	Alternative 2A *(Bridge & Headlands with Top of Bluffs Connection)*	Alternative 2B *(Bridge & Headlands with Base of Bluffs Connection)*	Alternative 3A *(Island-Bridge & Headlands with Top of Bluffs Connection)*	Alternative 3B *(Island-Bridge & Headlands with Base of Bluffs Connection)*	Alternative 4A *(Headland Beach with Revetment to East Point Park)*	Alternative 4B *(Headland Beach to East Point Park)*	Alternative 5 *(Top of Bluffs Connection Over Grey Abbey Ravine)*
	Potential for impact on terrestrial Species at Risk	▪ Potential effects to habitat for Bank Swallow	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat.	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat, as no shoreline works are proposed. Top-of-bluff connection limits human disturbance.	**Least Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: Potential reduction in lesser quality Bank Swallow habitat availability, as protection works will halt toe erosion and encourage increased vegetation along the primarily bare bluff face. Human disturbance due to low bluff height is also increased.	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat, as no shoreline works are proposed. Top-of-bluff connection limits human disturbance.	**Least Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: Potential reduction in lesser quality Bank Swallow habitat availability, as protection works will halt toe erosion and encourage increased vegetation along the primarily bare bluff face. Human disturbance due to low bluff height is also increased.	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat, as no shoreline works are proposed. Top-of-bluff connection limits human disturbance.	**Least Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: Potential reduction in lesser quality Bank Swallow habitat availability, as protection works will halt toe erosion and encourage increased vegetation along the primarily bare bluff face. Human disturbance due to low bluff height is also increased.	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat, as no shoreline works are proposed. Top-of-bluff connection limits human disturbance.	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat, as no shoreline works are proposed. Top-of-bluff connection limits human disturbance.	**Most Preferred** Between Grey Abbey Park and west of East Point Park: No direct impacts to Bank Swallow habitat, as the nests are currently restricted to the upper portion (due to existing vegetation) that is expected to continue eroding into the future. Around East Point Park: No direct impacts to Bank Swallow habitat, as no shoreline works are proposed. Top-of-bluff connection limits human disturbance.
Objective-Level Ranking			**Intermediate Preferred**	**Preferred**	**Least Preferred**	**Intermediate Preferred**	**Least Preferred**	**Intermediate Preferred**	**Least Preferred**	**Preferred**	**Most Preferred**	**Intermediate Preferred**

Finally, regarding the Criterion *Potential for Impact on Terrestrial Species at Risk*, the “Do Nothing” Alternative, along with Alternatives 1A (Headland Beach with Top of Bluffs Connection), 2A (Bridge & Headlands with Top of Bluffs Connection), 3A (Island-Bridge & Headlands with Top of Bluffs Connection, 4A (Headland Beach with Revetment to East Point Park), 4B (Headland Beach to East Point Park, and Alternative 5 (Top of Bluffs Connection Over Grey Abbey Ravine) were ranked as Most Preferred, as the existing Bank Swallow nests between Grey Abbey and East Point Park are currently restricted to the upper portion of bluff (due to existing vegetation) that is expected to continue eroding into the future. As the existing Bank Swallow nests located at East Point Park are also situated lower to the ground due to the lower height of the Bluffs, relative to the bluff heights west of East Point Park, a tableland trail through East Point is likely to reduce human disturbance to these nests (as compared to a formal shoreline trail around East Point Park).

Considering the above Criteria-level rankings, Alternative 4B (Headland Beach to East Point Park) was ranked Most Preferred in the East Segment for Objective 1 as it provides the most opportunities for aquatic and terrestrial habitat enhancement.

5. Detailed Assessment of Preferred Alternative

5.1 Overview of Preferred Alternative

A variety of naturalized terrestrial and aquatic habitats will be created and/or enhanced as a result of the implementation of the SWP. A summary of the various habitat creation opportunities and enhancement techniques, by Project Study Area Segment, is provided below.

The habitats described in this section are at a coarse community level. Site-level details and specific plantings will be determined at the Detailed Design stage of the SWP planning. These habitat types are recommended based on similar shoreline sites found along the north shore of Lake Ontario. Species will be selected that are consistent with TRCA and the City of Toronto’s approved planting lists. All vegetation to be installed will be approved by TRCA, the City of Toronto, and other applicable agencies.

5.1.1 Terrestrial Habitat

Approximately 17.6 ha of new naturalized terrestrial habitat is proposed in the Refined Preferred Alternative conceptual design for the SWP (**Table 20**). It should be noted that unvegetated shoreline and manicured areas are not considered terrestrial habitat enhancements, as they do not provide any meaningful habitat; therefore they are not included in the total area of terrestrial habitat enhanced. Terrestrial habitat features include meadow and successional habitats, as well as beach, sand dune, forest, and wetland habitats. **Table 20** details the various terrestrial naturalization/enhancements and their contributing area per Project Study Area Segment. Native species that may be used in restoration plantings are outlined in **Table 21**.

Table 20: Terrestrial Habitat Enhancements by Project Study Area Segment

Habitat Type	West	Central	East	Total
	Approximate ha			
Beach	6.4	--	--	6.4
Sand Dunes	1.3	--	--	1.3
Meadow	1.6	0.4	1.6	3.6
Successional	1.8	1.5	2.1	5.4
Wetlands	--	0.2	0.1	0.3
Wet Features	--	0.1	--	0.1
Forest	--	--	0.5	0.5
Manicured	--	0.3	--	0.3
Unvegetated shoreline	1.6	1.2	1.8	4.6

Table 21: Native Species That May be Included in Restoration Plantings

Common Name	Scientific Name
Beach marram grass (grass)	*Ammophila breviligulata*
Switchgrass (grass)	*Panicum virgatum*
Black-eyed Susan (wildflower)	*Rudbeckia hirta*
Heath aster (wildflower)	*Symphyotrichum ericoides*
New England aster (wildflower)	*Symphyotrichum novae-angliae*
Common milkweed (wildflower)	*Asclepias syriaca*
Hairy beardtongue (wildflower)	*Penstemon hirsutus*
Wild bergamot (wildflower)	*Monarda fistulosa*
Canada wild rye (grass)	*Elymus canadensis*
Staghorn sumac (shrub/small tree)	*Rhus typhina*
Red-osier dogwood (shrub)	*Cornus stolonifera*
Serviceberry (shrub/small tree)	*Amelanchier sp.*
Chokecherry (shrub/small tree)	*Prunus virginiana*
Ninebark (shrub/small tree)	*Physocarpus opulifolius*
Speckled alder (tree)	*Alnus incana*
Willow species (shrub/tree)	*Salix sp.*
Eastern cottonwood (tree)	*Populus deltoides*
Trembling aspen (tree)	*Populus tremuloides*
White birch (tree)	*Betula papyrifera*

Beaches and Sand Dunes

Beaches are areas that are sparsely vegetated and are typically subject to natural or human disturbance. Sand dunes are vegetated ridges that form just landward of the beach backshore and run parallel to the shoreline. Wind-blown sand from the dry beach is trapped by vegetation, allowing an undisturbed dune to continually grow in width and height.

Coastal sand dune systems, such as the one currently at Bluffer's Park Beach, are considered to be one of the rarest and most fragile ecosystems in Canada, as they are literally held together by beach grasses (e.g., marram grass) and other vegetation (Peach, 2006). Very specialized tree, shrub and grass communities have also become adapted to these systems.

Implementation of the SWP will result in an increase in the amount of beach and sand dune habitat within the Project Study Area. Beaches and sand dunes provide habitat for species such as shorebirds and turtles.

Meadow

Meadows typically consist of a mixture of grasses and wildflowers with less than 25% shrub cover, and are generally formed following a natural or human disturbance, such as flooding, wind or land-clearing, which result in the removal of woody species and allow for the colonization of herbaceous plants and grasses, or in the case of the SWP, newly created land.

The meadow habitats will be designed to provide a number of habitat functions, including but not limited to habitat elements for butterflies and other pollinators, migratory and breeding birds and mammals. Newly created meadow habitat within the Study Area is expected to be temporary or transitional; that is, it will not be maintained as meadow and will be allowed to naturally succeed over time. For example, the newly created headland at Bluffer's Park will initially be planted as a meadow with shrub and tree nodes, with installation of native species; however, over time as the soil community matures, and seeds arrive via wind and wildlife, shrubs and trees are expected to colonize the site resulting in the transition of the meadow to successional habitat and eventually to woodland. The habitats that are restored immediately after construction will not be maintained as static communities; rather they will naturally transition to other vegetation communities based on natural conditions.

Successional

Successional habitats are those that are transitioning from being primarily unvegetated or dominated by herbaceous vegetation (i.e., containing grasses and forbs) to vegetation communities that have more woody vegetation such as thickets (i.e., containing shrubs) and eventually into woodland and forest communities (i.e., containing trees). In the case of SWP new or restored natural habitats will be planted with native species appropriate to the specific site conditions (i.e., soil composition and moisture regime). However, those communities will be allowed to ecologically succeed; that is, communities will naturally transition to different communities – nature will do what it wants to do.

Similar to the meadows, the successional habitats will be designed to provide a number of habitat functions, including but not limited to habitat elements for butterflies and other pollinators, migratory and breeding birds, and mammals, as well as habitat features suitable for amphibians and reptiles.

Wetlands and Wet Features

Wetlands are areas of land that are seasonally or permanently covered by shallow water, or lands where the water table is close to or at the surface (MNR, 2010).

Wetland creation and enhancement for the SWP will focus on establishment of marsh communities at several locations along the shoreline. These constructed wetlands will be designed to capture water from stormwater outfalls to improve aesthetics and contribute to minor improvements in water quality, through minor reductions in Total Suspended Solids (TSS).

Coastal wetlands share similar characteristics to their land-based counterparts; however, they have a direct connection to the lake for all or part of the year, depending on water levels.

Wet features are landscape elements that contain water. These features include engineered ponds which may or may not be vegetated. In the case of SWP wet features will be designed to accommodate stormwater flows and improve aesthetics.

Forest

Forests are vegetation communities that have greater than 60% tree cover. Forests can be dominated by native or exotic species and may include coniferous, deciduous or mixed species. Forest habitat will be restored as part of the SWP and as it matures will provide habitat for various wildlife species including birds and mammals and will improve terrestrial connectivity.

Manicured

Manicured areas refer to non-naturalized areas that could include mowed grass or gathering spaces that lack natural vegetation cover. Manicured areas with the SWP helps provides gathering areas for the public which helps minimize impact on adjacent natural vegetation communities.

Unvegetated

Unvegetated shoreline refers to man-made areas of the shoreline that lack vegetation. These could include armourstone or boulder shorelines and revetments. Unvegetated shorelines are used by species such as Purple Sandpiper (*Calidris maritima*) and American Mink (*Neovison vison*).

In general habitat enhancements will focus on the provision of elements that facilitate natural succession and functional habitat for wildlife life stages.

5.1.1.1 West Segment

The headland at Bluffer’s Park is approximately 2.8 ha and will be graded to a gently rolling topography (see **Figure 22**). Natural vegetation communities will begin initially as meadow communities (approximately 1.6 ha) with strategic areas of native trees and shrubs. Over time the meadow community will naturally transition to successional communities. In addition to naturalized habitat, the headland will also contain manicured areas.

The Bluffer’s Park sand beach will be extended to the Meadowcliffe shoreline and is expected to increase by approximately 6.4 ha. The associated sand dune community is projected to increase by approximately 1.3 ha over time as sand accumulates on the beach. Dune species will likely colonize the area from the adjacent dune vegetation; however strategic plantings will also advance the establishment of dune communities. Currently, a series of informal trails bisect the existing dune habitats, particularly on the east side of Bluffer’s Park Beach. These informal trails will be

Figure 22: Proposed Terrestrial Habitat Enhancements in West Segment

decommissioned and further controlled by using techniques such as fencing and signage. It is recommended that a Revitalization Plan be developed for Bluffer's Park that includes further detail on trail management, in addition to habitat restoration and management.

The area at the base of the Cudia Park Bluffs will be enhanced to facilitate the development of approximately 1.8 ha of successional habitat, and the area will be strategically planted with site appropriate native species. The area is expected to experience sedimentation from the Bluffs over the long-term which may result in natural changes to the vegetation communities.

5.1.1.2 Central Segment

The headland beach system at the base of Doris McCarthy Trail will allow for the creation of a constructed wet feature, approximately 0.1 ha in size, that will capture baseflow from Bellamy Ravine (see **Figure 23**). It will function primarily to improve aesthetics and contribute to minor water quality improvements, through a small reduction in TSS. Species expected to colonize the wet feature include cattail. The wet feature will be designed to retain baseflows flowing through to the lake. During periods of high flow water would bypass the wetlands and flow directly into the lake.

An approximately 0.1 ha public gathering space at the base of the Bellamy Ravine, adjacent to the wet feature, will be a combination of mowed grass and a hard surface gathering area. The area at the base of the Bluffs will be actively restored to approximately 1.5 ha of successional habitat, which will succeed naturally over time.

The Guild Public Gathering Space will be actively restored to a combination of approximately 0.2 ha of mowed grass and approximately 0.4 ha of meadow habitat. It is anticipated that the manicured areas will be positioned around the perimeter of the new public gathering space, while the middle will consist of meadow habitat.

Two wetland features are expected to develop on each side of the Guild Public Gathering Space that will occupy a total area of approximately 0.2 ha. These wetlands will be connected to the lake and appropriately incorporated at the base of the Guild Park and Gardens to provide shoreline vegetation and sheltered areas for fauna such as waterfowl. The wetlands will be designed so that wave action is buffered through the use of boulders to allow wetland vegetation such as cattails to become established.

5.1.1.3 East Segment

The area at the base of the Bluffs will become the future backshore area and will be dominated by successional habitat (see **Figure 24**). Approximately 2.1 ha of successional habitat will be developed that will provide a vegetated buffer between the trail and the Bluffs, providing wildlife a corridor along the shoreline.

The shoreline of the headland beach system, which includes cobble beaches between the headlands provides suitable stopover habitat for species such as Purple Sandpiper that prefer rocky shorelines.

Figure 23: Proposed Terrestrial Habitat Enhancements in Central Segment

Scarborough Waterfront Project

Refined Central Segment Preferred Alternative

Legend

Risk Line
Proposed Trail

0 200 400 m

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Figure 24: Proposed Terrestrial Habitat Enhancements in East Segment

Habitats on the headland will begin primarily as meadow, but are expected to naturally transition over time to successional habitats. A total of approximately 1.6 ha of meadow habitat will be created along with strategically planted shrub nodes.

A small 0.1 ha wetland feature at Grey Abbey Ravine will be designed to capture baseflow before allowing it to return to the lake. During periods of high flow (e.g., storm events) flows will be conveyed directly to the lake.

In the area where the corkscrew ramp will be constructed to facilitate the access to the shoreline in the East Segment, the existing slope is oversteepened at the top of the bluff and will experience crest migration in the long-term. To minimize the risk to the foundations of the corkscrew ramp due to talus runout, where the upper slope is oversteepened it should be trimmed back to a stable inclination prior to construction. This slope trimming will affect the existing terrestrial habitat.

A portion of the industrial tableland in the East Segment will be re-graded to create a berm or hill with a perimeter fence to separate the industrial site from the Project Area. The hill will be planted with native shrubs to both shield the industrial site from public views, as well as discourage public access into the industrial site.

East Point Park contains some of the most significant habitat within the Study Area; however, a network of approximately 8 km of informal trails has resulted in habitat fragmentation. These informal trails will be decommissioned using techniques such as installation of habitat piles that block access, installation of native plants such as wild rose, hawthorn and raspberries, and signage. Community stewardship of East Point Park will play a significant role in providing observations and advice to the City of Toronto and TRCA on trail use and management, as well as contribute directly to efforts to decommission trails via the techniques outlined above. Community stewardship efforts will also play a significant role in communicating the rationale for informal trail decommissioning to park users, policing the site and passing on observations of new trails to the City and TRCA. It is recommended that a Revitalization Plan be developed for East Point Park that includes further detail on continued trail management as well as habitat restoration and management.

Approximately 0.5 ha on the north side of the hill east of Beechgrove Drive will be restored to a forest community which will improve forest connectivity between Highland Creek and East Point Park.

5.1.2 Aquatic Habitat

The SWP Refined Preferred Alternative results in the increase in sand shoreline length of close to 400 m, and an additional 1,000 m of cobble beach.

Naturalization of the aquatic habitat within the Project Study Area includes retrofitting existing shoreline structures and enhancing and/or designing the proposed structures such that their ecological value is maximized. Headland beach systems provide better aquatic habitat over the traditional linear revetment as they lengthen the shoreline, and increase the diversity of the substrate and shoreline, providing improved cover and foraging opportunities. Aquatic habitat enhancements beyond these features maximize the potential to contribute to functional nearshore open coast habitat.

The summary of individual naturalization/habitat enhancement techniques that may be implemented for the Refined Preferred Alternative is provided in **Table 22**, and detailed below. Where possible, combinations of techniques will be used.

Table 22: Potential Aquatic Habitat Enhancement Techniques Overview

Naturalization/Habitat Enhancement Technique	Target/Benefit
Surcharging (Revetments and Headlands/Groynes)	▪ Improves habitat quality by diversifying habitat structure and shoreline profile
Shoreline Shoals	▪ Adds structural elements to improve nearshore habitat quality: improves foraging opportunities, increases essential habitat for cool and cold water species (open coast) and improves submergent vegetation (sheltered embayment)
Boulder Pavement Restoration	▪ Replaces coarse substrate to re-instate substrate diversity and increase habitat structural elements.

<u>Surcharging (Revetments, Headlands and Groynes)</u>

Revetments, headlands, and groynes are widely used in coastal engineering for shoreline stabilization and enabling shoreline use. While these structures typically lack the physical habitat complexity of historically unaltered shorelines, they can be designed and/or enhanced to incorporate more ecological functions. Surcharging, in particular, is an effective method of improving the quality of aquatic habitat associated with these structures.

Surcharging involves placing coarse substrate (e.g., rubble, boulders and cobble) underwater within the wave zone along the revetments, vertical walls, headlands or groynes. In headland beach systems, the material can be placed both within and at the end of beach cells. Larger material is typically arranged to protect smaller material from being moved offsite, and reworked by wave action into nearshore shoals and bars, as illustrated in **Figure 26**.

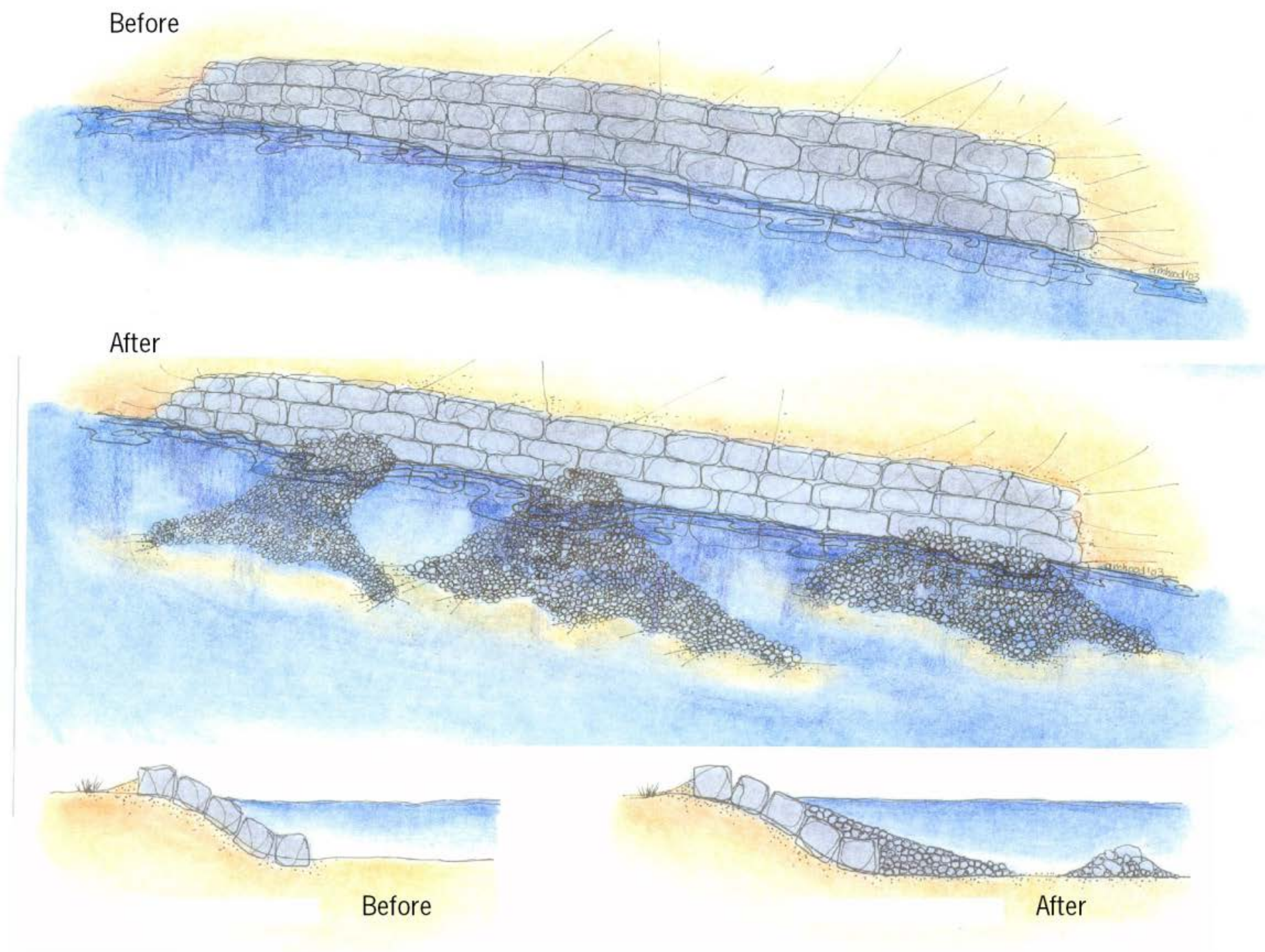
Surcharging revetments results in an improvement of habitat quality and benefits aquatic organisms utilizing the shoreline. Surcharging provides for aquatic habitat physical structure diversity along revetments, headlands and groynes, therefore making these otherwise uniform, linear (in the case of walls and revetments) shorelines more functional and attractive to fish and other aquatic life.

<u>Shoreline Shoals</u>

Used in areas with uniform substrates and general lack of habitat structural diversity, shoreline shoals are aggregations of coarse materials placed along the shoreline in sheltered embayment and open coast habitat. These structures improve shoreline structural habitat, providing cover and improving foraging opportunities for various aquatic organisms.

Shoreline shoals are typically connected to the shoreline (**Figure 27**). Materials such as armourstone, boulders, rubble, rip rap, cobble and gravel are selected and placed (typically, with an extended reach excavator) according to coastal conditions and area use. If conditions allow, stepped shoals may be constructed by forming ridges that further increase habitat diversity.

Figure 25: Surcharged Revetment Technique



Scarborough Waterfront Project

Surcharged Revetment Technique

Figure 26: Shoreline Shoal Treatment Technique

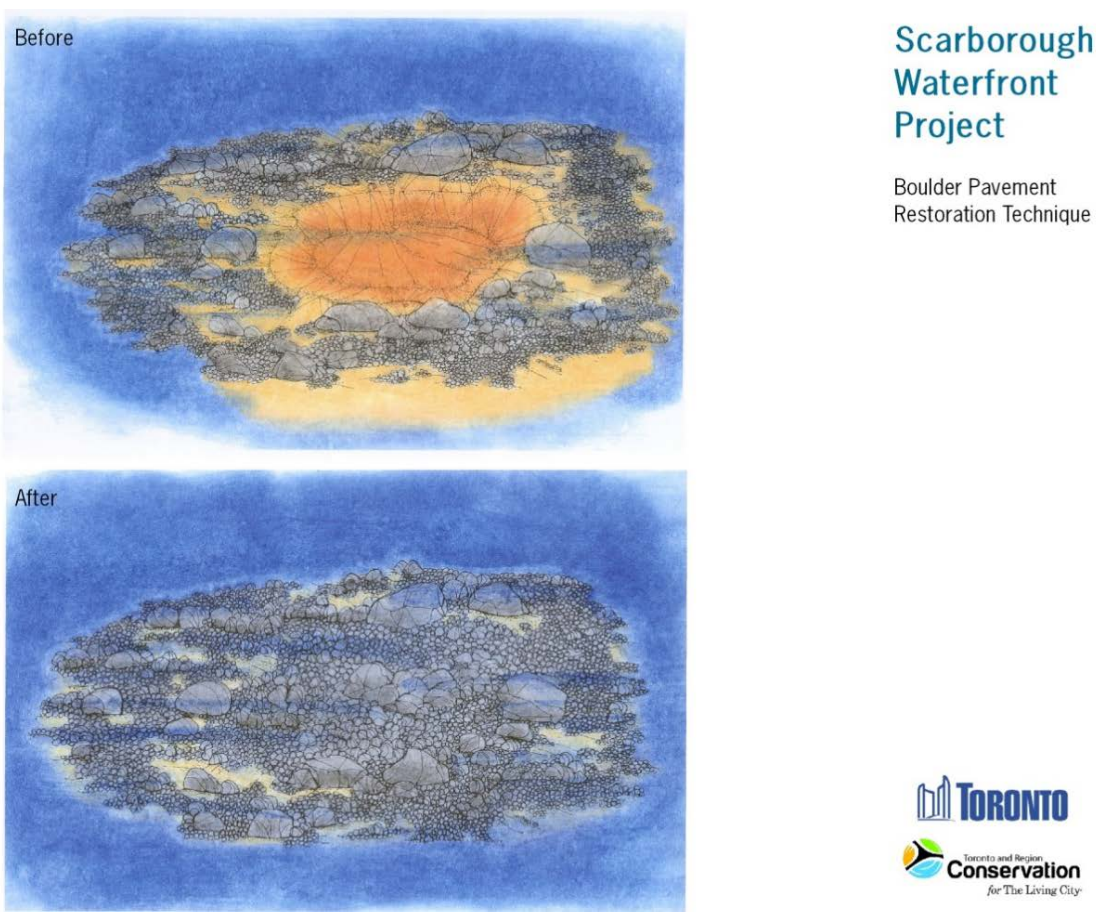
Shoreline shoals improve habitat quality for many fish and benthic invertebrate species by providing cover and improved foraging opportunities. They can also provide spawning habitat for certain fish species (e.g., Lake Trout), where shoal location, size, configuration, and aggregate materials of appropriate size would be selected based on the spawning habitat requirements of that species.

Boulder Pavement Restoration

Boulder pavement is formed by aggregations of coarse material such as cobble, gravel and boulders that were eroded from the shore. It provides essential habitat for fish species utilizing the shoreline. Historically, boulder pavement has been degraded by stonehooking activities that resulted in the partial, but substantial, removal of aggregates that formed the pavement. However, restoration can be achieved within the areas that need repair, identified by shallow depressions along the shoreline.

Boulder pavement repair consists of filling the depleted areas with boulders and cobble and bringing the materials to grade with the surrounding areas, as illustrated in **Figure 28**. Typically, material greater than 20 cm in diameter remains within the repair location and traps and holds smaller materials such as sand and gravel.

Figure 27: Boulder Pavement Restoration Technique



Boulder pavement repair replaces lost coarse substrate to re-instate substrate diversity and increase habitat structural elements. Improved habitat is better able to meet the requirements of the various life stages of fish and other aquatic organisms that utilize the Scarborough shoreline. For example, certain species of macroinvertebrates and fish require interstitial spaces within stable, coarse cobble and boulder substrates, which may serve as cover and shelter from predators.

5.1.2.1 West Segment

In the West Segment, open coast techniques will be used at the Bluffer's Park headland expansion, as well as the Meadowcliffe Drive headland expansion.

The Bluffer's Park headland expansion presents an excellent opportunity for installation of a Lake Trout spawning shoal/reef, contributing to re-instatement of the habitat lost to the stonehooking activities of the 1800s. Spawning shoals/reefs with a range of depths are thought to provide optimal conditions for Lake Trout reproduction. By inclining the structure into deeper water, a range of water depths and associated water currents would be available for spawning such that during any given year, conditions would be favourable along some portion of the structure for optimal egg retention and survival (**Appendix F**). In addition, the positioning of this headland would provide the shortest route for the young life stages of Lake Trout to reach deep water, therefore potentially reducing predation.

In shallower depths, other techniques appropriate for open coast habitat (surcharging, boulder pavement repair and/or shoreline shoals, in particular) will be used.

Specific locations, configuration and dimensions of the habitat enhancement features will be determined during the Detailed Design phase of the Project.

5.1.2.2 Central Segment

In the Central Segment, combinations of open coast naturalization/habitat enhancement techniques will be used.

The proposed shoreline structures along Sylvan shoreline and at the base of the Guild construction access route west would be enhanced through a combination of shoreline shoals and surcharging. Existing revetments along the South Marine and Guildwood Parkway shorelines would be retrofitted using a similar combination of surcharging and shoreline shoals. If possible, boulder pavement repair techniques will be applied. At the Guild Park and Gardens Shoreline Regeneration Zone, a large, continuous shoreline shoal would be installed along the shoreline. Importantly, integrating habitat enhancements along the entire length of the Central Segment shoreline would achieve a synergistic effect.

Specific locations, configuration and dimensions of the habitat enhancement features will be determined during the Detailed Design phase of the Project.

5.1.2.3 East Segment

In the East Segment, all three habitat enhancement techniques may be used to enhance the proposed shoreline structures. These enhancements will add structural habitat elements, increasing habitat complexity and partly re-instating substrates lost to stonehooking. Specific locations, configuration and dimensions of the habitat enhancement features will be determined during the Detailed Design phase of the Project.

5.2 Evaluation Criteria and Effects Assessment

Using the Evaluation Criteria developed in **Section 4** as a basis, a set of Indicators and their associated measures were defined for construction and operation/establishment in order to structure, and where possible, quantify the effects of the construction and operation/establishment of the SWP on the environment. For each Indicator, the effects to the existing conditions due to the SWP works and activities were evaluated. In some cases, no effects were predicted due to the application of mitigation or avoidance measures. Where net effects were predicted (i.e., effects remaining after mitigation is applied), they were classified as positive, negative, or negligible.

Positive effects (e.g., improved habitat) are generally associated with operation/establishment, and were quantified where possible. These are generally considered to be minimum design requirements that the SWP must achieve in Detailed Design and construction.

Effects that were either negative of negligible tended to be associated with construction activities. Negligible effects are generally short-term, localized, do not occur frequently, and can be minimized to a large extent through mitigation. These are often typical of construction projects.

Negative effects are those that mitigation could not minimize to the extent that it became negligible, thus, the effect was considered a net negative effect of the SWP.

5.2.1 Criteria: Ability to Minimize Effects Associated with Construction Works, Construction Access and Laydown Areas

5.2.1.1 Indicator: Alteration and Loss of Aquatic Habitat

Potential Effects During Construction

SWP construction activities, particularly land creation, will result the in alteration and loss of a portion of existing aquatic habitat. This Indicator was quantitatively assessed by estimating the footprint of the land creation and habitat modification associated with the Preferred Alternative using the Preferred Alternative concept drawings and typical cross-sections in ArcGIS. Both permanent loss of habitat (portions of the proposed structures that are above the high water mark) and habitat alteration (underwater portions of the proposed structures which are associated with a change in depth, vegetation and/or substrate type) were considered. Note that the footprint of habitat altered also includes areas positioned behind the headlands where waves are attenuated, thus providing additional shelter and cover opportunities for fish.

The Project will result in the loss of up to 20 ha and alteration of up to 16 ha of open coast habitat. However, existing habitat is generally considered to be poor, as it lacks substrate diversity and shoreline morphology to provide functional habitat for a variety of fish species and life stages. The SWP will result in a shoreline which is approximately 1,700 m longer, more irregular, and more diverse, thus increasing the quality of the local aquatic habitat by providing resident and migratory fish species with enhanced cover, shelter and foraging opportunities. Retrofitting the existing revetment shoreline along South Marine Drive and Guild Park and Gardens will result in valuable gains in habitat quality. Notably, the Project presents a unique opportunity to create spawning habitat for one of the most valuable native salmonids, Lake Trout, by constructing a Lake Trout spawning shoal off of the proposed Bluffer's Park headland extension.

In the Detailed Design stage, fish habitat alteration and loss will be quantified in more detail using DFO's Habitat/Ecosystem Assessment Tool (HEAT), and a comprehensive compensation plan will be developed in collaboration with appropriate agencies.

With the improvements to existing habitat quality and additional aquatic habitat enhancements, the net effect associated with fish habitat alteration and loss is expected to be negligible and the establishment of higher quality habitat will have a positive effect within the Project Study Area.

Mitigation Measures

The negative impacts will be mitigated via incorporating a diversity of shoreline substrate types and increased shoreline irregularity into the Preferred Alternative Detailed Design, employing a variety of aquatic habitat enhancement techniques, including retrofitting existing revetment shoreline structures, and development and implementation of a compensation program.

Net Effects

The net effects will be negligible, as the Project results in overall benefits to aquatic habitat.

Potential Effects During Operation/Establishment

This Criterion is not relevant to the operation/establishment phase.

5.2.1.2 Indicator: Disruptions to Fish and Fish Habitat

Potential Effects During Construction

SWP construction activities, particularly in-water works, have the potential to disrupt fish and fish habitat in adjacent areas through increases in water turbidity, increases in noise and vibration, release of deleterious substances, and entrapment of fish within the land creation area, resulting in a negative effect. This Indicator was assessed by reviewing the means by which disruptions to fish and fish habitat may occur and the application of mitigation measures which will significantly reduce or eliminate the impacts.

The environmental management practices and mitigative measures that will be employed during construction are outlined in the MOECC's *Fill Quality Guide and Good Management Practices for Shore Infilling in Ontario* (2011) and TRCA's Lakefill Quality Control Program. Other guidelines to be used include DFO's *Measures to Avoid Causing Harm to Fish and Fish Habitat* (2016). A comprehensive list of mitigation measures is provided in **Appendix H** of the EA document.

For each phase of fill operations, a containment berm will be constructed prior to placing any fill, which will eliminate sedimentation issues from fill placement operations. Once fill has been placed, there is potential for soils to be eroded by wind or water, resulting in offsite sedimentation issues. This will be mitigated by stabilizing soils using standard soil stabilization techniques, such as establishing vegetation cover upon completion of a construction cell. To prevent fish entrapment within the containment berm, fish rescue operations will be conducted prior to cell infilling. Potential disruptions to fish as a result of land creation activities are expected to be short-term in duration.

Restricted activity timing windows are applied to protect fish from impacts of works or undertakings in and around water during spawning migrations and other critical life stages (Fisheries and Oceans Canada, 2013). In Ontario, the MNRF has the responsibility for setting timing window guidelines. The timing windows are determined on a case-by-case basis according to the species of fish in the water body, whether those fish spawn in the spring or fall, and whether the water body is located in the Northwest, Northeast or Southern Region of Ontario.

The SWP is located in the Southern Region of Ontario. While over 100 fish species inhabit the Lake Ontario basin, only a subset of those utilizes the Project Area (**Section 2.3.3**). Habitat conditions in the areas where land creation is proposed are most suitable for species that broadcast their eggs over sand and coarser substrates, and do not require aquatic vegetation. Moreover, spawning period start, end and the overall length vary with environmental conditions such as temperature. Therefore, spawning periods in a given year may differ from the default timing windows set for the Southern Region of Ontario.

During the Detailed Design Project phase, an evidence-based approach will be applied to help guide the determination of the restricted activity timing windows, in consultation with MNRF. Scheduled fisheries monitoring using appropriate methods (e.g., electrofishing) and water temperature monitoring will be conducted near the end and/or beginning of the timing windows to determine if fish that may utilize the Project Area for spawning in a given season are present in the active construction areas. This scientific information will then be used to help determine and guide, in collaboration with MNRF, site-specific construction start and end dates for work areas of the SWP. Absence of fish that may utilize the Project Area for spawning in a given season indicates that the risk to fish and fish habitat associated with in-water land creation activities is minimal. If fish species associated with a given restriction window are present, in-water works will cease.

Further, potential impacts to fish and fish habitat will also be considered in developing water quality impact prevention and mitigation measures, such as a turbidity monitoring program to be developed at Detailed Design.

Overall, the negative effects associated with disruptions to fish and fish habitat as a result of construction activities will be short in duration, and mitigated with appropriate best management practices (BMPs), resulting in negligible net effects.

Mitigation Measures

Examples of mitigation measures to minimize negative effects associated with fish and fish habitat disruptions include:

- Use of Project-specific restricted activity timing windows for in-water works to be set in consultation with MNRF;
- Construct containment berm prior to placing any fill, which will minimize sedimentation;
- Remove any fish potentially trapped in a cell prior to commencement of filling;
- Sediment and erosion controls; and,
- Ensure equipment is free of leaks and fluids containing deleterious substances.

Net Effects

The net effects will be negligible, as appropriate mitigation measures will ensure that the negative impacts to fish and fish habitat are prevented/minimized.

Potential Effects During Operation/Establishment

This Criterion is not relevant to the operation/establishment phase.

5.2.1.3 Indicator: Nuisance Effects on Wildlife

Potential Effects During Construction

This Indicator estimates the temporary displacement of wildlife as a result of construction activities, such as the increase in noise and vibration from construction equipment and the displacement from areas of the shoreline under construction. The indicator was assessed based on previous project experience in similar environments with similar effects. It is noted that while construction will move across the shoreline, there are some areas where construction will persist throughout the entire construction period, in particular the Guild construction access route and the area at the base of the Guild construction access route. This area currently experiences maintenance traffic and many of the species are tolerant of existing traffic, are mobile, and their habitat exists across the shoreline, and are anticipated to move.

Potential impacts include reduced numbers of nesting and breeding birds; reduced foraging and loafing opportunities for migrating and resident waterfowl, waterbirds and shorebirds; reduced amphibian breeding; and the displacement of reptiles and urban mammals from areas of the shoreline that are under active construction. Wildlife is expected to relocate to other natural areas.

Mitigation measures include phasing construction across the Project Area into discrete areas so that wildlife that prefer the shoreline habitats will have the opportunity to move further along the shoreline where construction is not occurring to avoid construction activities. Mitigation measures will include a variety of BMPs to minimize effects where possible (see **Appendix H** of the EA document). In order to minimize impacts on breeding amphibians, no construction will occur during evening hours when amphibians are calling. Construction vehicles will not access the backshore of the Bluffer's Park Beach (a likely breeding location) between the third week of May and October due to recreational use, which will also allow most of the amphibian breeding season to occur without construction interference.

Mitigation measures for wildlife at East Point Park include scheduling activities related to the construction of the tableland trail outside of the late April to late May time period to avoid impacts to migrating birds. Prior to construction commencement, the active construction area will be surveyed for breeding birds and a species-appropriate buffer will be applied to any surveyed nests to avoid impact. With the implementation of mitigation measures, nuisance effects on wildlife are expected to be minimal, and temporary.

Bank Swallows are generally tolerant of human activities; construction activity in areas where Bank Swallow nesting occurs (primarily Cudia Park Bluffs) will be underway in May when swallows return so they become habituated to this disturbance. Additionally, phasing of construction activities along the shoreline will result in discrete areas of disturbance, so that not all Bank Swallow nesting locations in the Project Area will be disrupted at the same time, allowing for swallows to move to other locations. It is noted that Bank Swallow nest occupation significantly varies on an annual basis for a variety of reasons. Therefore, lack of Bank Swallow nesting within a discrete colony location may not be related to construction activities.

Overall, the nuisance effects on wildlife as a result of construction activities will be short in duration and mitigated with appropriate BMPs, resulting in a negligible net effect.

Mitigation Measures

Mitigation measures will include adherence to BMPs as outlined in **Appendix H** of the EA document to minimize disturbance, noise and dust, in addition to:

- Avoiding construction activities at East Point Park during the spring migration and breeding bird period (late April to late May); and,
- Where Bank Swallow colonies are located within 50 m of active construction, ensuring works are underway prior to Bank Swallows return in spring (~May) so they become habituated to the disturbance.

Net Effects

The net effects will be negligible, as nuisance effects to wildlife during construction are temporary and wildlife is generally tolerant of activities.

Potential Effects During Operation/Establishment

This Criterion is not relevant to the operation/establishment.

5.2.1.4 Indicator: Removal and Disturbance of Terrestrial Habitat

Potential Effects During Construction

This Indicator quantifies the approximate area of habitat that will be removed as a result of the Project. The amount of vegetation removal was estimated using field and GIS mapping of ELC communities overlain on the SWP concept drawings.

Some areas of existing natural habitat will be disturbed to facilitate construction, and approximately 2.90 ha of existing habitat will be permanently removed for the trail (**Table 23**).

Much of the habitat to be removed is located in ANSIs, and a portion is also within ESAs. However, the habitats are typical of urban areas, and are being impacted by unmanaged informal trails and invasive species. Although these areas provide a good representation of terrestrial habitat and natural cover within the urban context, these habitats are generally considered to be of fair to poor habitat quality, relative to less urbanized areas, based on a combined evaluation of patch size, patch shape, and matrix influences. Areas that will be impacted by construction access routes and staging activities will be restored to pre-construction conditions, where possible, and where appropriate, invasive species may be controlled to improve the quality of habitat. Impacted habitat features, such as cavity trees, will be replaced with artificial or constructed features such as nest boxes that mimic the original features. Following Project completion and habitat establishment, no long-term effects are anticipated.

Four vegetation communities will be impacted by the proposed path along Brimley Road. Two forest communities, Dry-Fresh Sugar Maple-Oak Deciduous Forest (FOD5-3) and Fresh-Moist Manitoba Maple Lowland Deciduous Forest (FOD7-a), representing 0.19 ha, will be removed. Approximately 0.09 ha of the Sumac Deciduous Thicket (CUT1-1) community will be removed and approximately 0.1 ha of the Exotic Forb Meadow (CUM1-c) community will be removed.

A total of 11 vegetation communities will be impacted as a result of the Project at East Point Park. Three forest communities, Silver Maple-Conifer Mixed Plantation (CUP2-E), White Cedar Coniferous Plantation (CUP3-G) and Fresh-Moist Poplar Deciduous Forest (FOD8-1), representing 0.08 ha will be removed. Five successional communities, Sumac Deciduous Thicket (CUT1-1), Exotic Deciduous Thicket (CUT1-c), Red Osier Dogwood Deciduous Thicket (CUT1-E), Willow Deciduous Thicket (CUT1-G) and Native Deciduous Successional Woodland (CUW1-A3), totalling 0.33 ha, will be removed. One meadow community, Native Forb Meadow (CUM1-A), totalling 0.24 ha will be removed. Two wetland communities, Common Reed Mineral Meadow Marsh (MAM2-a) and Red Osier Dogwood Thicket Swamp (SWT2-5), representing 0.008 ha will be removed.

One existing provincially rare vegetation community, Sea Rocket Open Sand Beach (BBO1-1), will be impacted by construction activities, with approximately 1.8 ha anticipated to be affected. Mitigation measures include plant salvage, where appropriate. Past salvage experience, where the sea rocket was removed and then replanted following construction, has proven successful for this species.

Approximately 0.05 ha of bluff communities is anticipated to be lost through bluff trimming to facilitate construction of the corkscrew tableland connection. This is composed of the Exotic Treed Bluff (BLTc-1) vegetation community, dominated by non-native species such as black locust (*Robinia pseudoacacia*) and Manitoba maple (*Acer negundo*), and the actively eroding Mineral Open Bluff (BLO1) community, which is not vegetated and restricted to the upper portion of the bluffs only.

An existing artificially-created wetland feature (~0.008 ha) at the base of the Guild construction access route is expected to be relocated and expanded as a result of the construction of the Guild Public Gathering Space. The wetland area will be expanded to include two wetland features, one on either side of the Guild Public Gathering Space, for an approximate total area of 0.2 ha.

No butternut trees, a SAR, have been identified within the footprint of the construction access roads or trail; therefore, no effects are anticipated. As part of the Detailed Design phase, a detailed survey will be conducted to confirm the absence of butternut.

Table 23: Existing Vegetation Communities to be Removed

SWP Area Feature	Area of Habitat to be Permanently Removed (ha)
Forest Communities	0.27
Successional Communities	0.42
Meadow Communities	0.34
Beach/Dune Communities	1.80
Wetland Communities	0.016
Bluff Communities	0.05

The area of privately owned tableland east of Grey Abbey Ravine has not been assessed. Therefore, impacts to vegetation communities in this location cannot be quantified, and were assessed qualitatively. Orthophotograph interpretation suggests this area consists of open habitat that is periodically mowed, likely resulting in a cultural meadow vegetation community. As this area is privately owned, the effects will be assessed at Detailed Design once access to the property has been achieved.

Approximately 2.90 ha of existing terrestrial natural habitat will be removed and approximately 17.6 ha of new naturalized habitat will be created by the Project, resulting in a net positive effect. Habitat restoration and enhancement are expected to mitigate terrestrial habitat impacts and no long-term impacts are anticipated. Impacts related to the disturbance or removal of vegetation are not expected to reduce ecosystem function within the existing ANSIs and ESAs, and together with informal trail decommissioning and the development of a Bluffer's Park Revitalization Plan, an East Point Park Revitalization Plan and a SWP Operations and Maintenance Plan, will result in benefits to ANSIs and ESAs.

Mitigation Measures

Mitigation measures will include:

- Salvage plants, including sea rocket, for replanting, where appropriate;
- Where appropriate, vegetation communities will be restored;
- Any habitat features (e.g., cavity trees) that will be impacted will be replaced with an artificial or constructed habitat (e.g., bird nesting boxes); and,
- Relocation and expansion of artificially created wetland at base of Guild construction access route.

Net Effects

The net effects are positive. While some areas of existing habitat will be removed, approximately 17.6 ha of new naturalized habitat will be created, resulting in a net increase in terrestrial habitat. Sea rocket is expected to re-establish resulting in no net loss. Habitat restoration is expected to mitigate terrestrial wildlife/bird habitat impacts and no long-term impacts are anticipated. There will be a net increase in size of wetland area which will be recreated properly.

Potential Effects During Operation/Establishment

This Criterion is not relevant to the operation/establishment phase.

5.2.2 Criteria: Ability to Provide Functional Nearshore Open Coast Aquatic Habitat

5.2.2.1 Indicator: Ability to Increase Shoreline Morphology by Increasing Shoreline Irregularity

Potential Effects During Construction

This Criterion is not relevant to the construction phase.

Potential Effects During Operation/Establishment

SWP presents a valuable opportunity to enhance the shoreline morphology within the Project Area via increasing shoreline irregularity. A more complex shoreline profile provides for more nearshore habitat by increasing fish foraging opportunities, cover and shelter. This Indicator was assessed quantitatively by comparing the pre-construction and post-construction shoreline lengths. The more irregular (longer) the shoreline is, the greater its ecological value. To calculate the percent change, pre-construction shoreline lengths were measured using geo-referenced aerial imagery and compared to the post-construction shoreline lengths which were measured in ArcGIS using the Preferred Alternative concept drawings.

The post-construction shoreline is approximately 15% longer and more undulating, resulting in a more irregular shoreline than the current shoreline. The Preferred Alternative increases shoreline irregularity and the ability to provide nearshore habitat. Net effects from the SWP on shoreline irregularity and nearshore habitat are positive, and as a result, no mitigation measures are required. Most gains in profile complexity are made along the shoreline between Bluffer's Park and Meadowcliffe, and along Grey Abbey Park shoreline to the east side of Grey Abbey Ravine.

Shoreline morphology enhancement through increasing shoreline irregularity as well as diversification of the shoreline vertical profile through the implementation of habitat enhancement techniques represent a net positive effect on the ability of the Preferred Alternative to provide functional nearshore habitat. No mitigation measures were identified.

Mitigation Measures

As the net effects are positive, no mitigation measures are identified.

Net Effects

The net effects will be positive, as enhanced shoreline morphology provides for increased ability of the Preferred Alternative to provide functional nearshore open coast aquatic habitat.

5.2.2.2 Indicator: Ability to Increase Shoreline Substrate Diversity

Potential Effects During Construction

This Criterion is not relevant to the construction phase.

Potential Effects During Operation/Establishment

The change in shoreline substrate diversity refers to the difference between each type of the pre-construction and post-construction shoreline substrate (cobble, sand, and armourstone/boulder). This Indicator was assessed quantitatively by measuring the lengths of each pre-construction shoreline substrate type using geo-referenced aerial imagery, and comparing them to the post-construction lengths of each shoreline substrate type measured in ArcGIS using the Project concept drawings.

There are three main shoreline substrate types within the Project Study Area: sand, cobble and armourstone (boulder). Coarse substrates such as cobble and boulders, constitute the major building blocks of habitat physical structure as they provide fish with cover and shelter, and enhance foraging opportunities. Though sand is preferred by certain species, sand shorelines lack the substrate diversity to be able to provide adequate cover, shelter and foraging opportunities for multiple species that constitute the majority of the local fish community.

The current shoreline consists of approximately 4,700 m of sand, 1,350 m of cobble and 4,950 m of armourstone (boulder). The post-construction shoreline will consist of approximately 4,000 m of sand, 1,900 m of cobble and 6,750 m of armourstone (boulder). The Preferred Alternative reduces the length of sand shoreline by 15%, while the length of cobble shoreline is increased by 40%, and the length of armourstone (boulder) shoreline is increased by 35%. Overall, the shoreline substrate type composition of the Preferred Alternative is more diverse, with an increase in the cobble and boulder proportions, relative to sand.

Cobble and armourstone (boulder) shorelines present valuable opportunities to increase substrate diversity in the nearshore areas adjacent to the proposed structures. This is achieved via implementing appropriate open coast habitat enhancement techniques such as shoreline shoals, underwater shoals and surcharged headlands. Moreover, habitat enhancements to the existing structures, particularly revetments, provide further benefits associated with diversifying shoreline and nearshore substrate.

Armourstone (boulder) serves an anchoring function, providing for overall shoreline stability and preventing cobble migration. At the same time, interstitial spaces between individual stones provide valuable shelter and cover for smaller fish, particularly when it comes to headlands surcharged with large, irregular shaped boulders and cobble. Cobble and rubble serve as spawning substrates for species that require these (e.g., Lake Trout).

Sand, though reduced in terms of length of shoreline, is still prevalent in the nearshore, where shallow depths (particularly east of Grey Abbey Park) are still available to those species that depend on it (e.g., Emerald Shiner).

Overall, diverse substrates provide higher quality cover, shelter and foraging opportunities, thereby increasing the capacity of the local shoreline to serve as nursery, spawning and migratory habitat. Thus, increased shoreline substrate diversity represents a net positive effect, and no mitigation measures are required.

Mitigation Measures

As the net effects are positive, no mitigation measures are identified.

Net Effects

The net effects will be positive, as increased shoreline substrate diversity represents a net positive effect associated with the ability of the Preferred Alternative to provide functional nearshore open coast habitat.

5.2.2.3 Indicator: Ability to Provide Habitat for Various Life Stages

Potential Effects During Construction

This Criterion is not relevant to the construction phase.

Potential Effects During Operation/Establishment

The nearshore zone of Lake Ontario within the Project Study Area provides habitat for various fish life stages: spawning habitat, nursery and juvenile habitat, and adult habitat. This Indicator was assessed by examining the various habitat requirements of the species found utilizing the Project Study Area nearshore habitat.

Habitat requirements vary by fish life stage and species. Adequate spawning habitat is necessary for successful reproduction (egg deposition and survival). Suitable nursery habitat is required for young fish survival and attainment of reproductive maturity. Important adult habitat is necessary to sustain adult populations to ensure successive reproduction and species persistence in the ecosystem.

Suitable habitat availability and habitat quality play an important role in how successful each fish life stage is. Availability of specific substrate is crucial in determining whether a given species is able to utilize an area for spawning, as different species are adapted to use different substrate types to deposit their eggs. The species anticipated to utilize aquatic habitat within the Project Study Area for spawning include those that broadcast their eggs over substrate and do not require aquatic vegetation or presence of woody debris. Such species include forage fish species such as Alewife, Rainbow Smelt and Emerald Shiner, and native salmonids including Lake Trout and Round Whitefish.

Non-native Alewife have been reported to spawn over a variety of substrates from boulder to sand and even silt and clay, in the 0-5 m depth range. Native Emerald Shiner and non-native Rainbow Smelt prefer rubble, gravel and sand, in the 0 to over 5 m depths (Lane et al., 1996). Lake Trout favour bedrock, boulder, cobble and rubble, and, though they have been observed to spawn in 0 to over 5 m depths, the 5-8 m range is the most suitable (**Appendix F**). Round Whitefish require rubble and gravel, and have been reported to spawn in the 0 to over 5 m depth range.

Though the land creation activities would reduce availability of sand in the primarily 0 to 3 m depth range, sand substrate in the depths utilized by Alewife, Emerald Shiner and Rainbow Smelt would still be widely available. At the same time, the Project would increase availability of cobble, boulder and rubble in depths used by Lake Trout (5 to 8 m, Bluffer’s Park headland extension) and potentially Round Whitefish.

Young and adults of species such as Smallmouth Bass, Northern Pike, American Eel, Yellow Perch and White Sucker utilize the Project Area nearshore habitat. Nursery and juvenile habitat has to provide sufficient cover, shelter and foraging opportunities to reduce competition for habitat and resources, and ensure young fish survival. Similarly, cover, shelter and foraging opportunities availability are equally important for adult survival. Cover, shelter and foraging opportunities would be enhanced via diversifying substrate and constructing a more irregular shoreline in the nearshore zone. It is anticipated that a variety species and life stages will be able to utilize those portions of the Project Area that currently lack a diversity of substrates and shoreline profile complexity.

Overall, the Project results in an enhanced ability of the local nearshore habitat to serve as habitat for a variety of native species and life stages, and no mitigation measures are required.

Mitigation Measures

As the net effects are positive, no mitigation measures are identified.

Net Effects

The net effects will be positive, as the Project results in an enhanced ability of the local nearshore habitat to serve as habitat for various life stages.

5.2.3 Criteria: Ability to Improve and Manage Functional Terrestrial Habitat

5.2.3.1 Indicator: Area of Terrestrial Habitat Removed from Unsustainable Inappropriate Use

Potential Effects During Construction

This Criterion is not relevant to the construction phase.

Potential Effects During Operation/Establishment

This Indicator measures the area of informal trails that will be decommissioned. The Indicator was assessed and mapped through field surveys and orthophoto interpretation. Final distances were measured using ArcGIS. Typically, telltale signs of human trails include a width of approximately 30 cm, trampled vegetation, broken branches, dead-ends, footprints, encounters with people, and/or litter.

The SWP will decommission approximately 8 km of informal trails at East Point Park and over 1 km of informal trails through Bluffer's Park, removing these sensitive areas from the negative effects associated with unmanaged use, such as habitat fragmentation, vegetation trampling, degradation of rare and sensitive bluff and dune vegetation communities, soil compaction, increased vulnerability for invasive species colonization, and increased wildlife predation (i.e., urban Raccoons depredating ground/low nesting bird nests) and parasitism (i.e., Brown-headed Cowbird parasitism).

Intensification and densification of residential urban areas will increase pressure on natural areas. Given the forecasted 24.9% population increase in Toronto over the next 30 years (2011 to 2041) (Hemson Consulting Ltd., 2012) and the upward trend of public use of greenspaces (Park People, 2016), managed access of natural areas, particularly ANSIs and ESAs, will be critical to helping ensure their ecological integrity persists. Techniques to manage use, including the decommissioning and management of informal trails, will be detailed in the Bluffer's Park and East Point Park Revitalization Plans and could include tree and shrub planting, installation of habitat piles (i.e., woody debris and aggregates), signage and bylaw enforcement.

The addition of a well-designed formalized trail system along the toe and top of the Bluffs and through Bluffer's Park and East Point Park, with formal access points, will provide a clear route for people to enjoy the waterfront, thereby reducing unmanaged use and mitigating associated impacts. This will help to achieve better conservation of natural areas, including rare and sensitive bluff and dune vegetation communities. Management of unsustainable inappropriate use will result in a net positive effect, and no mitigation measures are identified.

Mitigation Measures

As the net effects are positive, no mitigation measures are identified.

Net Effects

The net effects are positive, as overall, the Project will decommission the number of informal trails and lead to improved habitat quality.

5.2.3.2 Indicator: Area of Habitat Created

Potential Effects During Construction

This Criterion is not relevant to the construction phase.

Potential Effects During Operation/Establishment

This Indicator measures the area of forest, meadow, successional, beach/dune and wetland communities created. This Indicator was assessed quantitatively by measuring the approximate new habitat area created in ArcGIS.

The SWP will produce an increase in natural habitat cover within the Project Study Area through the addition of 17.6 ha of new naturalized terrestrial habitat, improving the shoreline as a critical stepping-stone habitat for birds, mammals, fish and other wildlife (**Table 24**).

Table 24 : Terrestrial Habitat Enhancements by Project Study Area Segment

Habitat Type	West	Central	East	Total
	Approximate ha			
Forest Communities	--	--	0.5	0.5
Successional Communities	1.8	1.5	2.1	5.4
Meadow Communities	1.6	0.4	1.6	3.6
Beach/Dune Communities	7.7	--	--	7.7
Wetland Communities	--	0.3	0.1	0.4

Restoration and enhancement areas include new lands, as well as a section of the north slope of the hill east of Beechgrove Drive. This 0.5 ha area will be restored to achieve a forest community, which will also improve habitat connectivity from East Point Park to Highland Creek. Native plant species will be planted to improve the overall diversity, and increase breeding, foraging and overwintering opportunities for wildlife. Appropriate restoration techniques and plant care will ensure successful establishment, and monitoring will identify areas that may require additional infill planting over time. Potential negative effects related to invasive plant species colonizing the created habitat will be managed to the extent possible using adaptive management and BMPs, such as identifying target invasive species for removal. Invasive species management will be developed as part of an Operations and Maintenance Plan, to be prepared in collaboration with the City of Toronto at Detailed Design.

The overall quantity of forest, meadow, successional, beach/dune and wetland communities created increases due to the SWP; therefore, net effects are anticipated to be positive.

Habitat features, such as bird nest boxes and woody habitat piles, will be installed where appropriate to maximize the functionality of the new habitat for wildlife which will result in improved breeding, migratory, and overwintering opportunities. Habitat features will be closely examined during the Detailed Design phase to enhance the overall functionality of habitat within the Project Area.

Mitigation Measures

Mitigation measures will include the development of an Operations and Maintenance Plan collaboratively with the City of Toronto to address inappropriate use and promote community stewardship.

Net Effects

The net effects are positive, as the total natural cover and the number of essential wildlife habitat features increase which provide positive influences on the functionality of the habitat.

5.2.4 Summary

SWP Objective 1 is to protect and enhance terrestrial and aquatic natural features and linkages within the Project Area.

SWP Area habitat will undergo changes along the Lake Ontario shoreline, tablelands, and construction access routes and laydown areas both during and following construction. The summary of net gains and losses with respect to Objective 1 of the Project is presented in **Table 25**, while the overall effects related to Objective 1 are listed in **Table 26**.

Table 25: Net Gains and Losses with Respect to Objective 1

SWP Area Feature	Losses	Gains	Net Effect
Aquatic Habitat along the Lake Ontario shoreline	▪ Loss of 20 ha ▪ Alteration of 16 ha ▪ Sand shoreline reduced by 15%	▪ 15% increase in shoreline irregularity ▪ 40% increase in cobble beach ▪ 35% increase in armourstone (boulder) ▪ Functional habitat for all life stages	Positive
Forest Communities	0.27 ha	0.50 ha	Positive
Successional Communities	0.42 ha	5.40 ha	Positive
Meadow Communities	0.34 ha	3.60 ha	Positive
Beach/Dune Communities	1.8 ha	7.70 ha	Positive
Wetland Communities	0.016 ha	0.40 ha	Positive
Bluff Communities	0.05 ha	0.00 ha	Negative

Table 26: Overall Effects Related to Objective 1

Criteria	Indicator	Overall Effects
Ability to minimize effects associated with construction works, construction access and laydown areas	Alteration and loss of aquatic habitat	Negligible
	Disruptions to fish and fish habitat	Negligible
	Nuisance effects on wildlife	Negligible
	Removal and disturbance of terrestrial habitat	Positive
Ability to provide functional nearshore open coast fish habitat	Ability to increase shoreline morphology by increasing shoreline irregularity	Positive
	Ability to increase shoreline substrate diversity	Positive
	Ability to provide habitat for various life stages	Positive
Ability to improve and manage functional terrestrial habitat	Area of terrestrial habitat removed from unsustainable inappropriate use	Positive
	Area of habitat created	Positive
Summary:		
Overall, the Preferred Alternative for the SWP provides an improvement to the ecological conditions within the Project Study Area. The loss or alteration of poorer quality habitat is offset by the creation of higher quality aquatic and terrestrial habitat. Thus, the Preferred Alternative meets the Objective to protect and enhance terrestrial and aquatic features and linkages.		

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APPENDIX A

Project Area ELC Communities

ELC Code	ELC Name	L-Rank	
SDO1-1	Switchgrass - Beachgrass - (Little Bluestem) Open Sand Dune	L1	Communities of Regional Concern
TPO2-1	Fresh-Moist Tallgrass Prairie	L1	
SDT1-2	Balsam Poplar Treed Sand Dune	L2	
MAM5-1	Mineral Fen Meadow Marsh	L2	
BBO1-1	Sea Rocket Open Sand Beach	L2	
BLS1-B	Serviceberry - Buffaloberry Shrub Bluff	L2	
CBS1	Shrub Clay Barren	L2	
CBT1-A	White Cedar Low Treed Clay Barren	L2	
BBS1-2A	Willow Shrub Beach	L2	
FES2-A	Willow Shrub Mineral Fen	L2	
MAS2-7	Bur-reed Mineral Shallow Marsh	L3	
BLT1-B	Deciduous Treed Bluff	L3	
FOD2-3	Dry-Fresh Hickory Deciduous Forest	L3	
BLT1-c	Exotic Treed Bluff	L3	
FOM8-B	Fresh-Moist Ash Mixed Forest	L3	
MAM2-7	Horsetail Mineral Meadow Marsh	L3	
BBO1	Mineral Open Beach	L3	
BLS1	Mineral Shrub Bluff	L3	
BBT1-A	Mineral Treed Beach	L3	
CUT1-H	Ninebark Planted Deciduous Thicket	L3	
BLS1-A	Sumac - Willow - Cherry Shrub Bluff	L3	
SDS1-A	Willow Shrub Sand Dune	L3	
SBO2	Anthropogenic Sand / Gravel Barren	L4	Communities of Urban Concern
CUP2-b	Black Locust - Conifer Mixed Plantation	L4	
MAS2-2	Bulrush Mineral Shallow Marsh	L4	
MAM2-a	Common Reed Mineral Meadow Marsh	L4	
MAS2-a	Common Reed Mineral Shallow Marsh	L4	
CUP3	Coniferous Plantations	L4	
FOD4-1	Dry-Fresh Beech Deciduous Forest	L4	
FOD4-A	Dry-Fresh Ironwood Deciduous Forest	L4	
FOD4-d	Dry-Fresh Norway Maple Deciduous Forest	L4	
FOD2-4	Dry-Fresh Oak - Hardwood Deciduous Forest	L4	
FOD3-2	Dry-Fresh Paper Birch Deciduous Forest	L4	
FOD5-b	Dry-Fresh Sugar Maple - Norway Maple Deciduous Forest	L4	
FOD5-3	Dry-Fresh Sugar Maple - Oak Deciduous Forest	L4	
FOD5-10	Dry-Fresh Sugar Maple - Paper Birch - Poplar Deciduous Forest	L4	
FOM2-A	Dry-Fresh White Pine - Hardwood Mixed Forest	L4	

ELC Code	ELC Name	L-Rank	
CUH1-d	Exotic Shrub Hedgerow	L4	Communities of Urban Concern
FOD7-F	Fresh-Moist Basswood Lowland Deciduous Forest	L4	
FOD7-b	Fresh-Moist Norway Maple Lowland Deciduous Forest	L4	
FOD9-1	Fresh-Moist Oak - Sugar Maple Deciduous Forest	L4	
FOD8-B	Fresh-Moist Paper Birch Deciduous Forest	L4	
FOM6-1	Fresh-Moist Sugar Maple - Hemlock Mixed Forest	L4	
TPO2-A	Fresh-Moist Tallgrass Prairie Planting	L4	
CUP2-h	Horticultural Mixed Plantation	L4	
CUP2-f	Hybrid Poplar - Conifer Mixed Plantation	L4	
CUM1	Mineral Cultural Meadow	L4	
BLO1	Mineral Open Bluff	L4	
CUT1-A	Miscellaneous Native Cultural Thicket	L4	
CUP2-c	Norway Maple - Conifer Mixed Plantation	L4	
SWD4-3	Paper Birch - Poplar Mineral Deciduous Swamp	L4	
MAM2-b	Purple Loosestrife Mineral Meadow Marsh	L4	
SWD2-2	Red (Green) Ash Mineral Deciduous Swamp	L4	
SWT2-5	Red Osier Dogwood Mineral Thicket Swamp	L4	
MAM2-3	Red-top Mineral Meadow Marsh	L4	
BBO2-A	Rubble Open Shoreline	L4	
BBT2-A	Rubble Treed Shoreline	L4	
CUP2-E	Silver Maple - Conifer Mixed Plantation	L4	
SWD3-2	Silver Maple Mineral Deciduous Swamp	L4	
SWD3-3	Swamp Maple Mineral Deciduous Swamp	L4	
SWM1-1	White Cedar - Hardwood Mineral Mixed Swamp	L4	
CUS1-2A	White Cedar Successional Savannah	L4	
CUW1-A1	White Cedar Successional Woodland	L4	
CUP1-b	Willow Deciduous Plantation	L4	
CUT1-G	Willow Deciduous Thicket	L4	
SWD4-1	Willow Mineral Deciduous Swamp	L4	
SWT2-2	Willow Mineral Thicket Swamp	L4	
FOD5-6	Dry-Fresh Sugar Maple - Basswood Deciduous Forest	L5	Generally Secure Communities
FOD5-2	Dry-Fresh Sugar Maple - Beech Deciduous Forest	L5	
FOD5-4	Dry-Fresh Sugar Maple - Ironwood Deciduous Forest	L5	
FOD5-8	Dry-Fresh Sugar Maple - White Ash Deciduous Forest	L5	
FOD5-1	Dry-Fresh Sugar Maple Deciduous Forest	L5	
FOD7-2	Fresh-Moist Ash Deciduous Forest	L5	
FOD7-E	Fresh-Moist Hawthorn - Apple Deciduous Forest	L5	
FOD7-a	Fresh-Moist Manitoba Maple Lowland Deciduous Forest	L5	

ELC Code	ELC Name	L-Rank	
FOD8-1	Fresh-Moist Poplar Deciduous Forest	L5	Generally Secure Communities
FOD6-1	Fresh-Moist Sugar Maple - Ash Deciduous Forest	L5	
FOD6-5	Fresh-Moist Sugar Maple - Hardwood Deciduous Forest	L5	
FOD7-3	Fresh-Moist Willow Lowland Deciduous Forest	L5	
CUP1-c	Black Locust Deciduous Plantation	L5	
CUP1-4	Hybrid Poplar Deciduous Plantation	L5	
CUP1-A	Restoration Deciduous Plantation	L5	
CUP2-A	Restoration Mixed Plantation	L5	
CUH1-A	Treed Hedgerow	L5	
CUP3-G	White Cedar Coniferous Plantation	L5	
CUM1-b	Exotic Cool-season Grass Graminoid Meadow	L5	
CUM1-c	Exotic Forb Meadow	L5	
CUM1-A	Native Forb Meadow	L5	
CUT1-c	Exotic Deciduous Thicket	L5	
CUS1-b	Exotic Successional Savannah	L5	
CUW1-b	Exotic Successional Woodland	L5	
CUW1-D	Hawthorn Successional Woodland	L5	
CUS1-A1	Native Deciduous Successional Savannah	L5	
CUW1-A3	Native Deciduous Successional Woodland	L5	
CUT1-E	Red Osier Dogwood Deciduous Thicket	L5	
CUT1-1	Sumac Deciduous Thicket	L5	
MAM2-10	Forb Mineral Meadow Marsh	L5	
MAS2-1b	Narrow-leaved Cattail Mineral Shallow Marsh	L5	

APPENDIX B

Project Area Vascular Plants

*Note: * Species at Risk*

Scientific Name	Common name	L Rank	
Pedicularis canadensis	wood-betony	L1	Species of Regional Conservation Concern
Platanthera lacera	ragged fringed orchis	L1	
Ammophila breviligulata	marram grass	L2	
Cakile edentula	sea-rocket	L2	
Carex grayi	Gray's sedge	L2	
Chamaesyce polygonifolia	seaside spurge	L2	
Cirsium discolor	pasture thistle	L2	
Cyperus schweinitzii	Schweinitz's umbrella-sedge	L2	
Gentiana andrewsii f. alba	white bottle gentian	L2	
Gentianopsis crinita	fringed gentian	L2	
Heliopsis helianthoides	ox-eye	L2	
Lathyrus japonicus	beach pea	L2	
*Liatris spicata**	spike blazing-star*	L2	
Osmunda claytoniana	interrupted fern	L2	
Pinus resinosa	red pine	L2	
Pyrola asarifolia	pink pyrola	L2	
Spiranthes lucida	shining ladies' tresses	L2	
Sporobolus asper	rough dropseed	L2	
Agalinis tenuifolia	slender gerardia	L3	
Alnus incana ssp. rugosa	speckled alder	L3	
Anaphalis margaritacea	pearly everlasting	L3	
Andropogon gerardii	big bluestem	L3	
Anemone acutiloba	sharp-lobed hepatica	L3	
Artemisia campestris ssp. caudata	beach wormwood	L3	
Aster umbellatus var. umbellatus	flat-topped aster	L3	
Aster urophyllus	arrow-leaved aster	L3	
Bromus ciliatus	fringed brome grass	L3	
Carex alopecoidea	foxtail wood sedge	L3	
Carex eburnea	bristle-leaved sedge	L3	
Carex flava	yellow sedge	L3	
Carex pallescens	pale sedge	L3	
Carex platyphylla	broad-leaved sedge	L3	
Carex tuckermanii	Tuckerman's sedge	L3	
Carex viridula ssp. viridula	greenish sedge	L3	
Carya ovata	shagbark hickory	L3	
Celastrus scandens	American bittersweet	L3	
Chelone glabra	turtlehead	L3	

*Note: * Species at Risk*

Scientific Name	Common name	L Rank	
Cinna arundinacea	tall wood reed	L3	Species of Regional Conservation Concern
Claytonia caroliniana	broad-leaved spring beauty	L3	
Cornus amomum ssp. obliqua	silky dogwood	L3	
Cyperus odoratus	fragrant umbrella-sedge	L3	
Cypripedium calceolus var. parviflorum	smaller yellow lady's slipper	L3	
Cypripedium calceolus var. pubescens	larger yellow lady's slipper	L3	
Cystopteris tenuis	Mackay's fragile fern	L3	
Desmodium glutinosum	pointed-leaved tick-trefoil	L3	
Dryopteris filix-mas	male fern	L3	
Elodea nuttallii	Nuttall's water-weed	L3	
Equisetum pratense	thicket horsetail	L3	
Equisetum scirpoides	dwarf scouring-rush	L3	
Equisetum x nelsonii	Nelson's horsetail	L3	
Gentiana andrewsii	bottle gentian	L3	
Gymnocarpium dryopteris	oak fern	L3	
Hamamelis virginiana	witch-hazel	L3	
Helianthus decapetalus	thin-leaved sunflower	L3	
Helianthus divaricatus	woodland sunflower	L3	
Hydrophyllum canadense	Canada waterleaf	L3	
*Juglans cinerea**	butternut*	L3	
Juniperus communis	common juniper	L3	
Juniperus horizontalis x virginiana	hybrid juniper	L3	
Larix laricina	tamarack	L3	
Lemna trisulca	star duckweed	L3	
Lonicera canadensis	fly honeysuckle	L3	
Lonicera dioica	wild honeysuckle	L3	
Luzula multiflora ssp. multiflora	wood rush	L3	
Mitchella repens	partridgeberry	L3	
Nymphaea odorata ssp. tuberosa	tuberous water-lily	L3	
Oenothera oakesiana	Oakes' evening-primrose	L3	
Oenothera parviflora	smaller evening-primrose	L3	
Osmorhiza longistylis	smooth sweet cicely	L3	
Osmunda regalis var. spectabilis	royal fern	L3	
Panicum virgatum	switch grass	L3	
Physocarpus opulifolius	ninebark	L3	
Physostegia virginiana ssp. virginiana	false dragonhead	L3	
Picea glauca	white spruce	L3	

*Note: * Species at Risk*

Scientific Name	Common name	L Rank	
Potamogeton richardsonii	redhead pondweed	L3	Species of Regional Conservation Concern
Potentilla paradoxa	bushy cinquefoil	L3	
Potentilla simplex	old-field cinquefoil	L3	
Prenanthes alba	white wood lettuce	L3	
Prunus nigra	Canada plum	L3	
Pycnanthemum tenuifolium	narrow-leaved mountain-mint	L3	
Quercus alba	white oak	L3	
Ribes triste	swamp red currant	L3	
Rubus flagellaris	northern dewberry	L3	
Salix lucida	shining willow	L3	
Sanicula odorata	clustered sanicle	L3	
Scirpus pendulus	drooping bulrush	L3	
Shepherdia canadensis	russet buffalo-berry	L3	
Sicyos angulatus	bur cucumber	L3	
Sisyrinchium montanum	blue-eyed grass	L3	
Sparganium eurycarpum	great bur-reed	L3	
Spartina pectinata	prairie cord grass	L3	
Spiranthes cernua	nodding ladies' tresses	L3	
Taxus canadensis	Canada yew	L3	
Teucrium canadense ssp. canadense	wood-sage	L3	
Uvularia grandiflora	large-flowered bellwort	L3	
Viburnum acerifolium	maple-leaved viburnum	L3	
Zizia aurea	golden Alexanders	L3	
Abies balsamea	balsam fir	L4	Species of Urban Concern
Acer rubrum	red maple	L4	
Acer saccharinum	silver maple	L4	
Acer saccharum ssp. nigrum	black maple	L4	
Acer spicatum	mountain maple	L4	
Acer x freemanii	hybrid swamp maple	L4	
Actaea pachypoda	white baneberry	L4	
Actaea rubra f. neglecta	white form red baneberry	L4	
Allium tricoccum	wild leek	L4	
Amelanchier arborea	downy serviceberry	L4	
Amelanchier laevis	smooth serviceberry	L4	
Amelanchier sanguinea var. sanguinea	round-leaved serviceberry	L4	
Amelanchier x interior	serviceberry complex	L4	
Antennaria howellii ssp. howellii	Howell's pussytoes	L4	

*Note: * Species at Risk*

Scientific Name	Common name	L Rank	
Apios americana	ground-nut	L4	Species of Urban Concern
Apocynum androsaemifolium	spreading dogbane	L4	
Apocynum sibiricum	clasping-leaved hemp dogbane	L4	
Aquilegia canadensis	wild columbine	L4	
Asarum canadense	wild ginger	L4	
Asclepias incarnata ssp. incarnata	swamp milkweed	L4	
Aster macrophyllus	big-leaved aster	L4	
Aster oolentangiensis	sky-blue aster	L4	
Aster x amethystinus	amethyst aster	L4	
Betula alleghaniensis	yellow birch	L4	
Betula papyrifera	paper birch	L4	
Calamagrostis canadensis	Canada blue joint	L4	
Caltha palustris	marsh marigold	L4	
Cardamine diphylla	broad-leaved toothwort	L4	
Cardamine pensylvanica	bitter cress	L4	
Carex arctata	nodding wood sedge	L4	
Carex aurea	golden-fruited sedge	L4	
Carex cephaloidea	thin-leaved sedge	L4	
Carex communis	fibrous-rooted sedge	L4	
Carex deweyana	Dewey's sedge	L4	
Carex gracillima	graceful sedge	L4	
Carex hirtifolia	hairy wood sedge	L4	
Carex hystericina	porcupine sedge	L4	
Carex intumescens	bladder sedge	L4	
Carex laxiflora	loose-flowered sedge	L4	
Carex lupulina	hop sedge	L4	
Carex pedunculata	early-flowering sedge	L4	
Carex pellita	woolly sedge	L4	
Carex pensylvanica	Pennsylvania sedge	L4	
Carex pseudo-cyperus	pseudocyperus sedge	L4	
Carex retrorsa	retrorse sedge	L4	
Carex sparganioides	bur-reed sedge	L4	
Carex sprengelii	long-beaked sedge	L4	
Carex tenera var. echinodes	marsh straw sedge	L4	
Carpinus caroliniana ssp. virginiana	blue beech	L4	
Carya cordiformis	bitternut hickory	L4	
Caulophyllum giganteum	long-styled blue cohosh	L4	

*Note: * Species at Risk*

Scientific Name	Common name	L Rank	
Ceratophyllum demersum	coontail	L4	Species of Urban Concern
Cornus rugosa	round-leaved dogwood	L4	
Corylus cornuta	beaked hazel	L4	
Crataegus holmesiana	Holmes' hawthorn	L4	
Crataegus macracantha	long-spined hawthorn	L4	
Crataegus pedicellata	scarlet hawthorn	L4	
Cystopteris bulbifera	bulblet fern	L4	
Danthonia spicata	poverty oat grass	L4	
Desmodium canadense	showy tick-trefoil	L4	
Dichanthelium acuminatum ssp. acuminatum	hairy panic grass	L4	
Diervilla lonicera	bush honeysuckle	L4	
Dryopteris intermedia	evergreen wood fern	L4	
Dryopteris marginalis	marginal wood fern	L4	
Dryopteris x triploidea	confusing hybrid wood fern	L4	
Elymus canadensis	Canada wild rye	L4	
Elymus hystrix	bottle-brush grass	L4	
Epifagus virginiana	beech-drops	L4	
Epilobium coloratum	purple-leaved willow-herb	L4	
Equisetum variegatum ssp. variegatum	variegated scouring-rush	L4	
Eupatorium perfoliatum	boneset	L4	
Fagus grandifolia	American beech	L4	
Fraxinus nigra	black ash	L4	
Geranium maculatum	wild geranium	L4	
Glyceria grandis	tall manna grass	L4	
Helianthus strumosus	pale-leaved sunflower	L4	
Impatiens pallida	yellow touch-me-not	L4	
Juncus balticus	Baltic rush	L4	
Juncus effusus ssp. solutus	soft rush	L4	
Juncus nodosus	knotted rush	L4	
Juncus torreyi	Torrey's rush	L4	
Lilium michiganense	Michigan lily	L4	
Luzula acuminata	hairy wood rush	L4	
Lycopus americanus	cut-leaved water-horehound	L4	
Lycopus uniflorus	northern water-horehound	L4	
Maianthemum canadense	Canada May-flower	L4	
Myosotis laxa	smaller forget-me-not	L4	
Osmorhiza claytonii	woolly sweet cicely	L4	

*Note: * Species at Risk*

Species of Urban Concern

Scientific Name	Common name	L Rank
Panicum acuminatum var. acuminatum	hairy panic grass	L4
Pinus strobus	white pine	L4
Polygonatum pubescens	downy Solomon's seal	L4
Polygonum pensylvanicum	Pennsylvania smartweed	L4
Polystichum acrostichoides	Christmas fern	L4
Populus grandidentata	large-toothed aspen	L4
Populus x jackii	Jack's poplar	L4
Potamogeton foliosus	leafy pondweed	L4
Potamogeton pectinatus	sago pondweed	L4
Prunus pensylvanica	pin cherry	L4
Pteridium aquilinum var. latiusculum	eastern bracken	L4
Pyrola elliptica	shinleaf	L4
Quercus macrocarpa	bur oak	L4
Quercus rubra	red oak	L4
Rorippa palustris ssp. fernaldiana	Fernald's marsh cress	L4
Rosa blanda	smooth wild rose	L4
Rubus pubescens	dwarf raspberry	L4
Rudbeckia hirta	black-eyed Susan	L4
Salix amygdaloides	peach-leaved willow	L4
Salix bebbiana	Bebb's willow	L4
Salix discolor	pussy willow	L4
Salix petiolaris	slender willow	L4
Sanicula marilandica	sanicle	L4
Scirpus cyperinus	woolly bulrush	L4
Scirpus validus	soft-stemmed bulrush	L4
Sium suave	water-parsnip	L4
Smilax hispida	bristly greenbrier	L4
Solidago juncea	early goldenrod	L4
Solidago rugosa ssp. rugosa	rough-stemmed goldenrod	L4
Sphenopholis intermedia	slender wedge grass	L4
Spirodela polyrhiza	greater duckweed	L4
Thelypteris palustris var. pubescens	marsh fern	L4
Thuja occidentalis	white cedar	L4
Tiarella cordifolia	foam-flower	L4
Trillium erectum	red trillium	L4
Trillium grandiflorum	white trillium	L4
Tsuga canadensis	eastern hemlock	L4

*Note: * Species at Risk*

Scientific Name	Common name	L Rank	
Typha latifolia	broad-leaved cattail	L4	
Waldsteinia fragarioides	barren strawberry	L4	
Actaea rubra	red baneberry	L5	Species Considered Generally Secure
Arisaema triphyllum	Jack-in-the-pulpit	L5	
Athyrium filix-femina var. angustum	northeastern lady fern	L5	
Carex radiata	straight-styled sedge	L5	
Carex tenera	straw sedge (sensu lato)	L5	
Clematis virginiana	virgin's bower	L5	
Dryopteris carthusiana	spinulose wood fern	L5	
Echinochloa microstachya	small-spiked barnyard grass	L5	
Galium aparine	cleavers	L5	
Galium triflorum	sweet-scented bedstraw	L5	
Juniperus virginiana	red cedar	L5	
Maianthemum stellatum	starry false Solomon's seal	L5	
Monarda fistulosa	wild bergamot	L5	
Onoclea sensibilis	sensitive fern	L5	
Podophyllum peltatum	May-apple	L5	
Rhus radicans ssp. negundo	poison ivy (vine form)	L5	
Ribes americanum	wild black currant	L5	
Sanguinaria canadensis	bloodroot	L5	
Scirpus microcarpus	barber-pole bulrush	L5	
Silphium perfoliatum	cup-plant	L5	
Actaea x ludovici	hybrid baneberry	LU	Not Assessed
Antennaria howellii ssp. neodioica	small pussytoes	LU	
Antennaria howellii ssp. petaloidea	sessile-leaved pussytoes	LU	
Carex flacca	heath sedge	L+	Exotic Species
Cryptotaenia japonica	Asiatic honewort	L+	
Galium sylvaticum	wood bedstraw	L+	
Hypericum hirsutum	hairy St. John's-wort	L+	
Juniperus chinensis	Chinese juniper	L+	
Juniperus x media	pfitzer juniper	L+	
Malus prunifolia	Chinese crab-apple	L+	
Prunus pumila var. pumila	sand cherry	L+?	
Sporobolus vaginiflorus	ensheathed dropseed	L+?	

APPENDIX C

Project Area Birds

Scientific Name	Common Name	L Rank	
Accipiter striatus	sharp-shinned hawk	L3	Species of Regional Conservation Concern
Coccyzus erythropthalmus	black-billed cuckoo	L3	
Dolichonyx oryzivorus	bobolink	L3	
Dryocopus pileatus	pileated woodpecker	L3	
Geothlypis philadelphia	mourning warbler	L3	
Hylocichla mustelina	wood thrush	L3	
Meleagris gallopavo	wild turkey	L3	
Piplio erythrophthalmus	eastern towhee	L3	
Podiceps grisegena	red-necked grebe	L3	
Setophaga pinus	pine warbler	L3	
Toxostoma rufum	brown thrasher	L3	
Troglodytes troglodytes	winter wren	L3	
Accipiter cooperii	Cooper's hawk	L4	Species of Urban Concern
Actitis macularia	spotted sandpiper	L4	
Aix sponsa	wood duck	L4	
Anas strepera	gadwall	L4	
Archilochus colubris	ruby-throated hummingbird	L4	
Bubo virginianus	great horned owl	L4	
Butorides virescens	green heron	L4	
Ceryle alcyon	belted kingfisher	L4	
Chaetura pelagica	chimney swift	L4	
Colaptes auratus	northern flicker	L4	
Contopus virens	eastern wood-pewee	L4	
Dumetella carolinensis	grey catbird	L4	
Empidonax alnorum	alder flycatcher	L4	
Empidonax minimus	least flycatcher	L4	
Empidonax traillii	willow flycatcher	L4	
Falco sparverius	American kestrel	L4	
Geothlypis trichas	common yellowthroat	L4	
Hirundo rustica	barn swallow	L4	
Melanerpes carolinus	red-bellied woodpecker	L4	
Myiarchus crinitus	great crested flycatcher	L4	
Otus asio	eastern screech-owl	L4	
Passerculus sandwichensis	savannah sparrow	L4	
Passerina cyanea	indigo bunting	L4	
Pheucticus ludovicianus	rose-breasted grosbeak	L4	
Picoides villosus	hairy woodpecker	L4	
Polioptila caerulea	blue-grey gnatcatcher	L4	

Scientific Name	Common Name	L Rank	
Riparia riparia	bank swallow	L4	Species of Urban Concern
Setophaga ruticilla	American redstart	L4	
Sitta canadensis	red-breasted nuthatch	L4	
Sitta carolinensis	white-breasted nuthatch	L4	
Stelgidoptery x serripennis	northern rough-winged swallow	L4	
Sturnella magna	eastern meadowlark	L4	
Tachycineta bicolor	tree swallow	L4	
Thryothorus ludovicianus	Carolina wren	L4	
Tyrannus tyrannus	eastern kingbird	L4	
Vireo olivaceus	red-eyed vireo	L4	
Agelaius phoeniceus	red-winged blackbird	L5	Species Considered Generally Secure
Anas platyrhynchos	mallard	L5	
Bombycilla cedrorum	cedar waxwing	L5	
Branta canadensis	Canada goose	L5	
Cardinalis cardinalis	northern cardinal	L5	
Carduelis tristis	American goldfinch	L5	
Corvus brachyrhynchos	American crow	L5	
Cyanocitta cristata	blue jay	L5	
Icterus spurius	orchard oriole	L5	
Melospiza melodia	song sparrow	L5	
Molothrus ater	brown-headed cowbird	L5	
Parus atricapillus	black-capped chickadee	L5	
Picoides pubescens	downy woodpecker	L5	
Quiscalus quiscula	common grackle	L5	
Sayornis phoebe	eastern phoebe	L5	
Troglodytes aedon	house wren	L5	
Turdus migratorius	American robin	L5	
Vireo gilvus	warbling vireo	L5	
Zenaida macroura	mourning dove	L5	
Passer domesticus	house sparrow	L+	**Exotic Species**

APPENDIX D

Scarborough Waterfront Bat Survey, prepared by Burton K. Lim and Toby J. Thorne (Royal Ontario Museum)

Scarborough Waterfront Project
Bat Survey

Burton K. Lim and Toby J. Thorne

Royal Ontario Museum

Final Report to the
Toronto and Region Conservation Authority
September 16, 2016

Summary:

As part of an Environmental Assessment for the Scarborough Waterfront Project, 3 sites were acoustically monitored for bats at Bluffers Park, Guild Park and Gardens, and Grey Abbey Park. Ultrasonic echolocation calls were recorded throughout the night with stationary recorders from May to mid-July. During the study, 6 of 8 known species of bats that are resident in Ontario were positively documented. The Big brown bat (*Eptesicus fuscus*) and Silver-haired bat (*Lasionycteris noctivagans*) were the most common species, but there was overlap in echolocation call variation that prevented exact enumeration of abundance. The Eastern red bat (*Lasiurus borealis*) and Hoary bat (*Lasiurus cinereus*) were moderately common, whereas the Little brown bat (*Myotis lucifugus*) and Tricolored bat (*Perimyotis subflavus*) were only sporadically recorded. Although the automated classifier software indicated the presence of the Eastern small-foot bat (*Myotis leibii*) and Northern long-eared bat (*Myotis septentrionalis*), we could not unambiguously confirm these 2 species with detailed manual verification and comparison to reference databases and the scientific literature. Bluffer's Park had the lowest level of activity whereas Grey Abbey Park had the highest bat activity and Guild Park and Gardens had moderate levels. Both Grey Abbey and Guild Park and Gardens had the highest diversity with 6 species documented, but Bluffer's Park had only 5 species with the Tricolored bat not recorded.

Limitations: Ecological assessments provide a snapshot of a site at a particular time. Observations can be used to draw conclusions as to the likely presence or absence of species and their use of the site. It is neither definitive nor complete. Seasonality, weather conditions and intra-site variation may also affect survey results.

Cover illustration: Big brown bat, Eptesicus fuscus, one of the commonest species detected around the Scarborough Bluffs (Photo by Burton Lim © 2014)

1. Introduction:

1.1. The Toronto and Region Conservation Authority (TRCA) is conducting an Environmental Assessment (EA) of the greenspace along 11 km of the north shore of Lake Ontario from Bluffer's Park to East Point Park in Toronto (Figure 28). This Scarborough Waterfront Project (SWP) includes the iconic Scarborough Bluffs escarpment, which faces a number of pressures, in particular the risk from erosion and the need to balance the popularity of the area for recreational use while ensuring public safety.

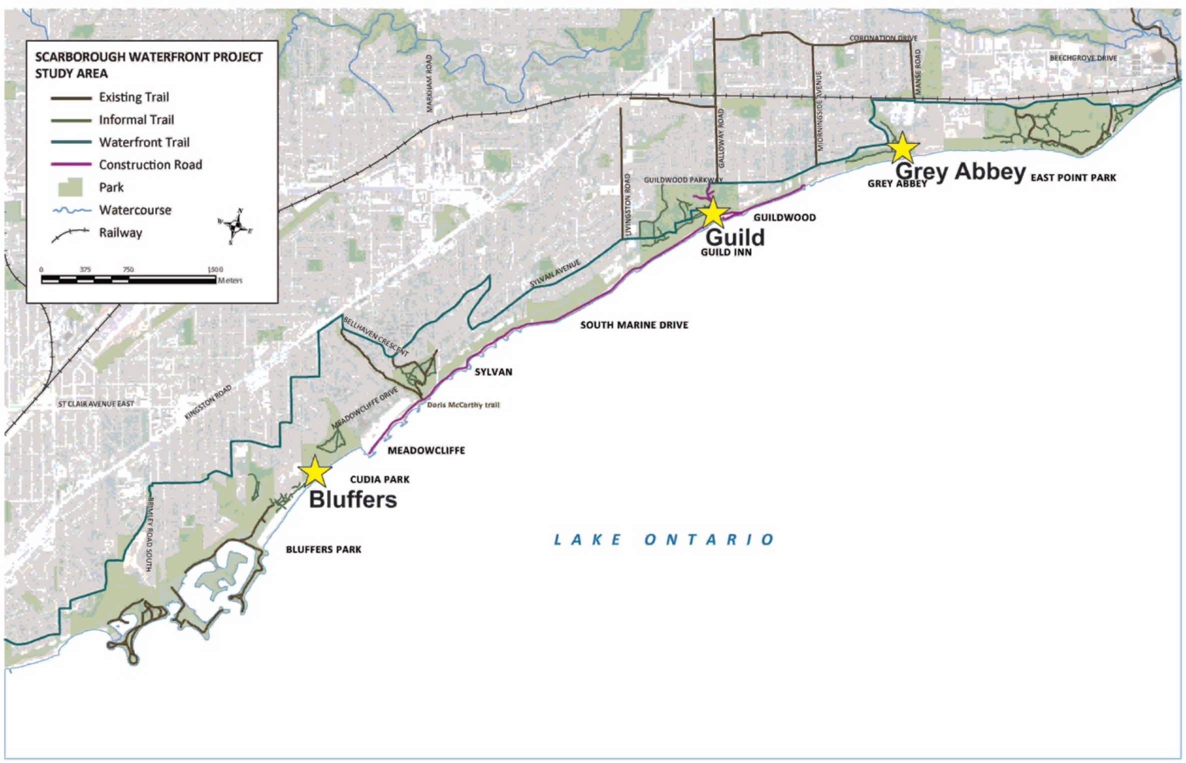


Figure 28: Map of the study area of the Scarborough Waterfront Project with stars indicating the bat recording sites at Bluffer's Park, Guild Park and Gardens, and Grey Abbey Park.

1.2. As part of the EA, bats have been selected for monitoring. These unique mammals, the only ones to have evolved self-powered flight, typically consume half their body weight in food each night. Unlike other similarly small-sized animals, bats in temperate areas typically give birth to 1 young per year, although twins have been documented in some species. Bats therefore have a low reproductive rate and are sensitive to environmental disturbances, such as habitat loss and climate change, which affect populations directly. All species of bats in Ontario are insect-feeders, so disturbances that disrupt insect populations, also affect bats indirectly. One attempt to estimate the value of ecosystem services from bats in North America, in the form of insect predation, estimated a value of billions of dollars (Boyles et al., 2011). However, this figure was reached primarily by extrapolation of data about agricultural pest control and is unlikely to be directly applicable to an urban environment. Nonetheless, bats are the primary predator of night-flying insects.

1.3. Eight species of bats are known to be present in Ontario (Dobbyn, 1994), though population and distribution records are sparse relative to some other groups of mammals. Four species are currently listed as Endangered Species at Risk under provincial and / or federal legislation (

1.4. Table **26)**. A summary of bat species ecology is given in Appendix 1.

Table 27: Bat Species Present in Ontario, and Indication of 'Species at Risk' Status

Scientific Name	Common Name	Provincial SAR	Federal SAR
Eptesicus fuscus	Big brown bat		
Lasiurus borealis	Eastern red bat		
Lasiurus cinereus	Hoary bat		
Lasionycteris noctivagans	Silver-haired bat		
Myotis leibii	Eastern small-footed bat	Y	
Myotis lucifugus	Little brown bat	Y	Y
Myotis septentrionalis	Northern long-eared bat	Y	Y
Perimyotis subflavus	Tricolored bat	Y	Y

1.5. Those species with current Species at Risk status were categorised as such due to an acute threat from a disease called White Nose Syndrome (WNS). WNS resulted from a fungus introduced to North America from Europe by inadvertent human activity. The fungus typically lives in the soil of temperate environments and can infect the 5 species of bats in Ontario that hibernate in caves, causing them to wake repeatedly, exhausting their energy supplies. This causes death by starvation as there is no food available for bats to eat in the winter. Our understanding of the impact of WNS is stymied by a lack of data about bat populations, but the available data for Little brown bats in Ontario indicates a decline of 92% at hibernation sites (Committee on the Status of Species at Risk in Ontario, 2012).

1.6. Although bats in temperate areas are historically difficult to survey with traditional mist netting techniques, technological advances have greatly increased the ease with which they can be acoustically monitored. Specifically, bat presence and activity can be monitored by recording and subsequent analysis of their ultrasonic echolocation calls, which are used for orientation and to locate insect prey. Acoustically monitoring bats involves no direct interaction or disturbance, and is thus non-invasive.

1.7. Automated recorders can be used to collect acoustic data over extended periods of time. Analysis of activity patterns over longer periods can give insight into the annual use of a site by individual species.

2. Objectives:

2.1. To identify bat species present in the vicinity of the Scarborough Bluffs.

2.2. To provide a basic assessment of bat activity, including seasonal patterns of activity throughout the period monitored, and nightly patterns of activity throughout the evening.

3. Methodology:

3.1. Data Collection:

3.1.1. We collected acoustic data at three locations along the Scarborough Waterfront Project Study Area (Figure 1): Bluffer's Park (N43.71970 W79.22242), Guild Park and Gardens (N43.74717 W79.19006) and Grey Abbey Park (N43.75584 W79.17165).

3.1.2. At each site we deployed automatic ultrasonic recorders ("SM4BAT FS" with "SMM-U1" microphone, Wildlife Acoustics, Maynard, Massachusetts, USA). We programmed the recorders to monitor continuously from 30 minutes before solar sunset to 30 minutes after solar sunrise each night, and to record any potential bat signals using the following settings: gain of 12 decibels (dB), 16 kilohertz (kHz) high-pass filter off, sample rate of 384 kHz, minimum duration of 1.5 milliseconds (ms), no maximum duration, minimum trigger frequency of

16 kHz, trigger level of 12 dB, trigger window of 3 seconds (s), and maximum length of 15 s.

3.1.3. Our recorders collected data as .wav sound files. A file is recorded each time a signal matching the trigger parameters is detected when the recorder is active. Our settings were selected with the goal that each file contains a single call sequence from a single bat, although some files are likely to contain multiple individuals or species, which can confuse species identification. A call sequence is the series of echolocation calls produced by the bat in flight. A typical call sequence recorded by a static microphone will have a pattern of increasing and decreasing amplitude as the bat approaches and passes the microphone (Figure 2).

3.1.4. It is essential to note that each file does not represent a different individual bat. Multiple files may be recorded concurrently from a single bat flying near to the microphone for an extended period. Therefore, neither the number of files nor the number of identifications correlate to the number of individuals. Ten identifications could result from 10 bats, or one bat recorded 10 times.

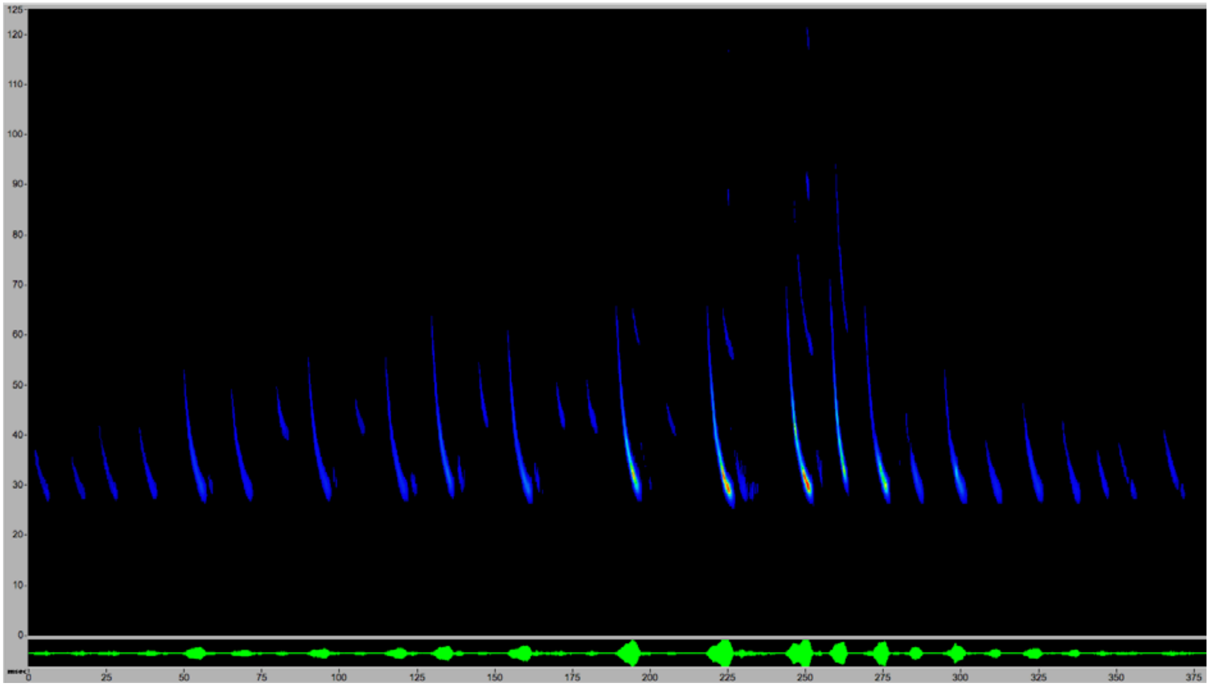


Figure 29: A typical sequence of echolocation calls produced by a Big brown bat. The calls increase in amplitude, as indicated by the warmer colours, towards the middle of the sequence, and the decrease before the end. This pattern of amplitude results from the bat moving towards and then away from the microphone.

3.2. <u>Automatic Species Identification:</u> We compiled data by monitoring site and conducted an initial identification of species using an automated classifier (Kaleidoscope Pro 3.1.8, Wildlife Acoustics, Maynard, Massachusetts, USA) to identify the most likely bat species recorded in each file. The classifier works on the assumption that each file contains a sequence of calls from a single bat. The software calculates the most likely species for each individual call in the sequence, and then combines this information to estimate the most likely species for the sequence overall. We set the classifier to include only species known to be present in Ontario (

3.3. Table **26**) and used the most conservative accuracy level. The classifier was also set to filter noise files using the following parameters for signals of interest: frequency range: 8 – 120 kHz, length: 2 – 500 ms, minimum number of calls: 3.

3.4. <u>Identification Verification:</u>

3.4.1. The accuracy of automated classification of bat echolocation call sequences is limited by a range of factors. Included among these are the high variability of calls within a single species that are dependent on the biological function of the vocalizations, the potential for overlap of call parameters between different species, and environmental factors affecting the quality of recording. It is not acceptable to use the results of automatic classification without further manual verification to a reference call library or comparison to the scientific literature.

3.4.2. We manually verified call sequences by viewing a spectrogram of the files and examining and measuring appropriate calls in Sonobat (Sonobat 4.0.5 Base, Sonobat, U.S.A.) by a researcher with several years of experience in the acoustic identification of bats in Ontario (T. Thorne). Call identification was based on published parameters for northeastern North America (Szewczak, 2009) and Ontario specifically (Ontario Bat Echolocation Summary Table, A. Adams, unpublished data). Calls were also compared, when required, to an extensive database of calls recorded in Ontario (T. Thorne, unpublished data).

3.4.3. We manually verified all species auto-identified as currently listed Species at Risk. We also manually verified all identifications of Eastern red bats, due to the similarity of calls by this species to those of species in the *Myotis* genus, and Hoary bats due to the low accuracy of the auto-classifier for this species.

3.4.4. Manual verification is problematic for Big brown or Silver-haired bats. This is due to the significant overlap in call parameters of these two species. Due to this overlap it is frequently not possible to separate the calls, and so verification would have limited benefits. Because the separation of these species could not be manually verified, the results were combined into a species group of “Big brown or Silver-haired bat” for the purpose of activity analysis. In order to confirm whether both species were present at each site, the first 100 call sequences classified as each species at each site were manually verified into the following catagories: incorrect, correct, or “Big brown or Silver-haired”. Call sequences were placed in the latter category if they could be placed within the spcecies group but not identified to speices.

3.4.5. For species where all calls were manually verified, any calls incorrectly identified via automatic classification were discarded from further analysis.

3.5. Seasonal Activity Plots: To illustrate the pattern of activity of each species or species group over the monitoring period, we created plots showing activity over time. We measured activity as the total number of call sequences recorded for each species in a night. We assumed that each file was equated to a single sequence and was supported by examination of the files.

3.6. Nightly Activity Plots: To further explore the time use at each site, we created a plot showing evening activity relative to sunset. Due to the low abundance of some species, we combined all species for plotting overall 'bat' activity. We firstly selected a subset of sequences recorded between sunset and midnight. We calculated the time of each sequence relative to sunset for each day to correct for the change in sunset time throughout the monitoring period. We then plotted the number of sequences recorded during each minute after sunset throughout the study period at each of the three sites.

4. Results:

4.1. We recorded a total of 17,482 files. After running these through the auto-classifier, 2,197 were discarded as noise, and 719 could not be identified to species. The remaining 14,566 were assigned a species identification by Kaleidoscope Pro. Representative spectrograms of echolocation calls for confirmed species are in Appendix 2. **Note that the number of identifications does not equate to the number of individuals (see point 3.1.4).**

4.2. Manual verification indicated varying levels of accuracy of the auto-classifier among the species (

4.3. Table **27**,

4.4. ***Table 28*** andTable **29**). The auto-classifier indicated the presence of Eastern small-footed and Northern long-eared bats. However, this was not supported by manual verification. Furthermore, while a large proportion of calls identified as Little brown bat could be confirmed to the *Myotis* genus, identification to species level was questionable. To address these difficulties all calls identified to the *Myotis* genus by the auto-classifier were grouped and manually categorised in the following categories: “Not *Myotis*”, “*Myotis* species” or “Little brown bat”.

Table 28: Results of manual verification of species identifications assigned by the auto-classifier during the Scarborough Waterfront Project bat study.

Species	Total Number of Identifications Suggested by Auto-classifier	Number of Identifications Discounted by Manual Verification	Number of Identifications Confirmed by Manual Verification	Percentage of Auto-classifier Results Confirmed by Manual Verification
Big brown or Silver-haired	12796	See table **Table 29** and point 3.4.4		
Eastern red	418	145	273	65.31
Hoary	1080	532	548	50.74
Myotis Sp. or Little brown	247	See table ***Table 28***		
Tricolored	25	3	22	88.00

Table 29: *Manual verification results for* Myotis *bats identified using the auto-classifier. Results are given separately for the Little Brown bat and* Myotis *Species catagories.*

	Total Number of Identifications Suggested by Auto-classifier	Number of Auto-classifer Suggestions Determined to be Non-Myotis by Manual Verification	Number of Auto-classifer Suggestions Determined to be Little Brown Bat by Manual Verification	Number of Auto-classifer Suggestions Determined to be Myotis Species by Manual Verification
Count	247	139	24	84
Percentage	100	56	10	34

Table 30: Manual verification of at least the first 100 calls of Big brown and Silver-haired at each of the 3 sites identified by the auto-classifier. Results are given separately for the Big brown bat and Silver-haired bat and the 'Either Big brown or Silver-haired bat' category.

	Total Number of Identifications Suggested by Auto-classifier	**Number of Auto-classifer Suggestions Determined to be Non-Big brown or Silver-haired by Manual Verification**	**Number of Auto-classifer Suggestions Determined to be Big brown bat by Manual Verification**	**Number of Auto-classifer Suggestions Determined to be Silver-haired bat by Manual Verification**	**Number of Auto-classifer Suggestions Determined to be either Big brown or Silver-haired bat by Manual Verification**
Count	616	28	28	32	528
Percentage	100	5	5	5	86

4.5. The relative proportions of each species are summarized in Figures 3 and 4. Big brown and Silver-haired bats were by far the most numerous in terms of activity. At Bluffer's Park, 5 species of bats were positively documented, whereas Grey Abbey Park and Guild Park and Gardens had 6 species of bats known from Ontario. Bluffer's Park did not record the Tricolored bat that was documented at the other 2 sites.

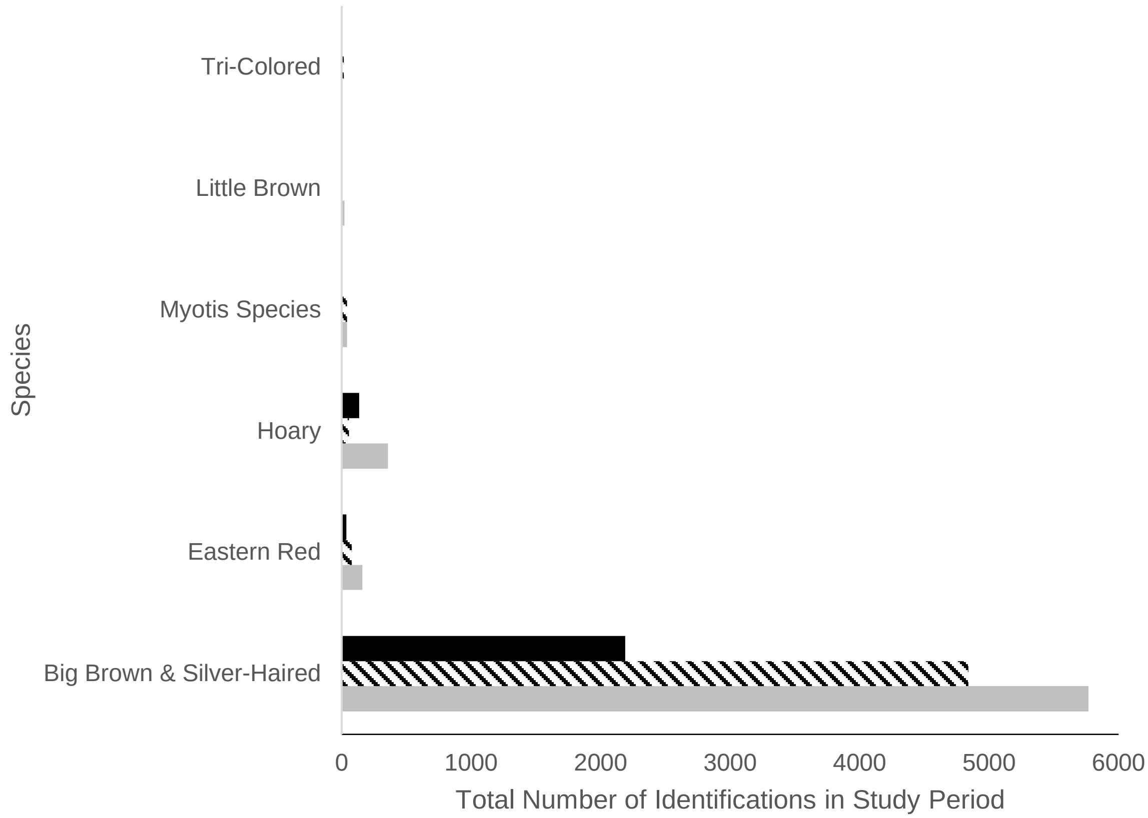


Figure 30: Total number of files of each species or species group identified during the study period at Bluffer's Park (solid black), Guild Park and Gardens (dashed black) and Grey Abbey Park (grey). Note that 'Myotis Species' does not include observations identified as Little Brown bats.

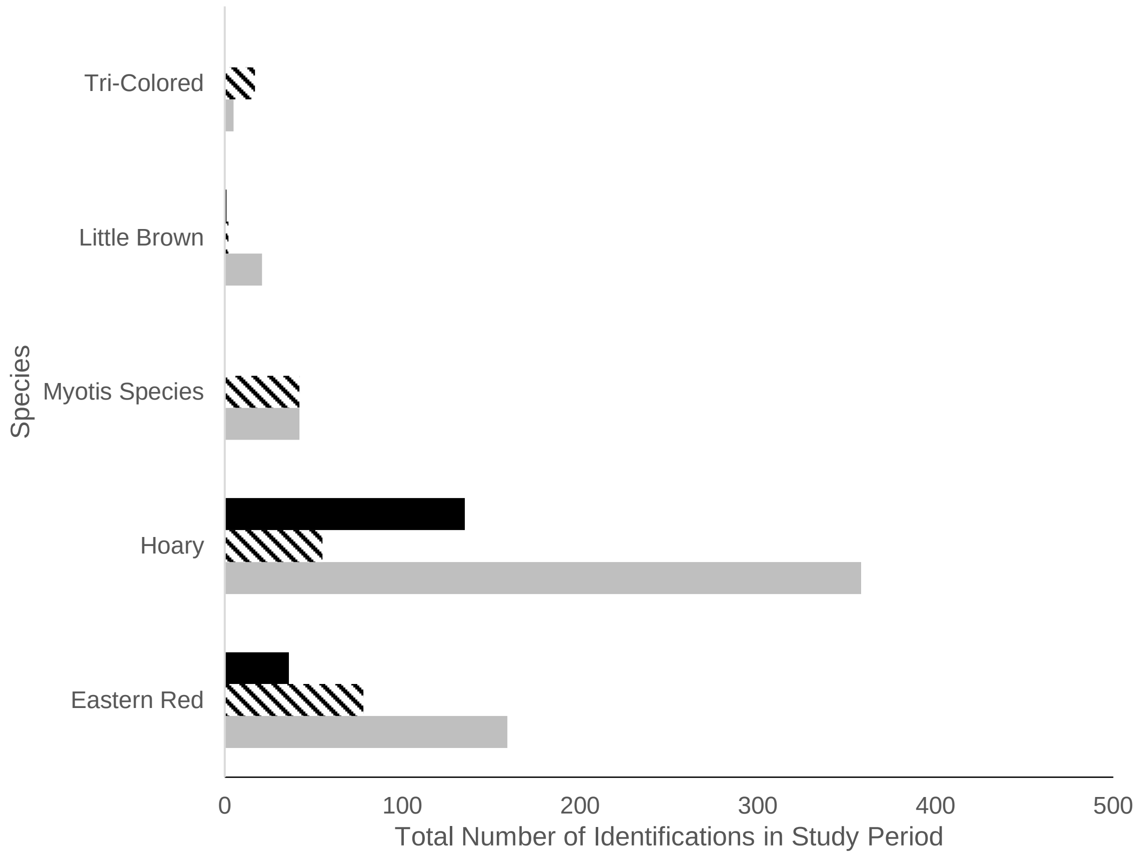


Figure 31: Total number of files of each species or species group, excluding Big brown and Silver-haired bats, identified during the study period at Bluffer's Park (solid black), Guild Park and Gardens (dashed black) and Grey Abbey Park (grey). Note that 'Myotis Species' does not include observations identified as Little Brown bats.

4.6. The nightly activity of each species is illustrated in Figures 5 – 10. After June 26, the microphone failed at Grey Abbey Park. In general, the bat activity was highest at Grey Abbey Park, lowest at Bluffer's Park, and intermediate at Guild Park and Gardens.

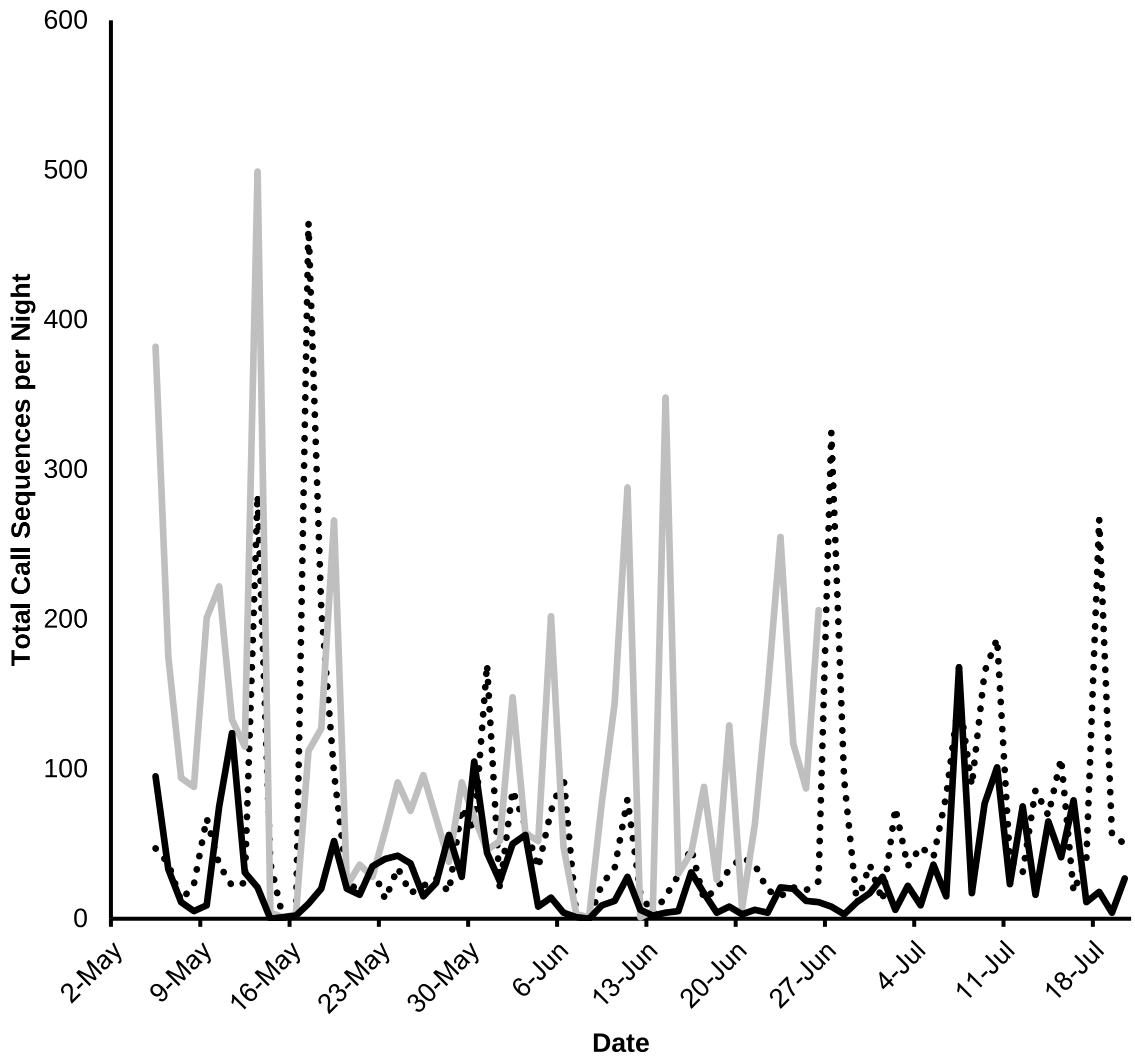


Figure 32: Combined total nightly call sequences of Big brown and Silver-haired bats throughout the monitoring period at Bluffer's Park (solid black), Guild Park and Gardens (dotted black) and Grey Abbey Park (grey). Identifications are based on auto-classifier results.

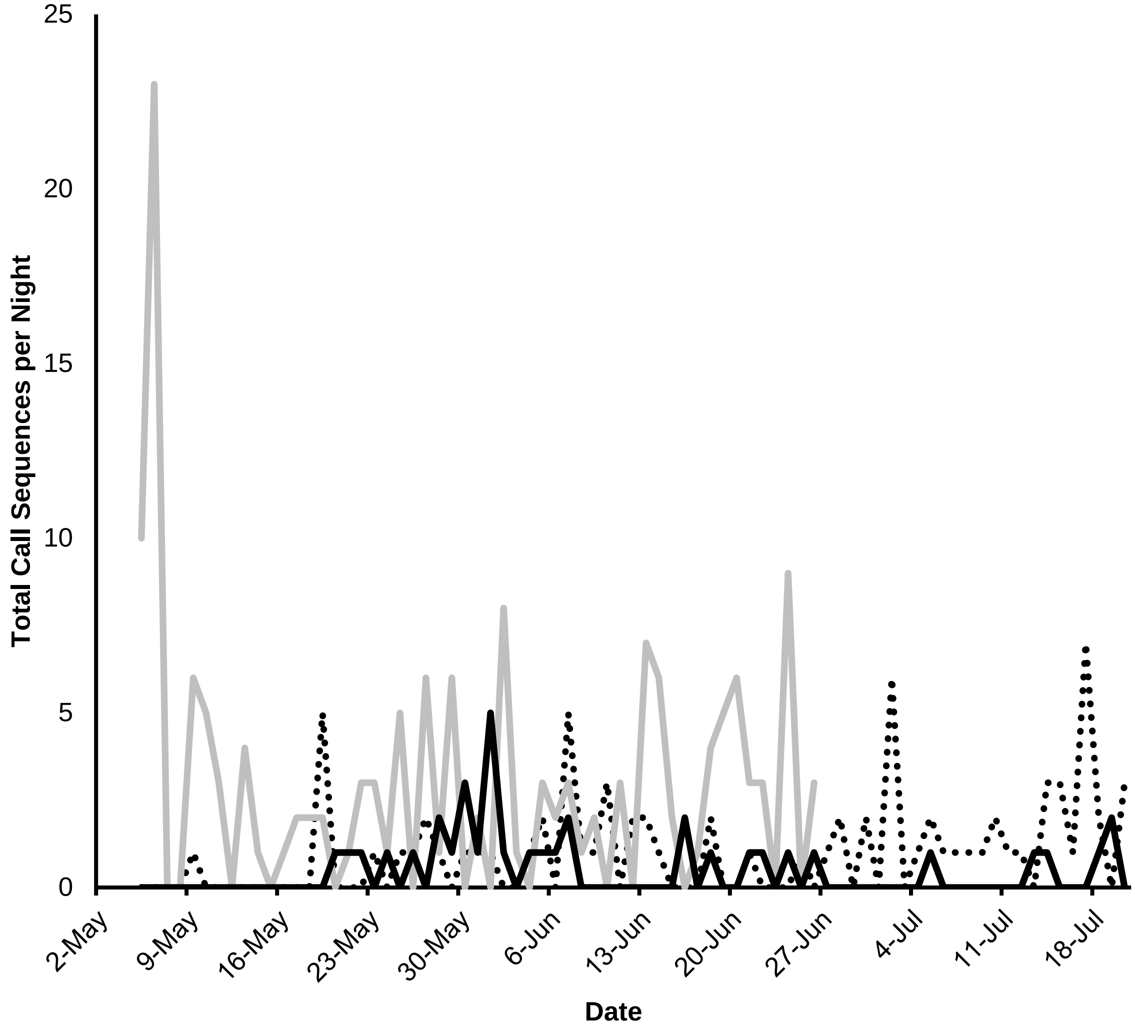


Figure 33: Total nightly call sequences of Eastern red bats throughout the monitoring period at Bluffer's Park (solid black), Guild Park and Gardens (dotted black) and Grey Abbey Park (grey). Identification is based on manual verification of auto-classifier results, with false positives discarded.

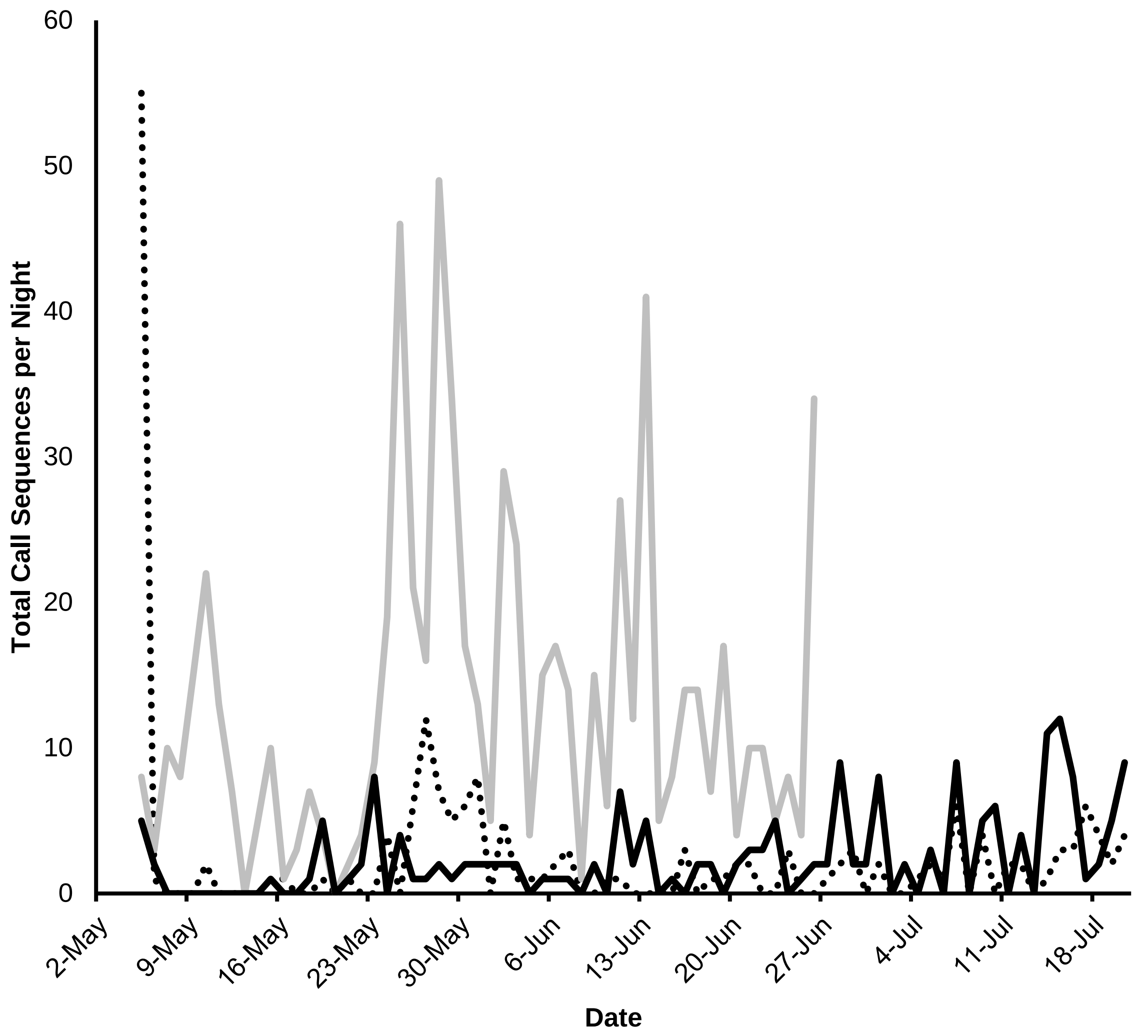


Figure 34: Total nightly call sequences of Hoary bats throughout the monitoring period at Bluffer's Park (solid black), Guild Park and Gardens (dotted black) and Grey Abbey Park (grey). Identifications are based on auto-classifier results.

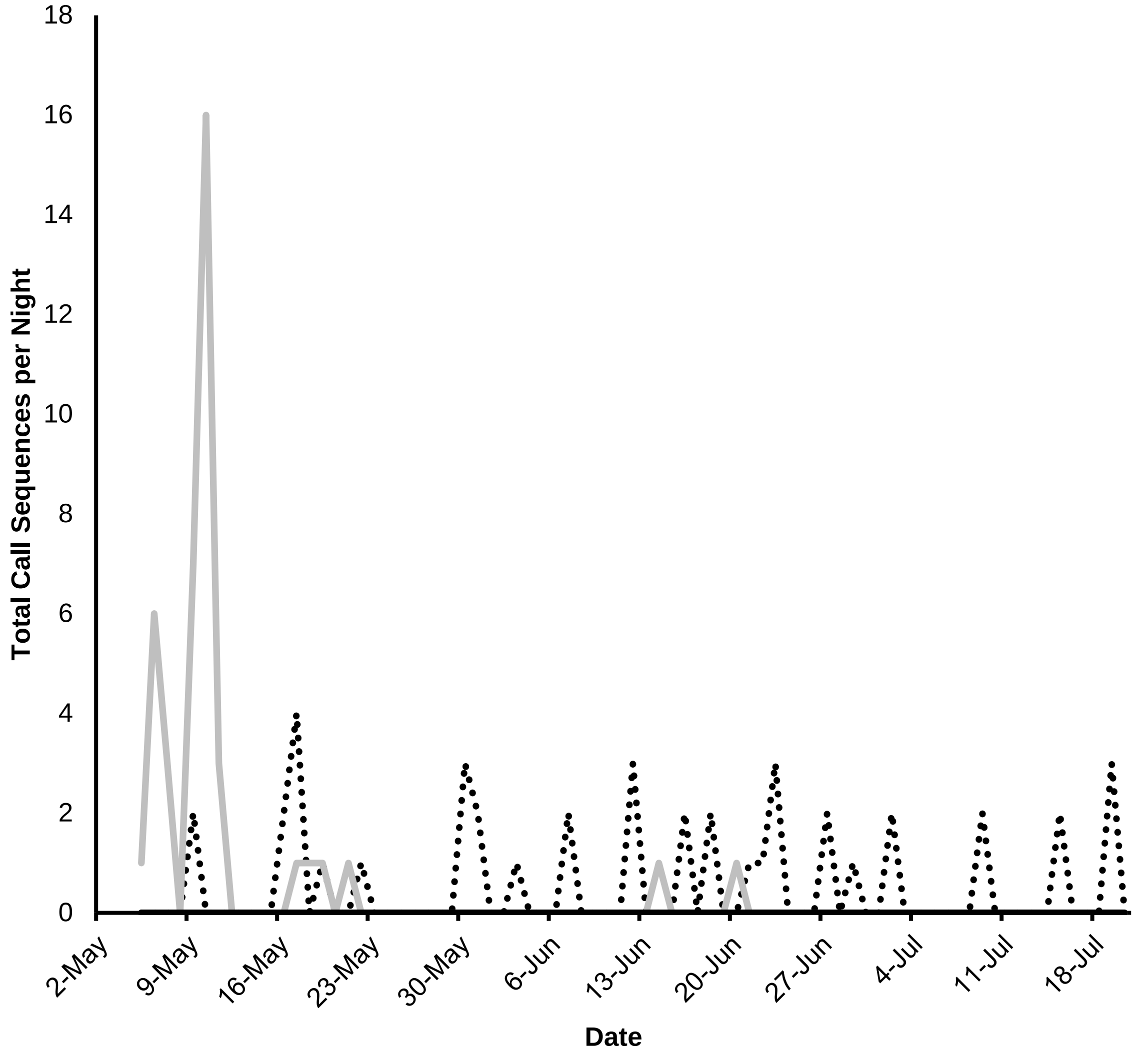


Figure 35: Total nightly call sequences of *Myotis* Species (excluding Little brown) bats throughout the monitoring period at Bluffer's Park (solid black), Guild Park and Gardens (dotted black) and Grey Abbey Park (grey). Identification is based on manual verification of auto-classifier results, with false positives discarded.

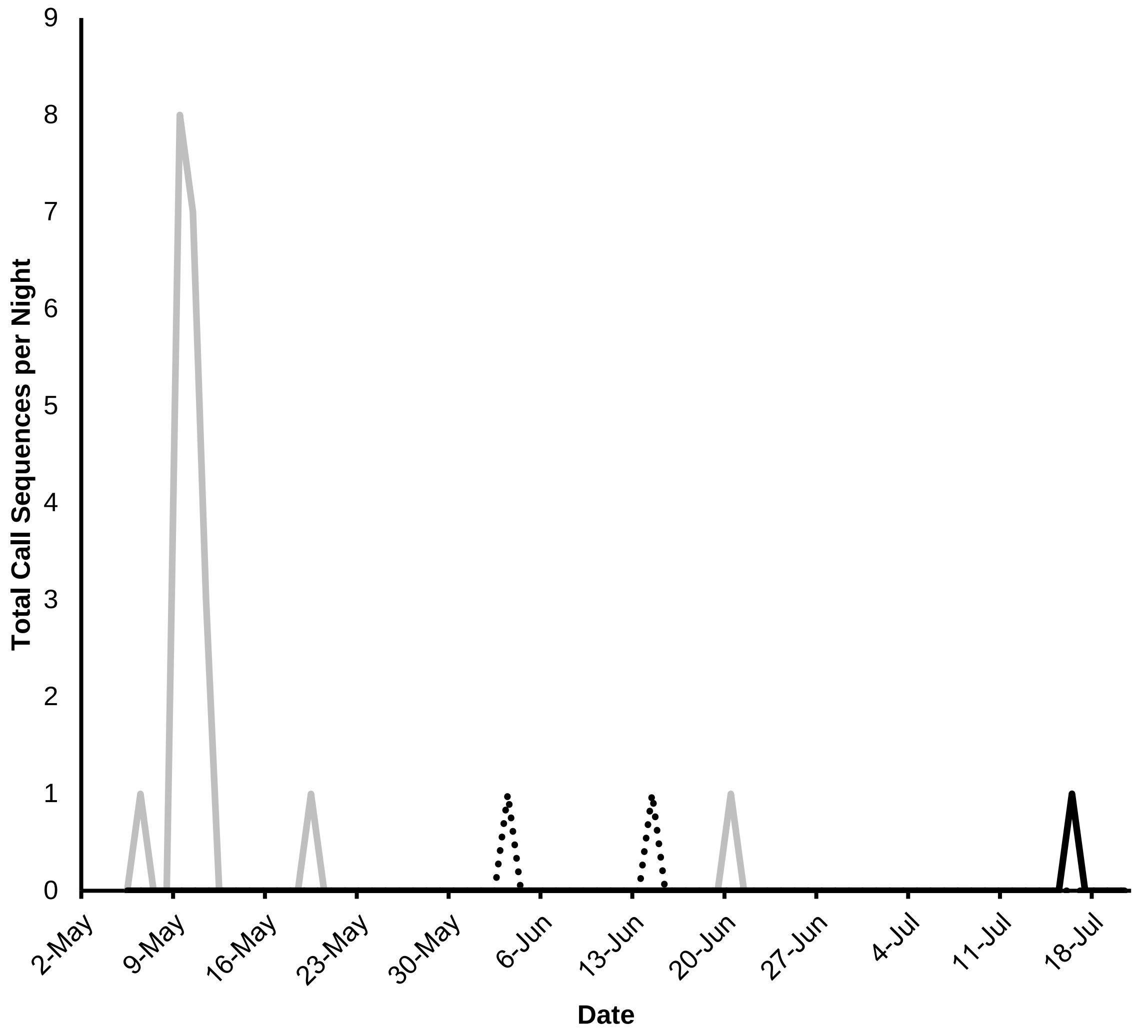


Figure 36: Total nightly call sequences of Little brown bats throughout the monitoring period at Bluffer's Park (solid black), Guild Park and Gardens (dotted black) and Grey Abbey Park (grey). Identification is based on manual verification of auto-classifier results, with false positives discarded.

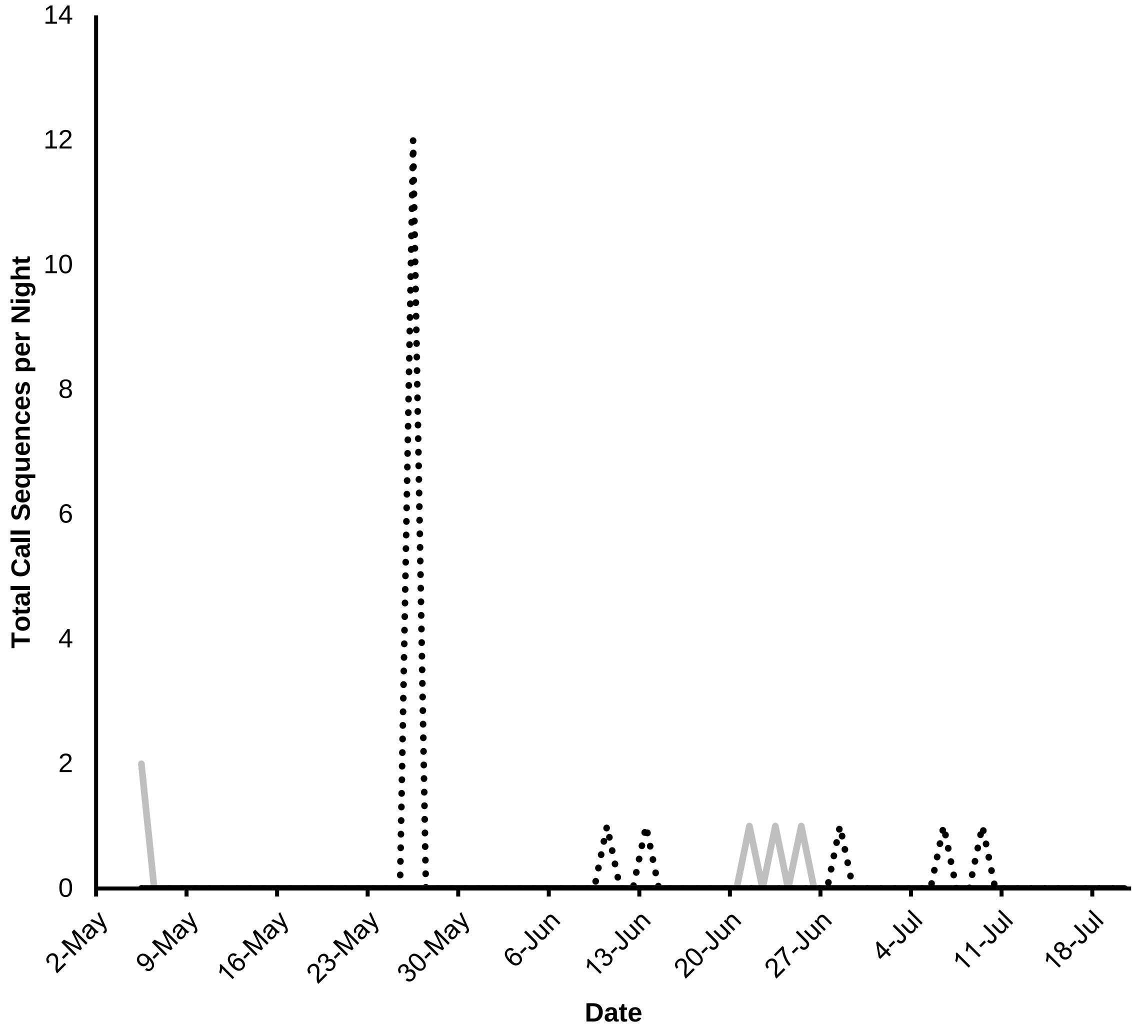


Figure 37: Total nightly call sequences of Tricolored bats throughout the monitoring period at Bluffer's Park (solid black), Guild Park and Gardens (dotted black) and Grey Abbey Park (grey). Identification is based on manual verification of auto-classifier results, with false positives discarded.

4.7. The temporal pattern of bat activity throughout the night during the monitoring period is illustrated in Figure 381. Activity of bats at Guild Park and Gardens began approximately 30 minutes after sunset, and peaked approximately 1.5 hrs after sunset. At Bluffer's Park and Grey Abbey Park bat activity began later, with little activity before 1.5 hrs after sunset and peak activity beginning closer to 2 hrs after sunset.

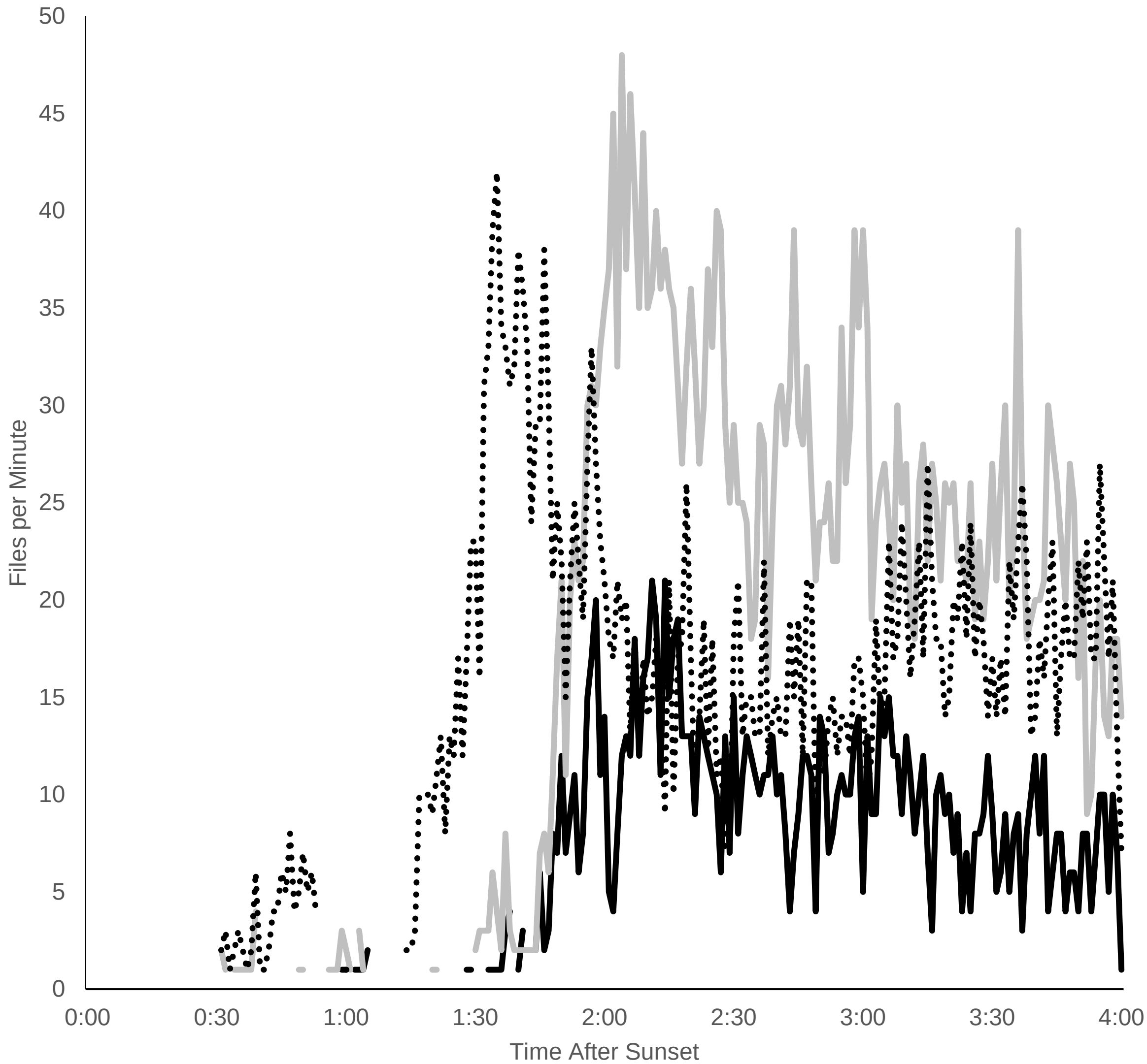


Figure 38: Plot of temporal activity patterns throughout the monitoring period at Bluffer's Park (solid black), Grey Abbey Park (grey) and Guild Park and Gardens (dotted black) relative to nightly sunset (00:00).

5. Discussion:

5.1. Accuracy of Species Identification:

5.1.1. The level of agreement between the auto-classifier results and manual verification was not perfect and varied by species (

5.1.2. Table **27**,

5.1.3. ***Table 28***Table 29). This is symptomatic of the difficulty of computerised identification of bat signals. Unlike many other animal vocalisations, such as the mating calls of birds and frogs, there is less selective pressure for bat echolocation calls to be species specific. Although there is a general trend of smaller bats having higher frequencies, the characteristics of the calls a bat produces are also substantially determined by the environment in which it is flying. Thus, two species with similar ecology and behaviour may have similar call characteristics. Conversely, an individual of a given species may greatly vary its call characteristics when flying in different environments. A result of these factors is that there can often be greater variation in the call repertoire of a single species than between two different species doing similar things while flying. This confounds identification of echolocation calls and applies to both manual and automated verification.

5.1.4. Automated systems must rely on computing measurements taken from the signals recorded. Inevitably these measurements cannot represent the full detail of a call. The relative crudeness of such measurements is vulnerable to misidentification of extraneous noise that has similar characteristics. This was a particular issue in the auto-classifier results for Eastern red and Hoary bats (Table 2). A large proportion of the calls identified as these species by the auto-classifier actually contained extraneous noise. This difference was easily detected by human verification conducted by manual review, but was undetected by the auto-classifier. This would seriously undermine the accuracy of the data if manual verification were not conducted and incorrect identifications excluded.

5.1.5. Although a certain level of error must be expected when using auto-classifiers, the level of accuracy based on this sole method of species identifications of our dataset was unacceptably low. This was addressed by manual verification in the case of species of particular interest. However, this only addresses false positives. False negatives are not accounted for and so species identifications should be considered minimum estimates.

5.2. *Myotis* species:

5.2.1. Little brown bat was confirmed as present in the study area, However, a number of calls could only be identified as *Myotis*, but not separated beyond genus. Activity levels were low, rarely more than a few calls each night, but were consistent throughout the monitoring period.

5.2.2. The low activity of *Myotis* species recorded may in part reflect the lower detectability of these species. *Myotis* bats produce lower amplitude calls than most other bat species in Ontario. However, activity is still low compared to another monitoring scenario located within 100 m of a known *Myotis* roost (T. Thorne, unpublished data). The aforementioned roost is located within alvar and alvar deciduous forest, on the Bruce Peninsula which is different to the land cover in this project. However, a recorder placed in close proximity to a roost is likely to record high activity regardless of habitat type. This low activity may reflect a difference in habitat between the monitoring sites in this study and any potential roosts in the area.

5.2.3. This low level of activity makes it unlikely that any of the monitoring recorders were located in the near vicinity of a roost. However, this does not exclude the possibility of a maternity roost in another part of the study area. Male and non-breeding female *Myotis* bats disperse away from maternity sites and could also account for the activity recorded.

5.3. Tricolored bats:

5.3.1. Occasional activity of Tricolored bats was recorded at Grey Abbey Park and Guild Park and Gardens. The species was not recorded at Bluffer's Park. The calls of Tricolored bats are highly distinctive relative to other species in Ontario, giving a high degree of confidence to these identifications.

5.3.2. The ecology of Tricolored bats is not well understood. They are known to use trees and rock crevices as summer roosts, both of which are available in the vicinity of the project study area. The low level of activity recorded could reflect low detectability of the species, but this is hard to quantify. The lack of information about this species makes it difficult to further understand the occurrence of this species within the area.

5.4. Big brown and Silver-haired bats:

5.4.1. Large numbers of Big brown and Silver-haired bats were recorded throughout the monitoring period. Nightly peaks sometimes exceeded 100 sequences, particularly at Grey Abbey Park and Guild Park and Gardens. Both species are widespread in southern Ontario and are commonly recorded, including at nearby sites in the Greater Toronto Area (Thorne, 2015; Thorne, Parr and Kroes, 2016).

5.4.2. Big brown bats are cavity roosting bats that make use of natural cavities such as tree hollows, as well as human-made cavities such as the attics of buildings. In both cases there are many roosting opportunities within the project study area.

5.4.3. Silver-haired bats roost externally on trees, including on the bark or among the leaves. They are largely solitary but females may form occasional small groups during maternity.

5.5. Eastern red bats:

5.5.1. Eastern red bats were present at moderate to low levels throughout the monitoring period at all three sites. This is consistent with the known ecology of this species, which forage in open space and are commonly encountered along forest edges, hedgerows and other sheltered areas. Identifying Eastern red bats at this site is consistent with data collected approximately 20 km east at Thickson's Woods (Thorne, Parr and Kroes, 2016) and approximately 15 km west at High Park (Thorne, 2015).

5.5.2. Eastern red bats are a widespread species in southern Ontario. It is solitary, and during the day hangs among the leaves of trees. Although the nightly activity was low, it was consistent. As the data were recorded in May – July, when bats in Ontario are breeding and most sedentary, it is feasible that Eastern red bats roost within the project study area.

5.6. Hoary bats:

5.6.1. Hoary bats are widespread in southern Ontario and has been recorded at two nearby sites (Thorne, 2015; Thorne, Parr and Kroes, 2016). It is the largest bat in Ontario, and forages with fast flight in open spaces. Activity of Hoary bats is consistent throughout the monitoring period, suggesting that individuals may roost nearby. Female Hoary bats do not form maternity colonies, remaining solitary.

5.7. Temporal Nightly Activity:

5.7.1. Roost emergence of bats in southern Ontario typically occurs between 30 and 60 minutes after sunset (T. Thorne, personal observation). Some activity was recorded approximately 30 minutes after sunset at Grey Abbey Park and Guild Park and Gardens. This suggests that individuals recorded at that time were roosting nearby however; this analysis provides only a basic indication.

5.7.2. Peak bat activity at Guild Park and Gardens began approximately 1.5 hours after sunset. At Bluffer's and Grey Abbey Parks peak activity began approximately two hours after sunset. The earlier peak observed at Guild Park and Gardens could reflect bats roosting closer, however it could also result from another unknown local factor.

6. Conclusion:

6.1. The three sites monitored within the Scarborough Waterfront Project Study Area had consistent bat activity throughout the monitoring period. There was also a high level of species diversity for Ontario. Big brown bats, Silver-haired bats, Hoary bats, and Eastern red bats were present consistently throughout the monitoring period. Little brown bats and Tricolored bats were recorded occasionally during the monitoring period.

6.2. The consistent presence of four species throughout the monitoring period suggests that these are resident in the vicinity of the project study area.

6.3. Two Species at Risk (Little brown bats and Tricolored bats) were recorded sporadically throughout the monitoring period. This does not exclude that these species could be resident in the project study area, but could reflect their low numbers and lower detectability than other, louder echolocating species.

6.4. Two other Species at Risk (Eastern small-footed bats and Northern long-eared bats were not unambiguously identified in the study area, but this may be an artefact of the difficulty in positively verifying species in the genus *Myotis*.

7. Recommendations:

7.1. This study provides basic information on bat species that are present within the shoreline area of the Scarborough Waterfront Project Study Area. Future studies could help identify roost locations and reproductive activity and assess general population health – specifically looking for signs of WNS on affected species of bats that hibernate. This would help to further the understanding of bats in Toronto and Ontario, and their role in the environment as related to ecosystem services.

7.2. Habitat enhancements:

7.2.1. Bat boxes could be erected in the parks or distributed at outreach events to increase the available roosting habitat. However, the benefits of such an initiative are likely to be primarily in the form of increasing public awareness of bats. With the surrounding greenspace and the density of buildings, it is unlikely that the availability of roosts is a limiting factor for such species that would use boxes.

7.2.2. Allowing the persistence of trees that offer potential bat roosting habitat may help maintain or improve bat populations in the project study area. Examples of roosting habitat include snags, and other trees with roosting potential such as broken limbs, tree hollows, woodpecker holes and loose bark. Such trees or parts of dying trees are often removed due to the hazard they present to park users, however inventive management practices can sometimes abate this risk.

7.2.3. In addition, planting new tree species likely to be used by bats may increase the available habitat. Appropriate species include, Aspen, Elm, Cherry, Maples, Oak and Spruce.

7.2.4. Other management practices that improve insect populations, such as maintaining water quality of ravines and shorelines, are also likely to benefit bats at some level.

8. Bibliography:

Boyles, J. G., Cryan, P.M., McCracken, G.F. and Kunz, T.H. (2011*) Economic importance of bats in agriculture*. Science, 332:41-42.

Committee on the Status of Species at Risk in Ontario (2012) *COSSARO Candidate Species at Risk Evaluation for Little Brown Myotis (Myotis lucifugus) [formerly Little Brown Bat]*

Dobbyn, J. S. (1994) *Atlas of the mammals of Ontario*. Federation of Ontario Naturalists, Don Mills, Ontario.

Szewczak, J. M. (2009) 'Echolocation Call Characteristics of Eastern US Bats', (March).

Thorne, T. J. (2015) *High Park Urban Bat Project*. Toronto.

Thorne, T. J., Parr, N. and Kroes, J. (2016) *Bats of Thickson's Woods 2015 Final Report*. Toronto.

9. Appendix 1, Species Table with Ecological Information on Ontario Bats:

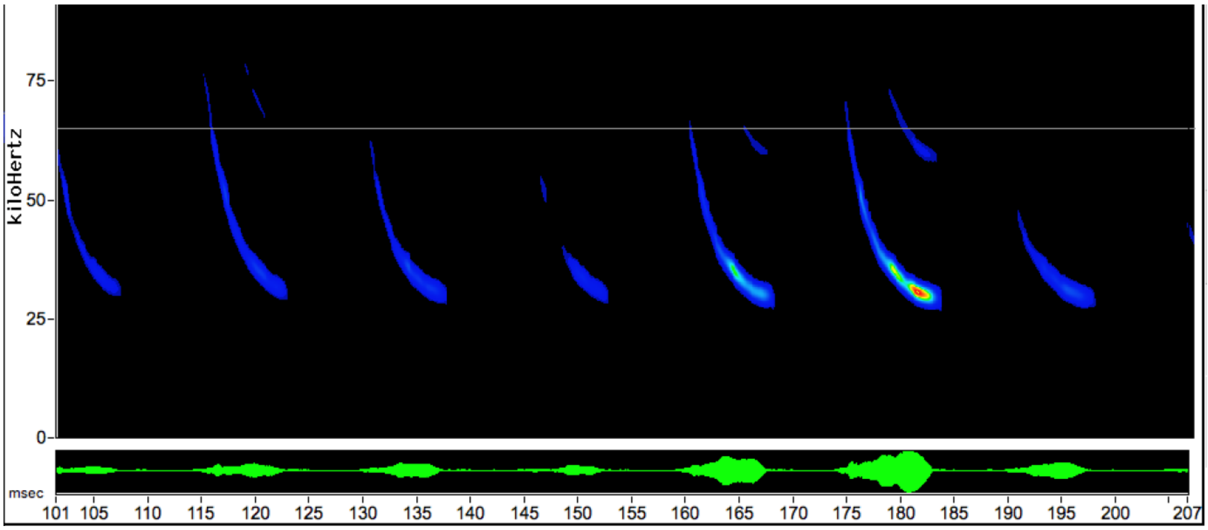
<table>
<tr><th>Species</th><th>Summer Roosts</th><th>Maternity</th><th>Foraging</th><th>Migratory</th></tr>
<tr><td>Big brown</td><td>Hollow trees and (readily) buildings</td><td>Forms large maternity colonies that may be as large as several hundred individuals</td><td rowspan="4">Foraging associated with edge habitat, such as forest edges, hedgerows etc.

Strong, fast fliers that require open, uncluttered habitat</td><td>No</td></tr>
<tr><td>Eastern red</td><td>On the outside of the trunk and hanging among the branches of trees. Particularly Elm and Maple</td><td>Solitary</td><td rowspan="3">Long-distance migrant: travel south to warmer climates to overwinter

Routes and mechanisms poorly understood</td></tr>
<tr><td>Hoary</td><td>On the outside of the trunk and hanging among the branches of trees. Particularly Elm and Maple</td><td>Solitary</td></tr>
<tr><td>Silver-haired</td><td>In small hollows and on the outside of the trunk among bark. Particularly Elm and Maple</td><td>Largely solitary, occasionally forms small maternity groups</td></tr>
<tr><td>Little brown</td><td>Hollow trees and (readily) buildings</td><td>Forms large maternity colonies that may be as large as several hundred individuals</td><td>Forest edges and other sheltered spots</td><td rowspan="2">Migrate short distances (a few hundred kilometres) to suitable overwintering sites</td></tr>
<tr><td>Tricolored</td><td>Rock crevices and foliage</td><td>Forms small maternity colonies (<20 individuals)</td><td>Forest edges and open water</td></tr>
</table>

10. Appendix 2, Acoustic Identification of Ontario Bats:

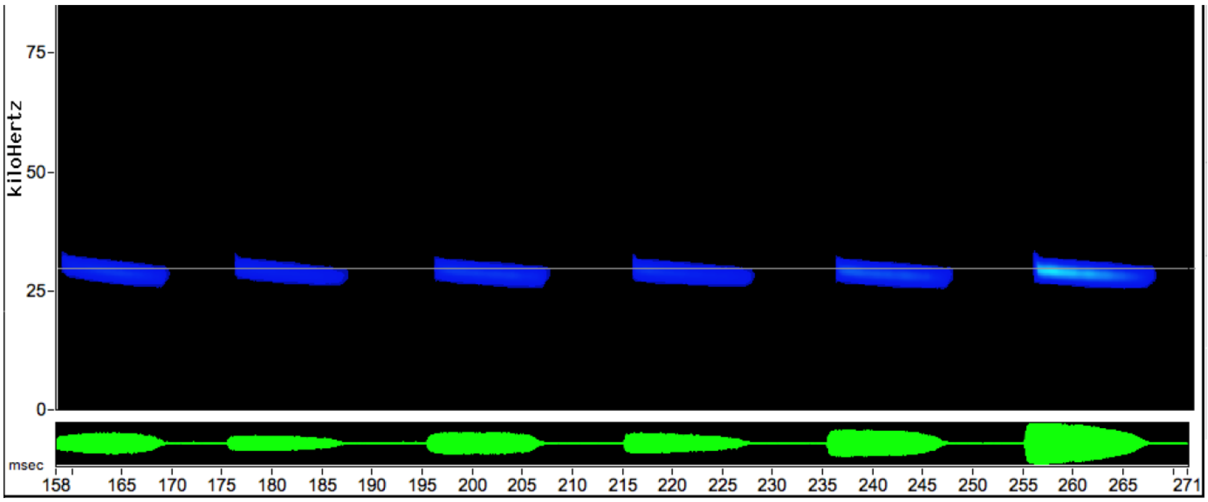
Big Brown Bat:



Spectrogram of representative Big brown bat search phase echolocation call. A smooth frequency sweep beginning > 65 kHz (indicated by horizontal line) ending at ~ 30 kHz.

Note that the frequency sweep of the Big brown bat can often be reduced and that Silver-haired bats can produce similar calls, in addition to their narrowband calls described below. However, the frequency sweeps of Silver-haired bats do not typically begin above 65 kHz, allowing some distinction.

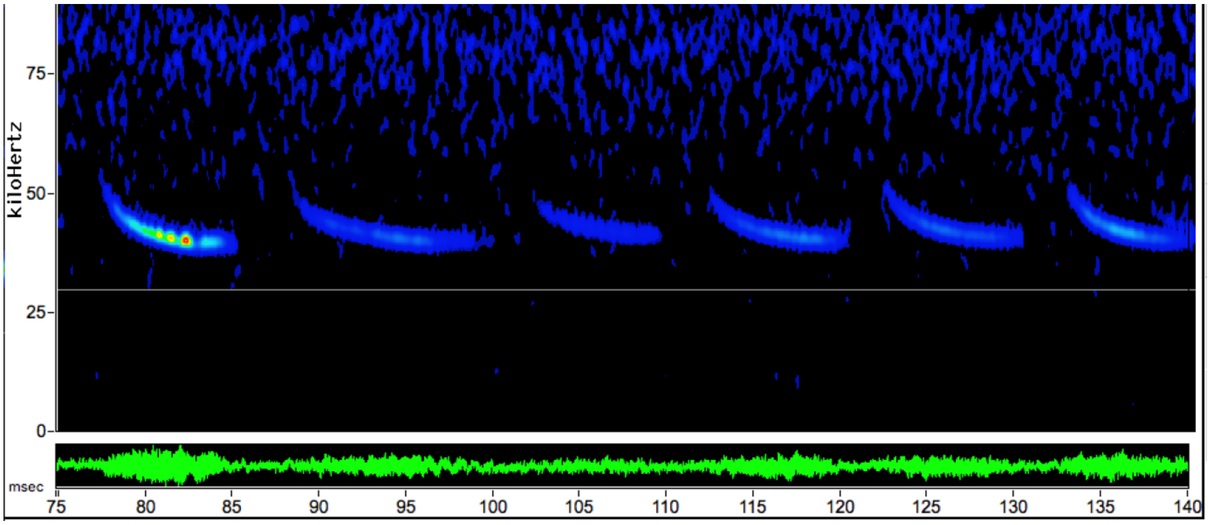
Silver-haired Bat



Spectrogram of representative Silver-haired bat search phase echolocation call. A narrowband call around 30 kHz with no inflection (distinct change in angle partway through the call).

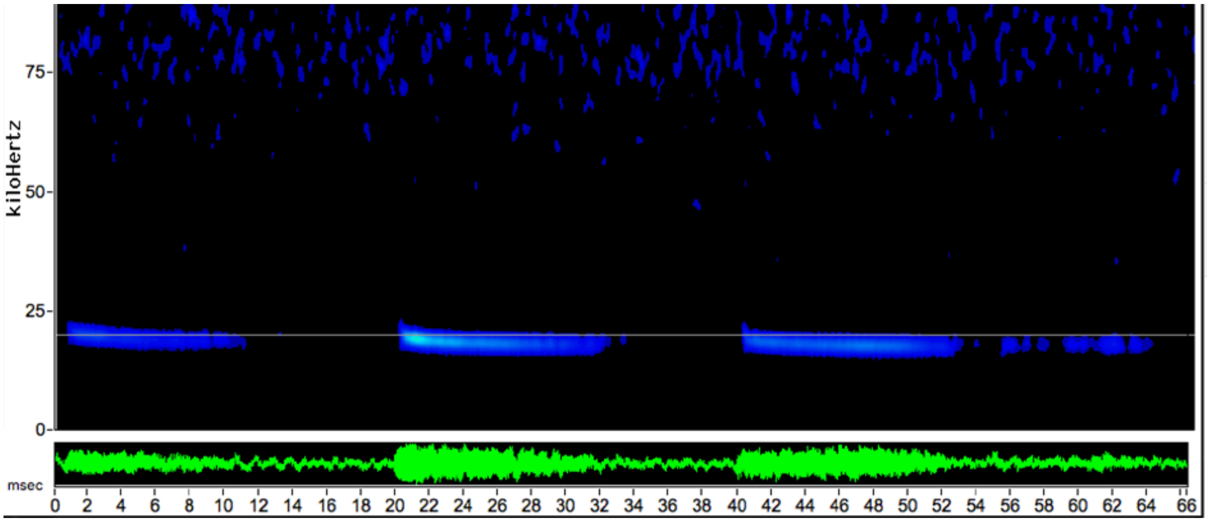
Note that Silver-haired bats also produce calls with a larger frequency sweep. These calls overlap with some calls by Big brown bats, confounding the identification of these two species. Narrowband calls with no inflection, such as this example, provide a more reliable distinction from Big brown bats.

Eastern Red Bat:



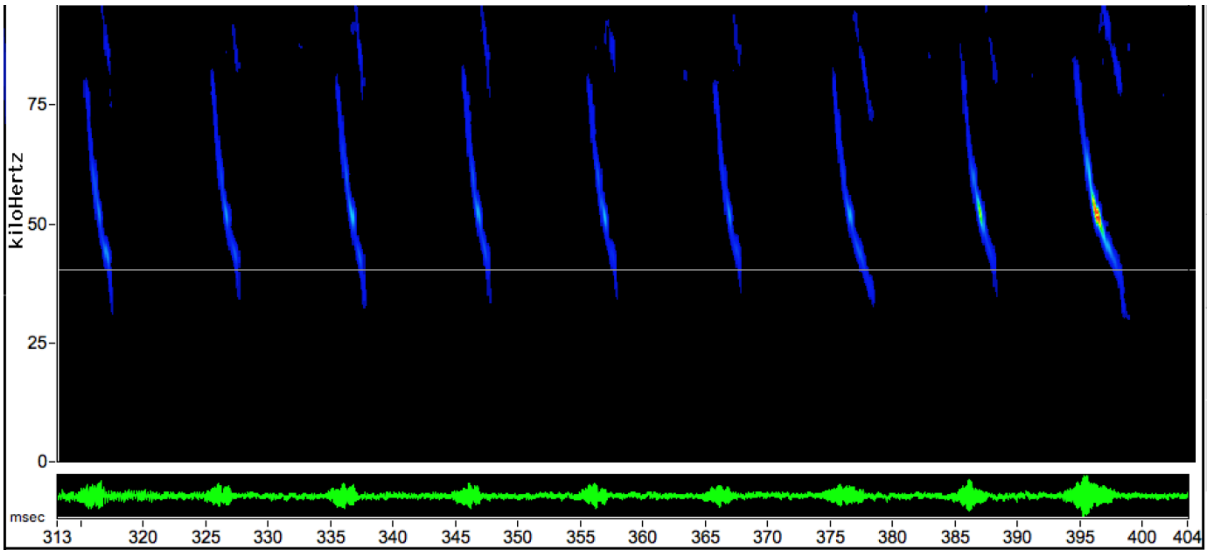
Spectrogram of representative Eastern red bat search phase echolocation calls. A short, smoothly curved (even U shaped) frequency sweep between ~ 60 kHz and ~ 35 kHz.

Hoary Bat:

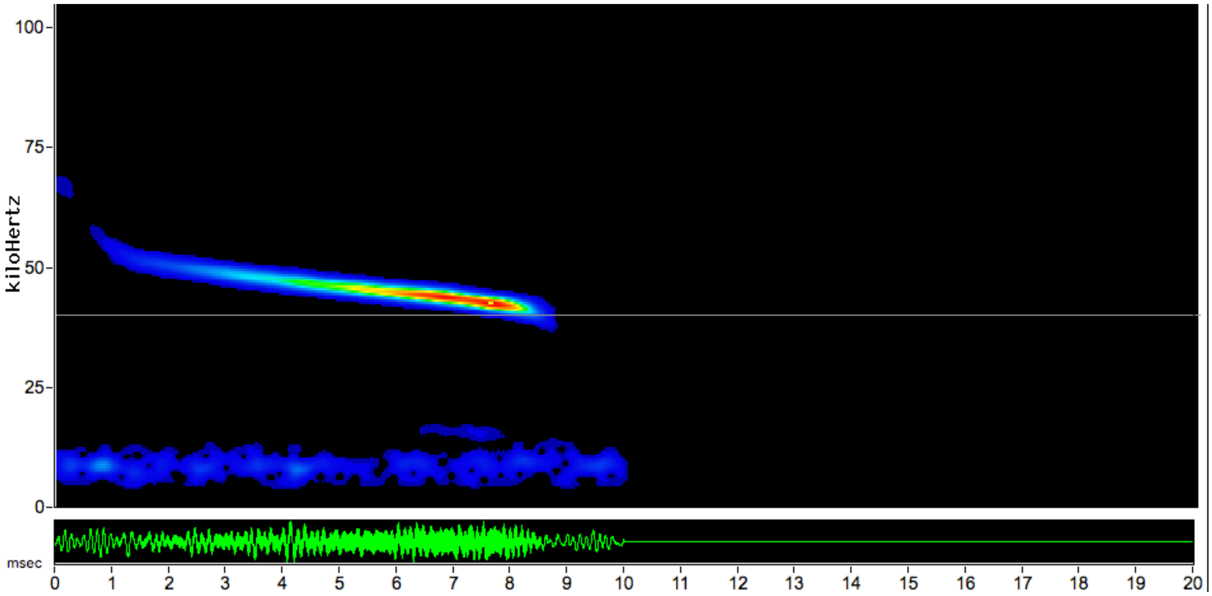


Spectrogram of representative Hoary bat search phase echolocation call. A long (> 10 ms) narrowband call at ~ 20 kHz.

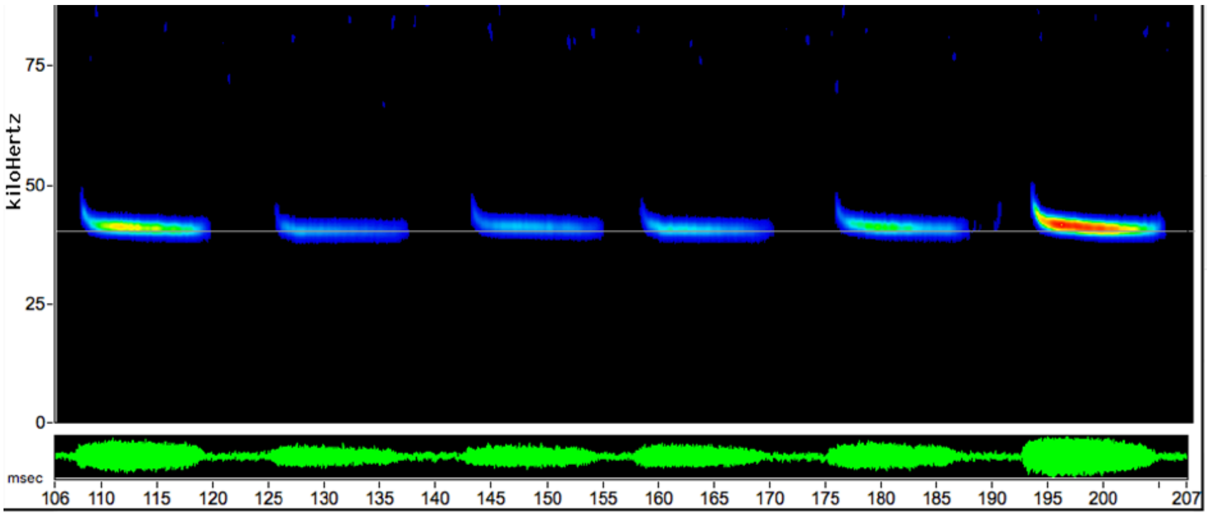
Myotis Species:



Spectrogram of representative Myotis species search phase echolocation call. A short (in this case 2-3 ms, can be above 7 ms) frequency sweep from 80-100 kHz to ~ 40 kHz depending on species. Often a relatively straight sweep, often with strong inflection (a distinct change in slope angle). Most notable feature is the downwards sloping tail at the end of the call. Call duration of > 7 ms is distinctive of Little brown bat, illustrated below.



Tri-Colored Bat:



Spectrogram of representative Tricolored bat search phase echolocation call. A very short frequency sweep leading into a large narrowband component > 40 kHz.

APPENDIX E

Project Area Annual Fish Species Richness by Habitat Type

Sheltered Embayment											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
American Eel							x	x	x	x	x
Brook Silverside											x
Common Shiner				x					x		
Creek Chub							x				
Emerald Shiner	x	x	x	x	x		x	x	x		x
Golden Shiner									x	x	
Northern Pike	x	x	x	x	x	x	x	x	x	x	x
Rainbow Darter							x				
Spottail Shiner			x								
Threespine Stickleback								x			x
Walleye	x										
White Sucker	x	x	x	x	x	x	x	x	x	x	x
Yellow Perch	x	x	x	x	x	x	x	x	x	x	x
Bluegill						x			x	x	
Bluntnose Minnow	x	x	x	x	x		x			x	
Bowfin							x		x		x
Brown Bullhead	x	x	x	x	x	x	x	x	x	x	x
Fathead Minnow							x				
Freshwater Drum	x	x			x						
Gizzard Shad	x				x	x	x		x	x	x
Largemouth Bass		x			x	x	x	x	x	x	x
Pumpkinseed	x	x	x		x	x	x	x	x	x	x
Rock Bass	x	x	x	x	x	x	x	x	x	x	x
Smallmouth Bass					x				x		
Brown Trout	x	x	x	x			x		x	x	x
Chinook Salmon	x						x				x
Alewife	x	x	x	x	x	x	x	x	x	x	x
Rainbow Smelt				x						x	
Round Goby	x	x	x	x	x	x	x	x	x	x	x
Sea Lamprey	x										
Common Carp		x		x			x	x		x	x
Goldfish											x
Species Richness	**16**	**14**	**12**	**13**	**14**	**11**	**20**	**13**	**18**	**17**	**19**

Open Coast with Headland Features											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Atlantic Salmon											x
Longnose Sucker											x
Mottled Sculpin	x						x				
Trout-perch	x										
American Eel								x	x	x	

Open Coast with Headland Features (Continued)											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Emerald Shiner	x	x	x	x	x	x	x	x	x	x	x
Lake Chub							x			x	x
Logperch							x	x		x	
Longnose Dace	x				x		x	x	x	x	x
Northern Pike	x		x	x				x	x		
Threespine Stickleback										x	
White Sucker	x		x	x	x	x	x	x	x	x	x
Yellow Perch	x	x		x	x		x	x	x	x	x
Freshwater Drum	x										
Gizzard Shad	x						x	x	x	x	x
Largemouth Bass								x	x	x	x
Pumpkinseed	x							x		x	x
Rock Bass	x							x	x		
Smallmouth Bass	x	x								x	
Brown Trout	x			x		x	x	x	x	x	
Chinook Salmon			x			x	x	x	x	x	x
Coho Salmon										x	
Rainbow Trout	x				x		x	x			x
Alewife	x	x	x	x	x	x	x	x	x	x	x
Rainbow Smelt	x	x				x	x	x	x	x	
Round Goby	x				x	x	x	x	x	x	x
Sea Lamprey											x
Common Carp	x	x			x	x	x	x	x		x
Species Richness	**18**	**6**	**5**	**6**	**8**	**8**	**15**	**18**	**15**	**18**	**16**
Open Coast with Revetment Features											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Atlantic Salmon									x		
American Eel									x		
Emerald Shiner		x	x		x	x	x	x	x	x	x
Logperch	x									x	x
Longnose Dace	x		x		x						x
Spottail Shiner	x										
Threespine Stickleback		x									
White Sucker	x	x	x		x	x	x	x	x	x	x
Yellow Perch	x	x	x							x	
Freshwater Drum					x						
Gizzard Shad								x		x	
Largemouth Bass											x
Rock Bass			x						x	x	
Smallmouth Bass	x										x

Open Coast with Revetment Features (Continued)											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Brown Trout	x								x	x	x
Chinook Salmon			x		x	x	x			x	x
Rainbow Trout	x						x	x	x	x	x
Alewife	x	x	x		x	x	x	x	x	x	x
Rainbow Smelt										x	
Round Goby	x	x	x				x	x	x	x	x
Common Carp		x	x					x	x		x
Species Richness	**10**	**7**	**9**	**0**	**6**	**4**	**6**	**7**	**10**	**12**	**12**
Non-engineered Open Coast											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Blacknose Dace											x
Emerald Shiner	x	x			x						
Logperch											x
Spotfin Shiner											x
Spottail Shiner					x						
Threespine Stickleback										x	
White Sucker									x	x	x
Yellow Perch	x				x						
Brown Bullhead					x						
Gizzard Shad										x	
Smallmouth Bass											x
Brown Trout									x		
Rainbow Trout										x	
Alewife	x	x							x		x
Rainbow Smelt									x		
Round Goby									x		x
Species Richness	**3**	**2**	**0**	**0**	**4**	**0**	**0**	**0**	**5**	**4**	**7**
Project Area											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Atlantic Salmon									x		x
Longnose Sucker											x
Mottled Sculpin	x						x				
Trout-perch	x										
American Eel							x	x	x	x	x
Blacknose Dace											x
Brook Silverside											x
Common Shiner				x					x		
Creek Chub							x				
Emerald Shiner	x	x	x	x	x	x	x	x	x	x	x
Golden Shiner									x	x	

Project Area (Continued)											
Common Name	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Lake Chub							x			x	x
Logperch	x						x	x		x	x
Longnose Dace	x		x		x		x	x	x	x	x
Northern Pike	x	x	x	x	x	x	x	x	x	x	x
Rainbow Darter							x				
Spotfin Shiner											x
Spottail Shiner	x		x		x						
Threespine Stickleback		x						x		x	x
Walleye	x										
White Sucker	x	x	x	x	x	x	x	x	x	x	x
Yellow Perch	x	x	x	x	x	x	x	x	x	x	x
Bluegill						x			x	x	
Bluntnose Minnow	x	x	x	x	x		x			x	
Bowfin							x		x		x
Brown Bullhead	x	x	x	x	x	x	x	x	x	x	x
Fathead Minnow							x				
Freshwater Drum	x	x			x						
Gizzard Shad	x				x	x	x	x	x	x	x
Largemouth Bass		x			x	x	x	x	x	x	x
Pumpkinseed	x	x	x		x	x	x	x	x	x	x
Rock Bass	x	x	x	x	x	x	x	x	x	x	x
Smallmouth Bass	x	x			x				x	x	x
Brown Trout	x	x	x	x		x	x	x	x	x	x
Chinook Salmon	x		x		x	x	x	x	x	x	x
Coho Salmon										x	
Rainbow Trout	x				x		x	x	x	x	x
Alewife	x	x	x	x	x	x	x	x	x	x	x
Rainbow Smelt	x	x		x		x	x	x	x	x	
Round Goby	x	x	x	x	x	x	x	x	x	x	x
Sea Lamprey	x										x
Common Carp	x	x	x	x	x	x	x	x	x	x	x
Goldfish											x
Species Richness	**25**	**17**	**15**	**13**	**19**	**16**	**26**	**20**	**24**	**26**	**29**

APPENDIX F

Lake Trout Memorandum, prepared by John Fitzsimmons

Lake Trout Spawning - Lake Ontario

Introduction

Lake Ontario lake trout *Salvelinus namaycush* and their associated genetic composition were extirpated around the middle part of the last century primarily by overfishing and secondarily by predation from sea lamprey *Petromyzon marinus* that was potentiated by the low abundance and small size of lake trout resulting from overfishing (Christie 1972; Elrod et al. 1995). Although stocking to restore lake trout stocks began as early as the 1950s it was not until the early 1970s after control of lamprey predation and establishment of hatchery infrastructure capable of producing large numbers of fingerlings and yearlings for annual stocking, that restoration preceded in earnest. Restoration of Lake Ontario lake trout became embodied in the Lake Ontario Rehabilitation Plan (Schneider et al 1983). The plan had four strategies that involved annual stockings of 1.25 million yearlings, optimization of cultural techniques and stocking practices, achieve an annual survival rate of 60-65% by supressing sea lampreys and restricting fishing, and maximizing natural reproduction by identifying and mitigating factors limiting spawning and survival of early life stages

Lake trout stocking

Stocking of lake trout in the 1970s and 1980s involved multiple lake trout strains from both within as well as outside of the Great Lakes basin, and in addition some remnant Great Lakes strains established outside of the basin in the state of Wyoming. The diversity of strains used was intended to benefit from the effects of hybrid vigor and the interbreeding of the multiple strains. Although all strains showed evidence of spawning in the lake, some strains like the Seneca Lake strain showed greater spawning for the number stocked whereas for the Superior strain the amount of spawning was less than expected based on numbers stocked (Perkins et al. 1995). Differences in spawning among strains did not appear to involve differential spawning habitat selection as the spawning habitats used, that involved a combination of natural and man-made structures, were not clearly differentiated by strain (Fitzsimons 1995; Perkins and Krueger 1995; unpublished data). Variation by strain in spawning habitat selection would not be expected either, based on the diversity of spawning habitats used in Seneca Lake (Sly and Widmer 1984) and Lake Superior (Bronte et al. 1995; Shreiner et al. 1995; Kelso et al. 1995). In addition it was unlikely that the differences in reproduction among strains observed in Lake Ontario could be related to age related changes in fecundity as both strains showed similar fecundity-age relationships (O'Gorman et al. 1998). Although the earlier data suggested that reproduction by some strains like the Seneca strain was more successful than other strains, estimates of fecundity that directly relate to spawning potential were greater for the Seneca strain than the Superior strain and this was a direct result of greater numbers of Seneca fish surviving to maturity (O'Gorman et al. 1998). Although this had led to speculation that Seneca fish were better able to tolerate sea lamprey mortality than Superior fish, modeling of the effects of sea lamprey on lake trout mortality suggested that both Seneca and Superior strains were equally vulnerable so the reason for their differential survival remains unclear (Madenjian et al. 2003).

In 2014 USFWS stocked 970,000 yearling and fall fingerling lake trout into the US waters of Lake Ontario, most of which were of the Seneca strain. The closest stocking location to the Niagara River is Olcott located approximately 30 km east of the Niagara River. It appears though that stocked lake trout follow the shoreline and that fish stocked at Olcott only spawned as far away as Fifty Point (Perkins et al. 1995), a shoreline distance of approximately 90 km which is somewhat greater than the estimated home range of lake trout of 60 km (Ihssen et al. 1988). Therefore it is unlikely that lake trout stocked by USFWS in western Lake Ontario would spawn along the Toronto waterfront. However, it appears that lake trout stocked by MNR at Fifty Point could spawn along the Toronto waterfront, a shoreline distance of approximately 80 km from Fifty Point. In 2014, MNR stocked 76, 000 yearling lake trout of a Superior strain at Fifty Point, a site used for stocking for over ten years. When assessed in 1995, lake trout spawning use was documented on man-made material at Colonel Sam Smith and Thommy Thompson Parks and Humber Bay Park West (unpublished data) with egg deposition similar to that for Fifty Point (Fitzsimons 1995)

Changes in habitat with life stage

Spawning habitat for lake trout generally consists of cobble substrate along a shoreline, island, or submerged reef that is relatively shallow and well oxygenated by waves and currents but generally not to an excessive degree that the substrate and the eggs contained therein are displaced. In Lake Ontario spawning occurs as early as September and as late as November with spawning occurring earlier in the western basin than the eastern basin due to a combination of prevailing winds and upwelling (Fitzsimons 1995). These factors cause the lake to cool down faster reaching the spawning temperature of 7-9°C earlier in the west compared to the east. Eggs incubate in the substrate until late winter when they hatch but remain associated with the spawning habitat until April-May when emergence occurs. Prior to emergence, developing embryos are almost totally dependent on the yolk sac for nutrition (Heming and Buddington 1988) although reports from Lake Champlain (Ladago et al. 2016) indicate some limited feeding on zooplankton occurs within weeks of hatching. Once emergence is complete, alevins feed on a variety of prey including zooplankton, chironomid pupae and larvae, and *Mysis,* with increased amounts of larval fish as they increase in size based on work in Lake Superior. (Swedberg and Peck 1984). Once a temperature of 15°C is reached on the natal spawning area, yearlings move offshore (Peck 1982) presumably to deeper water to avoid cannibalism by adult lake trout (Evans et al. 1991; Elrod et al. 1993). Mean survival indices of lake trout stocked nearshore in Lake Ontario as yearlings declined by more than 50% from 1981 to 1991 with the buildup of adult lake trout in the lake, and survival was negatively correlated with abundance of large lake trout (Elrod et al. 1993). Elrod (1997) reported that when groups of yearling lake trout were stocked either nearshore or offshore in 46-52 m, survival of yearling lake trout was better when stocked offshore which they attributed in part to reduced cannibalism by adult lake trout. After colonization of Lake Ontario by dreissenids and an increase in water clarity, a greater depth of midsummer occupancy by age-2 lake trout a year after stocking from 36 to 49 m, suggested cannibalism as well as predation by salmonines other than lake trout was occurring at 36 m (O'Gorman et al. 2000). In Lake Huron, Bergstedt et al. (2003) reported that during the summer, adult lake trout were in depths of 20-30 m, based on a combination archival temperature tags and the relationship between depth and temperature from a bathythermograph. Given the predation gauntlet that yearling lake trout need to traverse from nearshore spawning areas to deepwater foraging areas, those spawning areas with the shortest physical distance to deepwater habitat may provide the best survival.

Diet

For the period of 1979-1987 Elrod and O'Gorman (1991) reported that juvenile lake trout (<450 mm) fed primarily on slimy sculpins *Cottus cognatus*, followed by alewives *Alosa* *pseudoharengus*, rainbow smelt *Osmerus mordax* and johnny darters *Etheostoma nigrum* suggesting a mixture of primarily bottom as well as pelagic feeding. Feeding on these prey fish was opportunistic with seasonal and annual changes in diet reflecting seasonal and annual changes in abundance of prey fish near bottom where collected. It is expected based on the opportunistic feeding of lake trout that changes in prey fish species abundance in Lake Ontario since 1987 would be reflected in juvenile lake trout diets. Specifically abundance of rainbow smelt has declined by over 10-fold between 1987 and 2014, while abundance of alewives has declined two-fold over this same period but remains the dominant pelagic prey fish (Walsh et al. 2014). Similarly populations of slimy sculpin, once the dominant benthic species in the lake, have also declined to the point where they are now at their lowest abundance in 27 years of monitoring, declining by over 10-fold (Weidel and Walsh 2014). Ironically their current abundance is similar to that of the deepwater sculpin *Myoxocephalus thompsonii*, a species thought to be extirpated from Lake Ontario, but now making a resurgence but with uncertainty as to the source population (Lantry et al. 2007). In contrast to rainbow smelt, alewife, and slimy sculpin, the abundance of round goby *Neogobius melanostommus*, an invasive species from Europe that was first observed in Lake Ontario in 1998 (Owens et al. 2003), has increased dramatically and is now the dominant benthic species in the lake. Round gobies show marked year to year variation in abundance although it is not clear if these trends are real or an artifact of the sampling methodology that has been affected by large accumulations of dreissenids on bottom. A recent study to understand the trophic position of lake trout in Lake Ontario using the stable isotopes of nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) and mixing models to assess diet, reported that alewife (28-56%) and round goby (36-52%) were the dominant prey items for both juvenile and adult lake trout, while smelt (3-9%) and slimy sculpin (2-10%) were much less important reflecting their reduced abundance in Lake Ontario (Rush et al. 2012). These authors reported a greater reliance on nearshore carbon production in 2008 compared to 1992 when lake trout were more dependent on offshore carbon production. Nearshore carbon production likely reflects consumption of round gobies although because they undergo seasonal migrations spending summer months nearshore and winter months offshore (Pennuto et al. 2012), foraging would involve substantial variation in nearshore and offshore habitat exploitation. Such variation is consistent with reports of within-population heterogeneity in habitat use by lake trout (Morbey et al. 2006).

Spawning habitat

Although there are variations on the theme (Fitzsimons et al. 2005; Janssen et al. 2006), spawning habitat for Lake Ontario lake trout like lake trout in other lakes consists of cobble substrate (10-20 cm) in relatively shallow water, having deep interstices, wherein spawning occurs on a bench immediately adjacent to a steep slope into deeper water (Fitzsimons 1994a, 1995; Perkins and Krueger 1995; Marsden et al. 1995; unpublished information). Survival of spawned eggs can be affected by a variety of biological, chemical and physical factors. Egg predation by egg predators including crayfish, sculpins, and round goby can reduce egg survival, the degree of which is dependent on the species involved and its abundance. Fitzsimons et al. (2002) reported that at low lake trout egg density (<100 eggs/m^2), the abundance of sculpins and crayfish was sufficient at some spawning reefs in Lake Ontario to cause almost 100% egg mortality. However, even at a relatively high lake trout egg density (>5000 eggs/m^2), round goby abundance was such at one spawning reef in western Lake Ontario as to almost eliminate survival past the emergence stage (Fitzsimons et al. 2009). Currently round goby are the major egg predator of lake trout in western Lake Ontario because of declines in slimy sculpin, and the near absence of crayfish, presumably as a result of the coldwater upwelling that occurs in western Lake Ontario (Fitzsimons 1995) The expansion of round goby in Lake Ontario (Walsh et al. 2007) may pose a significant bottleneck to lake trout restoration unless measures such as the provision of a biological control agent such as smallmouth bass *Micropterus dolomieu* can be taken. Smallmouth bass, a major predator on round goby (Steinhart et al. 2004), inhabits cobble areas during summer months that can support high numbers of round goby during the summer and lake trout spawning in the fall. Degradation of water quality within interstices by decreased dissolved oxygen, or increases in ammonia or hydrogen sulphide can also result in egg mortality (Garside 1959; Carlson and Siefert 1974; Smith and Oseid 1974; Sly 1988). Growth of the benthic algae *Cladophora* were dominant in the 1970s but reduced considerably by the 1980s (Painter and Kamaitis 1987) by a reduction in phosphorous and a shift to oligtrophy (Mills et al. 2003). Increased water clarity and the nearshore phosphorous shunt (Hecky et al. 2004) associated with the invasion of Lake Ontario by dreissenids, has resulted in recent increases in the abundance of *Cladophora* and across a greater range in depths (Kuczynski et al. 2016). Based on past experience (Sly 1988) with accumulation of *Cladophora* on some lake trout spawning reefs, this accumulation has the potential to result in reduced dissolved oxygen, and increased ammonia and hydrogen sulphide especially on spawning reefs with insufficient wind exposure. As well as biological and chemical factors, physical factors can also affect lake trout eggs, and in Lake Ontario lake trout eggs are particularly sensitive to the physical shock caused by disturbance in the laboratory (Fitzsimons 1994b). This appears to have implications to survival in the wild as Fitzsimons (1995) found a linear relationship between egg survival of naturally spawned eggs collected at seven spawning reefs and wind fetch in Lake Ontario. It's likely however, that the study of Fitzsimons (1995) underestimated total egg mortality resulting from the effects of currents as Fitzsimons et al. (2007) found an exponential relationship between the losses of eggs and wind fetch for known number of eggs added to 12 spawning reefs in Lake Michigan, Parry Sound (Georgian Bay), and Lake Champlain. It seems probable though, given the exposure to currents that have the potential to maintain interstices free of fines and decaying organic material but high in dissolved oxygen, that some lake trout egg mortality is to be expected and may well be part of a bet hedging strategy used by lake trout (Fitzsimons and Marsden 2014). In such a strategy, lake trout at a given spawning reef may spawn across a range of water depths such that eggs at shallower depths are subjected to more physical disturbance whereas those at greater depths receive less physical disturbance. Although higher levels of disturbance at shallower depths may cause increased egg loss, these losses may be offset by high levels of dissolved oxygen and reduced fine material and as a result high egg survival for those eggs that remain. Conversely while reduced physical disturbance may occur at greater depths resulting in reduced egg loss this may be offset by lower dissolved oxygen and accumulation of fines with reduced egg survival. It is expected, given annual variation in winds and storms and resulting currents, that the zone on a reef with optimal egg survival may vary and be deeper some years but shallower in some years. Accordingly spawning reefs having a range of depths may provide optimal conditions for the annual production of recruits.

Recommendation

Building new lake trout spawning habitat in the vicinity of the Bluffers Park has the potential to markedly increase the amount of spawning habitat in the area, and in part make up for the loss of spawning habitat associated with the stone hooking operations of the 1800s. Man-made structures are known to enhance reproduction by lake trout in the Great Lakes basin (Fitzsimons 1996) although much remains uncertain as to what attracts lake trout to them and determines the amount of use they receive (Marsden et al. 2016). In Lake Ontario, man-made structures are used by lake trout at Port Weller and Burlington Pier in the western basin (Fitzsimons 1995), several areas along the shoreline in the Kingston area (unpublished data), and an artificial reef west of Port Hope (Fitzsimons 2014). Common to the two spawning areas in the western basin, the two most important man-made sites in Lake Ontario are boulder based structures constructed offshore on sand substrate and associated with the shoreline of piers projecting out into the lake in relatively deep water (9m). The structures have a veneer of variable thickness of cobble material (9.8-13.8 cm) that slopes downward at approximately 30° from a bench at a water depth of 5 to 6 m where dense aggregations of lake trout and most spawning occurs. The two structures differ in terms of several attributes. The spawning area of the Burlington Pier is estimated at 6 m^2 whereas that of the Port Weller site is estimated at 150 m^2. Egg survival of naturally spawned lake trout eggs prior to invasion of round gobies was higher at Port Weller owing to its shorter wind fetch, although since the site was invaded by round gobies, survival past the emergence stage is almost non-existent (Fitzsimons et al. 2009). The current abundance of round gobies at the Burlington Pier site is not known. The knowledge gained about spawning activity and factors affecting egg survival at the two sites can be used to optimize the construction of spawning habitat at Bluffers Park where there are three headlands projecting out into Lake Ontario with the end of the headlands in relatively deep water. Any of the three headlands but primarily the west headland would seem to offer the best opportunity as a base for constructing spawning habitat for lake trout where alevins have a shorter route to take to reach deep water and reducing the effect of the predator gauntlet. Like the Burlington Pier and Port Weller sites, the Bluffers Park spawning habitat should have a core of large boulders to prevent movement and be covered with a veneer of cobble. The sediments in the area of Bluffers Park are primarily sand and subject to local coastal conditions that may lead to erosion (Mathews 1985), such that there should be appropriate review and input by a project coastal engineer. In the event that the sand material is deemed unsuitable to support the proposed structure (Barber et al. 2009), other location(s) with a depth profile equivalent to Bluffer's Park can be considered. Although the spawning bench at Burlington Pier and Port Weller occupied a single depth it is proposed that the bench at Bluffers Park have multiple depths. To accomplish this, the structure would be inclined into deeper water using the existing bathymetry, requiring that the structure be built perpendicular to shore and much like the shape of an underwater drumlin, a raised linear structure that slopes to either side. Such a structure is similar to an artificial reef built for lake trout spawning in Snap Lake, NT that was assembled on the ice in winter and allowed to sink to the bottom at ice out (Fig. 1). The dimensions of the reef were 5 by 20 m with a height of approximately 2 m, and an inclination on the two sides of 30°. Spawning was expected and confirmed by divers to occur primarily along a flat area or bench along the top of the reef although currents displaced eggs off the bench and down either side. Drumlins are used by lake trout for spawning in Lake Huron and may constitute one of the biggest supplies of cobble substrate with deep interstitial spaces (Riley et al. 2014). By inclining the structure into deeper water a range of water depths and associated water currents would be available across the top or bench of the structure for spawning such that during any given year, conditions would be optimal along some portion of the structure for optimal egg retention and survival. Inclination of the structure would be achieved by making use of the onsite bathymetry. This is similar to what was done in Snap Lake where the crest of the structure on ice was near level (Fig 2a) but once it sunk to the bottom, it took up the form of the local bathymetry and was inclined offshore (Fig 2b). The structure by projecting into the lake and perpendicular to longshore currents would interact with these currents, generating interstitial flow via the Bernoulli effect (e.g. Thibodeaux and Boyle 1987). The abrupt topography created by the structure would accelerate flow on the windward edge of the structure leading to lowered pressure on the structure's lee side causing water to flow through the structure. Such activity would be effective in removing fines and decaying organic material caused by sloughing of *Cladophora* beds although the ability to remove such material would be a function of current speed which is a function of water depth (Fitzsimons and Marsden 2012). Oscillation in current direction that is known to occur regularly on the north shore of Lake Ontario would prevent accumulation of material on either side of the structure. As with any cobble substrate it is expected that the proposed structure for Bluffers Park will likely become colonized by dreissenids and round goby, a known lake trout egg predator (Fitzsimons et al. 2006), and with known negative effects on lake trout reproduction in Lake Ontario (Fitzsimons et al. 2009). However, the embayments at Bluffers Park and the warm water contained within these embayments provide an opportunity for maintaining a resident smallmouth bass population that could be used for biological control of round goby in the lake around the proposed structure where temperature would be much more variable than in the embayments. Smallmouth bass prefer cobble habitat with vertical relief and are a known predator of round goby (Steinhart et al. 2004; unpublished information). The "dreissenid–round goby–smallmouth bass" food chain forms one of the key components within the trophodynamics of Lake Erie. (Campbell et al. 2009)

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Figures

Fig. 1: Long view of artificial reef constructed on the ice at Snap Lake, NT.

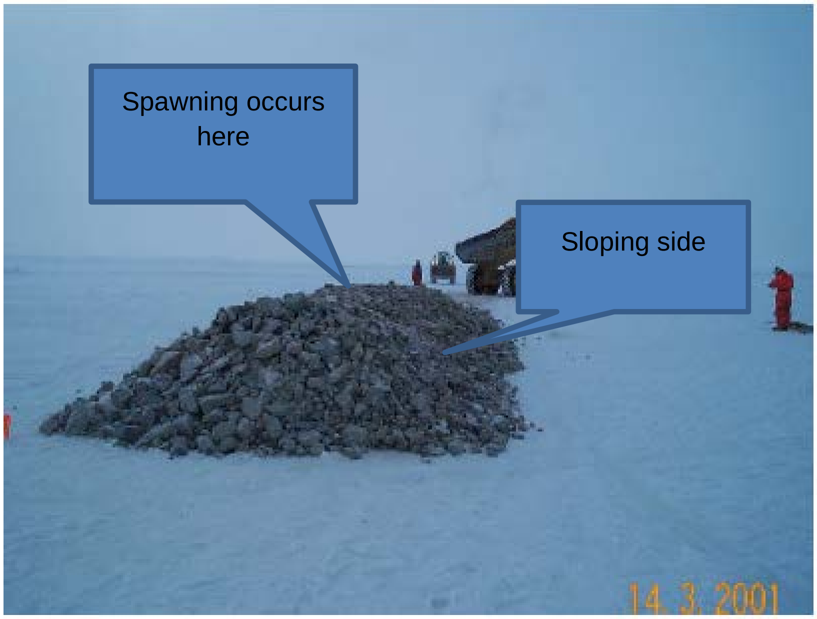

Fig. 2

a) Cross-section of artificial reef constructed on the ice at Snap Lake, NT

b) Artificial reef on bottom with sampling gear installed. Arrow shows incline in reef profile going offshore.