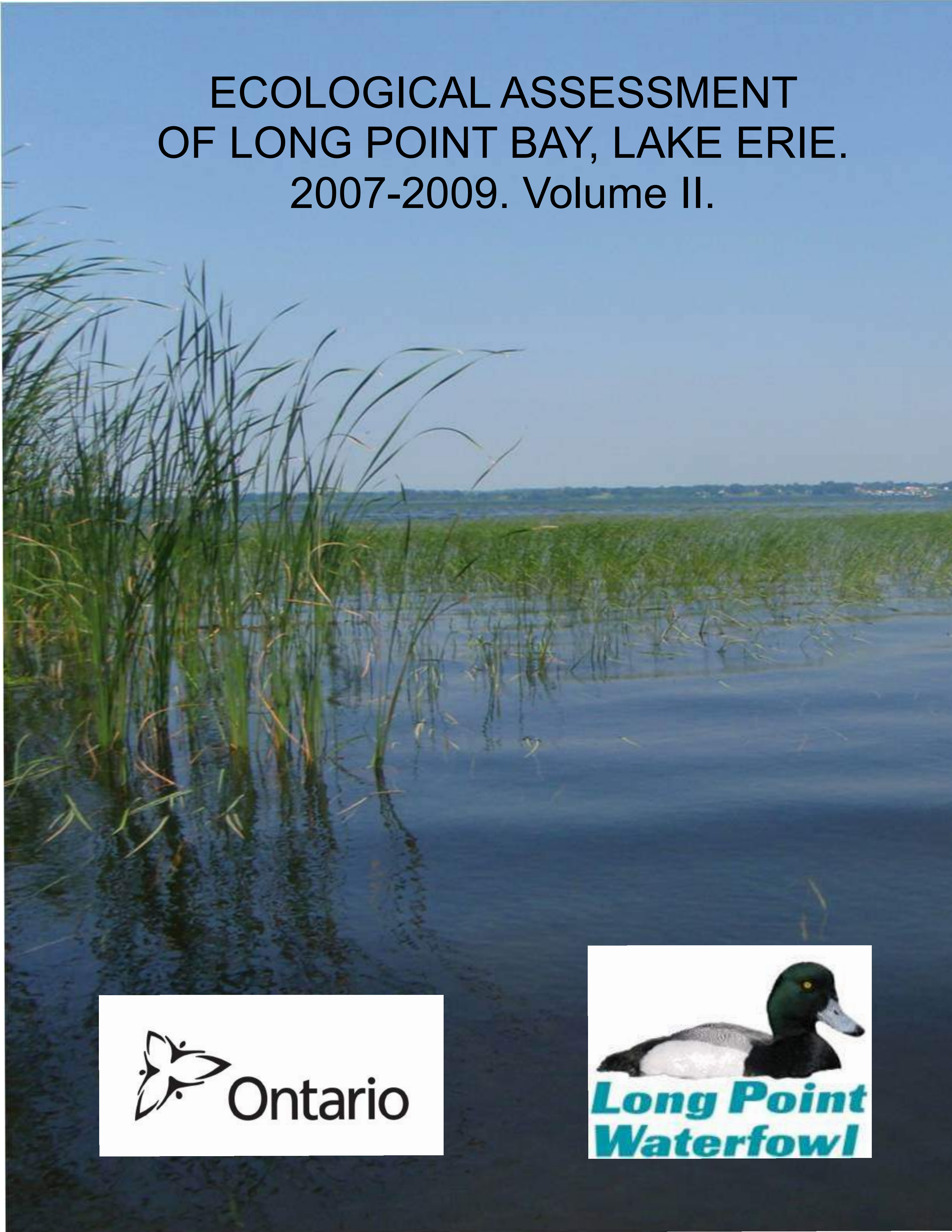
ECOLOGICAL ASSESSMENT OF LONG POINT BAY, LAKE ERIE. 2007-2009. Volume II.



Ontario

Long Point Waterfowl

Long Point Waterfowl (LPW) and
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INTRODUCTION

The Inner and Outer Bays of Long Point, Lake Erie and associated wetlands are regionally and internationally important habitats for a diversity of fish and wildlife (Nelson et al. 1993, Petrie 1998). Long Point also provides substantial ecosystem services including improvement of water quality through wetland nutrient abatement, recreational opportunity (i.e., wildlife watching, boating, fishing, and hunting), and food resources for harvest (e.g., fishing [commercial and sport], and hunting). For these and other reasons, Long Point and its associated bays and wetlands are designated as a World Biosphere Reserve, Ramsar Wetland of International Importance, and Important Bird Area (Lynch-Stewart 2008, Ramsar 2009). Land uses adjacent to Long Point are primarily agriculture and recreational cottages with ≤ 65,000 people living in Norfolk County (Petrie 1998, Norfolk County 2003, Edge and McAllister 2009). Threats to Long Point Bay include nutrient loading from adjacent lands, habitat loss through residential development, invasive species introductions and proliferation, atmospheric contaminant loading, and lack of public understanding of the importance of wetlands and wetland resources (Petrie 1998, Schummer et al. 2011, Schummer 2012). Challenges for the Long Point region includes balancing economic benefits of rural and tourism culture (e.g., farming, commercial fishing, sport hunting and fishing, wildlife watching, boating, cottagers and beach goers) with the long-term existence of the natural resources providing these ecosystem benefits.

Long Point is a cross-road for migratory birds using the Mississippi and Atlantic Flyways with birds traveling from eastern Canada to the Gulf Coast and from as far north and west as Alaska to wintering areas along the South Atlantic coast (Bellrose 1980). Also, Long Point wetlands provide a unique niche for a diversity of reptiles and amphibians (Crewe and Timmermans 2005). Because of wetland habitat loss and declines in abundance of some populations, several reptiles and amphibians of the Lower Great Lakes (LGL) watershed are now listed as federally, provincially, and/or state Endangered or Threatened. As a result of habitat loss Blanding’s, spotted, bog, and snapping turtles, as well as Fowler’s toads are listed in several jurisdictions as Endangered or Threatened species. In addition, coastal wetlands in Lake Erie are utilized by over 80 species of fish, with more than 50 species dependent upon them (Jude and Pappas 1992). Because loss of coastal wetland habitat is > 95% in many areas in the LGL whereas Long Point wetlands remain relatively pristine, Long Point serves as refugia for these fish and wildlife as habitat restoration activities occur throughout the region. Threats at Long Point that continue to decrease the capacity of the region to meet the life-cycle needs of these fish and wildlife include nutrient loading that can change the benthic invertebrate and plant communities, invasive plant species including narrow-leaved cattail and common reed that decrease wetland interspersion and hydrological connectivity between wetland and open bay habitats, and development and ‘hardening’ of nearshore environments.

Herein, an annotated bibliography and gap analysis of studies done in Long Point and five independent assessments of the natural resources of Long Point Bay provide the basis for a synthesis Discussion and Research and Management Recommendations. This document and accompanying Volume I serve as guidance in the decision-making process for a diversity of policy-makers and natural resource managers in the Long Point region.

NATURAL SCIENCES RESEARCH GAP ANALYSIS AND ANNOTATED BIBLIOGRAPHY FOR LONG POINT BAY AND THE GREATER LONG POINT AREA

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Introduction

Beginning in 2007, the Ontario Ministry of Natural Resources (OMNR) – Lake Erie Management Unit initiated a three-year multi-component study of the ecosystem-based state of Long Point Bay. This study incorporates assessments of fish communities, nutrient loading, sediment quality, marsh birds, waterfowl, invasive species and amphibians, among other aspects of Long Point Bay biotic and abiotic features.

In order to focus research priorities for this study, an examination of existing literature derived from Long Point-area research activities was performed to identify areas of research that are well-represented, under-represented, or completely lacking in scientific study in recent decades. As part of this examination, a "research information matrix" was developed (herein referred to as "the matrix"). The matrix uses unique identifiers to represent individual research reports, categorized according to research discipline and publication date range. Development of this matrix clearly indicated which information attributes of Long Point and area were both abundant and lacking in scientific research across seven research publication date ranges and one category for non-dated reports. Following this process, a research gap analysis was performed, in which those information attributes that appear to require further research were identified and reported.

This report includes an updated and complete research information matrix, research gap analysis results, and an annotated bibliography of documents reviewed through this analysis. The annotated bibliography, organized alphabetically by lead author (individual or organization), contains information pertaining to source location and availability, and detailed annotations of references that could be obtained for review (Appendix 2).

This gap analysis report is intended to provide a comprehensive assessment of existing research and research needs for Long Point Bay and the greater Long Point region.

Methods

Research

Information was compiled using library resources available at McMaster University in Hamilton, Ontario; the Ministry of Natural Resources Resource Library in Peterborough, Ontario; the Environment Canada Resource Library in Gatineau, Quebec; Bird Studies Canada's National Headquarters Library in Port Rowan, Ontario, and through extensive internet literature searches.

Resources were sought through a series of keyword and author searches, bibliographic cross-referencing, personal communications and searching through relevant collections where no database existed. Initial keyword searches of Long Point, Lake Erie, Big Creek and Nanticoke, were used as a basis for searching, with derivatives of these broad areas and relevant topics obtained from this location-based keyword search. A key resource for bibliographic cross-referencing was "*A Bibliography for Long Point, Lake Erie, Ontario*", a document developed by the Canadian Wildlife Service and released in 1989, as well as reference lists from other prominent Long Point documentation.

Due to the extensive list of Long Point literature, research efforts were prioritised by subdividing references into primary, secondary and peripheral categories based on the relevance of those references' topics of study to OMNR's information needs. For example, studies of Long Point Bay water quality were ranked as primary resources, while Long Point land bird studies were ranked as secondary resources, and studies of forest cover in the greater Long Point region were ranked as tertiary resources. Most of our effort for this project focused on obtaining detailed annotations for those documents identified as primary and secondary resources. Not all study documents could be obtained for annotation; however where possible, source information is provided. In cases where study documents are available from multiple sources, all known sources are listed.

Broadly, identified Long Point literature includes published and non-published reports from public and private sectors, academic theses, peer-reviewed publications, newsletters, progress reports, and conference proceedings relating to various biota, as well as some aspects of Long Point ecology and geography.

A significant number of documents within this completed bibliography were authored by or written for the Canadian Wildlife Service (CWS). In many cases, references for these documents were obtained from the 1989 CWS-authored bibliography and were identified as being available from the London CWS office. However, the London CWS literature collection has been significantly reduced since the publication of the 1989 bibliography, and although we made several attempts to obtain these CWS-specific documents, very few of these desired documents were obtained for review. Efforts are ongoing to locate these documents through several Environment Canada regional offices; however to-date these efforts have met with limited success.

Research Information Matrix

The matrix facilitated categorizing each report into one of seven research publication date range categories or a “non-dated” category for non-dated reports, and any of 23 research discipline categories (Table 1). Reports are categorized based on publication date. Each report was assigned a unique numeric identifier. Numeric identifiers listed within each matrix category correspond to numbered report references in the accompanying bibliography. Note that some reports might be associated with multiple research disciplines and thus appear multiple times within the matrix.

Both biotic and abiotic research discipline categories were incorporated into the matrix, reflecting the large variety of scientific studies conducted at Long Point during the past century. Most documented reports were identified within one of more of the 23 broad research categories. Certain reports for which a complete copy was not obtained for review, and in which the report title was ambiguous with respect to research discipline, were identified with the category called “General”. The following research discipline categories were also included as part of the matrix: Birds (Non-waterfowl); Waterfowl; Amphibians; Reptiles; Mammals; Fish; Terrestrial Vegetation; Aquatic Vegetation; General Wetlands; Land Use and Management; Human Impacts; Invasive Species; Water Quality/Limnology; Climate Change; Aquatic Macro-invertebrates; Zooplankton and Phytoplankton; Insects; Terrestrial Geography; Water Levels; Hydrology and Sediments; Weather and Air Quality; and Forests.

Categorizing reports into publication date ranges indicated time periods in which various research study types occurred in abundance or were lacking. This form of categorization also facilitated identification of certain reports from a given time period. In total, eight publication date ranges were specified: one period of 50 years, inclusive, from 1900 to 1949, five time periods of ten years each, inclusive, from 1950 to 1999, and one period of seven years, inclusive, from 2000 to 2007. One report was obtained from 1898 and was included within the 1900-1949 category.

Each “cell” within the matrix was shaded based on the level of research activity within the given time-period/discipline category combination. White cells correspond to relatively well-represented disciplines with greater than ten (10) references for a given time period; light-grey cells indicate under-represented disciplines having between six and ten (6-10) references for a given time period; mid-grey cells indicate poorly-represented disciplines with one to five (1-5) known study documents; and dark grey cells indicate those categories for which no known (0) study documents exist for a category within a given time period. The non-dated report column is not classified based on representation. Note that representation classes assigned in this report are relative to the total number of study documents found during the literature search for the Greater Long Point Area, and are therefore inherently subjective in nature.

Results and Discussion

Literature Summary

The following is a summary of specific research areas within each broad research discipline category, as compiled through the Long Point literature overview:

- Birds (Non-waterfowl): Represents studies involving avian species including swallows and flycatchers, shorebird species such as Piping Plovers, Bald Eagles and marsh birds. This category also includes references to a large number of Long Point breeding bird census results.
- Amphibians: Primarily consists of studies involving anuran species. Several reports within this category also include herpetofaunal studies that are incorporated here as well as certain documents that also appear in the Reptile category. Fowler's Toad (*Bufo fowleri*) studies and documents contribute heavily to the literature within this category.
- Reptiles: Largely consists of studies focused on various turtle species, and to a lesser extent, Garter Snakes. Several reports within this category are herpetofaunal studies and also appear within the Amphibians category. Spiny Softshell Turtles comprise a number of reptile-specific reports, as do studies of road mortality of reptiles.
- Mammals: Primarily consists of reports studying White-tailed Deer biology, ecology and their effects on vegetation, as well as studies of muskrats, deer mice and other small mammals. Several reports within this category include research into the spread and occurrence of Lyme disease and tick infestation and are also represented in the Insect category.
- Fish: Represents studies involving fish biology and ecology and studies of Long Point Bay fisheries – commercial and sport, historical and current. References to several creel census results are also included in this category.
- Waterfowl: Primarily focuses on the biology and ecology of ducks, geese and swans. Includes references to waterfowl population surveys, hunting reports and migratory notes.
- Terrestrial Vegetation: Includes references to all studies focusing on terrestrial vegetation. Several terrestrial vegetation surveys of Long Point are included in this category, as are studies of rare, individual plant species.
- Aquatic Vegetation: Includes references to aquatic vegetation surveys, as well as studies documenting submerged macrophyte distribution and abundance, and their effects on waterfowl populations.
- General Wetlands: Includes references to reports studying general wetland health or ecosystems. Also includes reports focused on wetlands research,

but with certain report titles ambiguous as to the specific biotic or abiotic topic of study.

- Land Use and Management: Most reports referenced in this category are studies of management options, conservation lands reports, and Official Plans. Other referenced reports discuss management options for various species of bird, fish or herptile.
- Human Impacts: Represents all studies focusing directly or indirectly on aspects of human influence on the natural environment. Includes references to studies on the effects of industrialization of the Nanticoke area on the aquatic environment, water quality issues in Big Creek and incidences of wildlife road mortality.
- Invasive Species: Documents the effects of various invasive (mostly non-native) plant and animal species on other native species and the natural environment. Includes some reports on the Common Reed (*Phragmites australis*), and a large number of studies relating to zebra mussels (*Dreissena polymorpha*).
- Water Quality/Limnology: Includes references to studies documenting toxic contamination and nutrient loadings in aquatic environments, as well as studies focused on limnological processes.
- Climate and Climate Change: Represents all studies focusing on the effects of climate change on the biotic and abiotic environment. Includes studies of effects of climate change on bird and coastal wetland communities. Studies focusing on climate of the Long Point area are also included in this category.
- Phytoplankton/Zooplankton: Studies within this category primarily examine the use of zooplankton and phytoplankton as indicators of water quality and ecosystem health.
- Macro-invertebrates: The references within this category focus primarily on mussels within Lake Erie, as well as the introduction of non-native species, identification, population dynamics, effects of waterfowl on population abundance and distribution; similarly, studies also investigate the effect of mussels on waterfowl populations and distribution.
- Insects: Although not true insects, the majority of references focus on ticks within the Long Point area, Lyme disease occurrence and transfer, and survivorship. Other references include studies of fly species and monarch butterflies.
- Terrestrial Geography: This category primarily includes references to all studies focused on any aspect of the physiography, geomorphology, pedology or geology of the Long Point sand spit and surrounding areas. Several referenced studies focus on sand dune formation.
- Water Levels: Represents all studies focused on changes in Lake Erie water levels.
- Hydrology and Sediments: Includes references to all studies involving lake sedimentation processes, wave action, beach erosion and sand wave formation. Some references regarding sediment contamination are also cross-referenced in this category.
- Weather and Air Quality: Includes references to studies on meteorological factors and air quality studies at Long Point.

- Forests: Primarily includes references to studies focused on the occurrence and distribution of trees and shrubs throughout the Long Point area.

Although significant effort was made to locate and document all available literature detailing studies that occurred within the greater Long Point area, study documents exist beyond those identified in this report. This may be particularly true of earlier time periods where study documents were not found using conventional research methods, or those published after the completion of the research for this report. Knowledge of additional study documents produced during these earlier periods might become available following completion of this report.

Gap Analysis

Several research categories are relatively well-represented in terms of number of released study reports in recent years (for the purposes of this report, since 1990), such as those representing non-waterfowl birds, waterfowl, amphibians, and water quality/limnology. However, when trends in number of identified documents are examined across all time periods, various patterns emerge that indicate any of three apparent directions in research occurring at Long Point over time: steady, increasing or decreasing numbers and intensities of research. Overall, the 1980-1989 publication date period had the highest representation of Long Point-related research documents found across all subject categories, which suggests a decline since that period in the number of studies conducted within several research categories.

<u>Recent Well-Represented Research Fields</u>

Non-waterfowl bird research (herein referred to simply as bird research) is represented by the greatest number of research reports among all research fields and across most time periods. This is also true for recent research. Within the 1990-1999 and 2000-2007 time periods, bird research was represented by a greater number of reports than all other research fields combined. However, a large number of these reports focus on specific bird species, such as Tree Swallows, while several other broad avian groups, such as marsh birds and raptors, have received considerably less research focus. Therefore, while bird research in general has been widespread at Long Point in recent years, there is much capacity for future work on particular bird groups or species.

Waterfowl in particular have received much research attention in recent years, particularly since the late 1990's. This is primarily due to numerous studies conducted by the Long Point Waterfowl and Wetlands Research Fund (LPWWRF). The LPWWRF has engaged in various studies of waterfowl species on and surrounding Long Point, but with a more intense focus on Scaup, Mute Swans and Tundra Swans. Beyond the LPWWRF, several studies have investigated the relationship between waterfowl and invasive species, with specific interest in zebra mussel predation.

Research focusing on amphibians has seen a steady increase in the Long Point area over the past four decades. Early amphibian research from 1900 through to 1969 was almost non-existent, but has steadily increased to an all-time high in the 2000-2007-time period. This increase in amphibian research might be somewhat skewed by a proliferation of research on Fowler's Toad (*Bufo fowleri*), which constitutes a large proportion of the studies within the 1990-1999 and 2000-2007 time periods. Therefore, despite the continual increase in amphibian-related research in recent decades, several amphibian taxa have received little research attention in the Long Point region.

Although the aquatic vegetation and general wetlands research categories are relatively well-represented within the 2000-2007 time period, the number of Long Point studies has been comparatively low over the last four decades within both of these categories. Further, compared to other well-represented research categories, aquatic vegetation and general wetland studies are relatively low in number. The value of the wetland complexes in the Long Point Area is not properly reflected in existing literature. Long Point area wetlands include over 70% of the total wetland areas along the north shore of Lake Erie, and encompass latitudinally rare fen and bog components (Ball *et al*, 2003) that are not discussed in any detail within the existing literature that was reviewed. Although wetland components within the Long Point area are relatively well-represented in most categories at a broader scale, wetland habitats *per se* have not been well investigated.

Fish, land use and management, and human impacts research peaked during the 1980s, only to be followed by steep declines in research output during the past two decades. As such, although each is defined as well-represented according to the designated criteria, all three categories have and continue to receive an appreciably lower level of research focus. This is particularly true of fish-based research and land use and management studies. Much of the research conducted during the 1980s, particularly the early part of that decade, is focused on the effects of the Nanticoke power generating station on the adjacent aquatic environment. Ongoing concerns about anthropogenic effects on biotic ecosystems (especially with increased population growth and agricultural intensification in the Long Point region in recent years) continue to stimulate research in those areas. Recent reports have addressed contamination of water and sediments with toxic compounds, incidences of wildlife road mortality, and contaminant burdens in waterfowl.

Reports addressing invasive plant and animal species are represented only during the last two decades in the Long Point area, and reflect an increase in the level of concern toward the impacts that these species might have on native biota. A large proportion of representative literature is focused on the introduction and proliferation of zebra mussels in Lake Erie. Reports on Mute Swans and the Common Reed are also found within this category. There might be other invasive species of interest in the Long Point area that have gone relatively unstudied in recent reports. These might include various exotic and invasive fish or plant species.

Water quality/limnology studies appeared rather abruptly in the 1970s and have maintained a steady presence in Long Point scientific literature to the present period. Several studies have focused on the eutrophication of Lake Erie, others on the transfer of nutrients and oxygen between Lake Erie's epilimnion and hypolimnion. Studies concerning contaminants from anthropogenic sources are also represented within this category, although studies specifically addressing water quality issues such as nutrient loadings and excessive sedimentation of watercourses and wetlands are not well represented.

Insect research has increased gradually over the last three decades, with the most recent time period (2000-2007) showing the greatest number of reports. However, this research category has had a limited scope, concentrating heavily on tick infestations, survivorship, and as carriers of Lyme disease. Otherwise, there have been few studies of other true insects such as flies or butterflies. Bird Studies Canada, however, is in the early stages of work to monitor Monarch Butterfly movements at Long Point.

Recent Under- and Poorly-Represented Research Fields

Reptiles have been generally under-represented in Long Point area research. The 1970's and 1980's saw a period of increased research. However, in the last two decades, reptile research has declined. Research has been relatively species-specific focusing predominantly on Garter Snakes and Spiny Softshell Turtles. Relatively fewer studies have focused on other reptile species in the Long Point area, with the majority of these studies focusing on turtles. Given the relatively specific nature of existing reptile research, there is significant opportunity for additional research.

Since the 1980s, mammal research in the Long Point region has been in decline. Among recent research, numerous studies have focused on deer browsing and population control, while several others have been associated with tick infestations, and relatively few have examined other mammal species. Non-deer research on mammals in the Long Point area and their habitat interactions and ecology could be of significant scientific value to Long Point literature and associated conservation efforts.

Terrestrial vegetation studies at Long Point was well-represented during the 1970s and 1980s, but has otherwise received relatively little focus. Only five known terrestrial vegetation studies exist for the 1990-1999 period, and only six occur for the 2000-2007 period, compared to double these numbers during its peak in the 1970s and 1980s.

Both invertebrate categories (phytoplankton and zooplankton, and aquatic macro-invertebrates) have been under-represented throughout much of the last century. Macro-invertebrate research underwent a rise in activity during the 1990s in concordance with the introduction of zebra mussels to the Great Lakes basin, but has otherwise been relatively little studied. Phytoplankton and zooplankton documents became evident in the 1970s but are under- and poorly-represented in all time-periods.

Terrestrial geography has received almost no recent research. Like other categories, research peaked during the 1980s and has declined to only one known report in the last decade. Physiography, geology, geomorphology and morphometric descriptions comprise all recent research, with the only report occurring during the 2000s examining morphometric influences on the formation of wetlands.

Lake Erie water level studies have been in decline since the 1970s during which the International Joint Commission was actively investigating the occurrence, control and effect of fluctuating lake levels. While earlier studies focused on flooding and erosion control, studies since 2000 have focused on the influence of fluctuating lake levels on wetlands, including vegetation cover and the responses of vegetation communities.

Hydrology and lake sediment-related research was relatively active between the 1970's and 1990's. However, a sharp decrease in scientific output has occurred since 2000. Predominantly, this research has dealt with wave angle and height, sediment transport and the formation of sand dunes and other coastal features. Some studies have also investigated substrate sediment quality and contamination within Lake Erie and Long Point Bay.

Collectively, climate and climate change, weather and air quality, and forests are under-represented in Long Point literature. Reports addressing climate change are primarily a recent occurrence, but are still few in number. These reports include studies on the effects of climate change on coastal wetlands, and the timing of bird breeding and migration. There is great potential for future studies to observe and predict the effects of climate change on various other biotic groups and on land formations. The latter may be very important given the effects of increasing water levels on low-lying areas of Long Point.

Weather and air quality research has yielded very few studies. Several studies focused on the air quality effects of the Nanticoke power generating station during the 1980s. However, of the three recent studies, only broad-scale atmospheric topics or climate baseline studies have been conducted.

Recent forest studies have investigated the quality and impact of forests and logging on bird populations, and seed dispersal and seedling development on Long Point in areas of frequent erosion and sediment shifting. Very little research exists on the quality, quantity and ecology of forests in the Long Point area.

Research Recommendations

With the recent general decline in scientific studies and resulting literature within the Long Point area, opportunities exist for research in all categories. Potential areas for future research for each category are presented in Table 1. It should be noted that this is not an exhaustive list of potential study topics, but rather aims to stimulate further discussion and consideration for potential studies.

Table 1: Research categories and potential study topics for the Long Point area.

Research Category	Research Needs/Niches
Birds (non-waterfowl)*	Broad avian groups – raptors, marsh birds; expand species-specific research base, breeding and staging ecology, toxicology, pathology
Waterfowl*	Broad waterfowl-habitat associations and interactions; expand species-specific research base
Amphibians*	Species-specific expansion; broader examinations of community relations, habitat associations, ecology, toxicology, pathology
Reptiles	Snakes and other reptile groups not represented; community interactions, habitat associations, toxicology, pathology, interference by human activities; currently a poorly-represented research area
Mammals	Non-deer mammal research; species diversity and abundance; habitat associations, community interactions, pathology
Fish*	Updated research on communities, abundance; fisheries status – commercial, sport; impact of continued development, agricultural intensification, toxicology, pathology, habitat associations
Terrestrial Vegetation	Poor recent representation; changes to community structure – on Long Point, particularly at the tip and in unstable locations; age structure; quality of habitat – stunting, etc.; links between flora and fauna communities
Aquatic Vegetation*	Community composition as indicators (further work possible); invasive species; ecological health indicators; climate change – particularly related to water levels
General Wetlands*	Ecological importance and integrity; contiguity; habitat characterization; latitudinally-significant wetland types; hydrologic characterization; landscape scale interactions; carbon cycling and dynamics – impacts from surrouding activities, and role in environment

Land Use and Management*	Agricultural intensification; increased development and population pressures; cottage communities and shore stability; impacts of water level control and diking on natural processes and habitat health
Human Impacts*	Pressures of cottages and recreational activities on Long Point biotic and abiotic components; introduction of invasive species; impact of domestic animals; agriculture and migration/bird use, urbanization, effects of sedimentation, non-point source pollution
Invasive Species*	Expansion into non-prolific invasive species – insects, plants, mammals, fish, etc.; incorporation of invasive species into local ecology; adaptations
Water Quality/Limnology*	Nutrient loading in wetlands – coastal, near-shore and within watershed-inland; sedimentation and suspended solids (turbidity, contaminants.); impacts of increased developmental and agricultural processes in tributaries and the bay
Climate Change	Very little examination of climate change in Long Point to-date; water level fluctuations related to climate change and the subsequent impacts on wetlands, near-shore and shoreline processes; expansion of southern species zones northwards, waterfowl and bird over-wintering and subsequent impacts, effects on other native biota
Macro-Invertebrates	Expansion beyond mussels; macro-invertebrate community within long point; use as water-quality indicators; importance in decomposition, or other processes within wetlands and the Inner and Outer bays
Phytoplankton and Zooplankton	Water quality indicators, Inner Bay and wetland community composition and abundance
Insects*	Invasive species; ecology; population dynamics; pathology; predation; habitat interactions – importance for seed or pollen dispersal/transfer
Terrestrial Geography	Substrate-plant community relationships; substrate mapping in relation to land use and land cover; temporal changes to Long Point land form and geomorphology
Water Levels	Particular relation to climate change studies, impacts on aquatic and wetland vegetation communities; influences on shoreline and near-shore processes; substrate exposure; contaminant flushing
Hydrology and Sediments	Importance of inundations to habitat quality and vegetation communities in shallow water wetlands and coastal wetlands; residence time; nutrient and contaminant transport; sedimentation in tributaries and wetlands
Weather and Air Quality	Local-scale impacts; storm frequency and relative importance
Forests	Age structure; coverage; diversity; ecology; contiguity, community and species-specific health, pathology

* - denotes categories listed as well-represented in recent literature through gap analysis

Conclusions

Overall, research in the Long Point area has significantly declined since its peak in the 1970s and 1980s. Eleven of twenty-three categories had a unimodal pattern in research intensity (see Appendix 1): nine with a peak centred in the 1980s, one with a peak in the 1970s, one in the 1990s and all eleven declining in the most recent 2000-2007 research period. Non-waterfowl bird research has declined slightly in 2000-2007; however it has retained much higher representation than any other research category.

Waterfowl, amphibians, and insects have consistently increased in research over time. However, increases are, at least in part, due to heavy weighting on specific topics or species, rather than on a diverse range of research topics. Invasive species and water quality/limnology have also shown increases in research, emerging within the previous few decades within existing literature and maintaining a stable research presence. Aquatic vegetation, general wetlands, zooplankton and phytoplankton, weather and air quality, and forest categories were under- or poorly-represented in virtually all time-periods for which they had a research presence.

The sharp decline in fish-related research in the last two decades highlights fish and fisheries as important areas for research development. Changes in population structure, community composition and in habitat quality, availability and use could be coupled with past research of similar focus to provide strong temporal trends and indications of Lake Erie quality and health. Near-shore and coastal wetland fish populations could also provide important information into the health and stability of the extensive wetland system protected by Long Point. Responses to increasing developmental pressure and agricultural intensification within the fish community could be extended to a broader understanding of the interactions between aquatic and terrestrial systems. Similarly, wetland health indicators, particularly related to broad scale changes, could provide context to existing literature, which focuses more specifically on wetland components. Changes in wetland cover, transitions between wetland types and community structure could provide vital links to the processes of natural succession, land use change, human impacts, and climate change that are influencing the natural environment of the Long Point area.

Recent research in the birds, waterfowl, amphibian and reptile categories has been relatively species-specific in nature, allowing for significant diversification within these broad classifications. Marsh bird research at Long Point has been relatively sparse, and increased focus on this avian group could again provide vital information regarding the quality of marshes, a major landscape feature within the Long Point area. Other groups within each of the abovementioned study categories have similarly been under-studied and would add significant value to the existing suite of Long Point research literature.

Although more than half of the research categories are considered 'well-represented' according to the criteria used in this gap analysis, there is considerable opportunity for enhanced scientific research, or for research diversification. With the relative decrease in Long Point research studies and associated literature, there is ample room for further exploration into the natural environment encompassing Long Point Bay and the greater area.

References

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Appendix 1 – Research Information Matrix

Research Category	Research Publication Date Range							
	1900-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007	Undated
Birds (Non-Waterfowl)	711 (1898), 781, 975, 992, 1051,	49, 50,	45, 54, 55, 56, 57, 58, 118, 119, 120, 135, 209, 290, 330, 331, 332, 334, 343, 344, 353, 488, 510, 511, 512, 513, 514, 515, 516, 517, 518, 577, 598, 599, 600, 673, 676, 677, 682, 683, 849, 850, 851, 852, 946, 951, 1114, 1144, 1145,	59, 83, 86, 103, 121, 122, 124, 125, 137, 166, 167, 176, 262, 263, 294, 296, 325, 326, 327, 328, 329, 335, 336, 398, 400, 465, 489, 490, 491, 507, 508, 509, 564, 570, 631, 684, 685, 730, 731, 732, 733, 734, 773, 774, 775, 791, 792, 793, 807, 808, 825, 842, 853, 854, 863, 906, 917, 950, 977, 980, 981, 1041, 1081, 1082, 1083, 1084, 1085, 1086, 1087, 1107,	126, 138, 151, 196, 210, 247, 248, 264, 266, 297, 298, 340, 377, 399, 444, 493, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 604, 632, 633, 634, 649, 735, 736, 737, 738, 739, 740, 742, 826, 827, 828, 864, 905, 907, 908, 909, 910, 911, 912, 913, 956, 957, 958, 960, 968, 1021, 1088, 1089, 1090, 1091, 1092, 1153, 1154,	19, 26, 28, 96, 97, 98, 104, 105, 127, 128, 129, 133, 134, 145, 146, 164, 184, 185, 197, 199, 258, 358, 359, 360, 386, 387, 388, 401, 478, 479, 480, 487, 496, 497, 498, 500, 501, 502, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 605, 703, 743, 744, 745, 746, 751, 758, 778, 855, 856, 899, 900, 949, 1006, 1007, 1060, 1061, 1062, 1097, 1139, 1140, 1146,	6, 7, 8, 30, 31, 32, 33, 34, 43, 84, 95, 152, 217, 219, 220, 227, 299, 300, 301, 302, 303, 304, 305, 314, 322, 348, 404, 441, 470, 549, 551, 552, 568, 571, 572, 583, 596, 601, 630, 637, 650, 704, 724, 764, 771, 776, 777, 788, 813, 894, 966, 985, 993, 1009, 1030, 1043, 1064, 1068, 1069, 1072, 1116, 1159	1115,
Waterfowl	92, 1058,		9, 57, 81, 142, 287, 702, 801, 802, 803, 841, 1150,	3, 82, 103, 254, 276, 293, 308, 354, 522, 561, 658, 720, 805, 830, 901, 931, 947, 969, 1002,	52, 111, 223, 255, 256, 492, 579, 690, 710, 713, 742, 749, 886, 887, 1021, 1073, 1074,	5, 11, 26, 292, 378, 448, 606, 691, 692, 782, 862, 866, 867, 1120, 1121, 1122,	21, 22, 36, 37, 38, 39, 40, 41, 42, 43, 44, 47, 48, 68, 114, 115, 169, 212, 216, 217, 219, 250, 251, 252, 314, 605, 608, 659, 784, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 1068, 1069,	4, 35, 257,
Amphibians	680,	1, 324,	681,	153, 155, 156, 202, 203, 504,	266, 376, 408, 409, 410, 411, 412, 413, 414, 574, 638, 883, 885, 1021, 1035, 1095,	19, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 581, 639, 1157, 1158,	27, 29, 101, 107, 108, 109, 110, 219, 314, 431, 432, 433, 434, 435, 436, 472, 771, 1010, 1011, 1012, 1013, 1014, 1015, 1016, 1068, 1069,	198, 846,
Reptiles	678, 679, 680,	1, 324,	347, 681,	153, 154, 155, 156, 202, 203, 381, 382, 383, 384, 504, 505, 978, 979,	18, 157, 266, 376, 385, 442, 689, 883, 885, 890, 902, 903, 1021, 1035, 1095,	19, 471, 972, 1157, 1158,	23, 139, 211, 231, 261, 314, 594, 973,	198, 846,
Mammals	60, 635, 976, 1017, 1018,	337, 726,	664, 994,	46, 53, 234, 235, 955, 1004, 1100, 1133, 1134,	93, 162, 265, 266, 272, 350, 377, 621, 741, 750, 823, 959, 1005, 1020, 1035, 1070, 1071, 1095, 1101, 1152,	19, 20, 116, 127, 128, 129, 375, 669, 672, 1123,	130, 131, 314, 405, 722, 771, 789,	

Research Category	Research Publication Date Range							
	1900-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007	Undated
Fish	503,	87, 88, 984,	221, 341, 694, 1044,	78, 175, 249, 315, 351, 362, 584, 585, 586, 587, 645, 674, 705, 707, 708, 714, 715, 716, 717, 718, 719, 765, 769, 779, 810, 822, 879, 922, 926, 927, 928, 929, 930, 1046, 1052, 1053, 1054, 1055, 1056, 1057, 1079, 1108, 1109, 1110,	85, 228, 266, 273, 352, 363, 394, 395, 396, 397, 406, 438, 445, 446, 451, 452, 453, 454, 696, 697, 698, 699, 700, 701, 709, 772, 831, 844, 848, 857, 898, 904, 932, 933, 934, 935, 948, 987, 990, 1036, 1047, 1048, 1049, 1065, 1066, 1077, 1104, 1111, 1137, 1138, 1155, 1156,	200, 213, 214, 282, 407, 573, 652, 653, 687, 780, 782, 800,	186, 204, 205, 206, 222, 283, 284, 470, 614, 766, 784, 860, 1029, 1076,	1067,
Terrestrial Vegetation	113 (1898),	355, 356, 357,	224, 440, 636, 963,	13, 170, 225, 226, 474, 475, 915, 916, 940, 641, 983,	14, 17, 377, 597, 621, 622, 741, 750, 785, 786, 823, 942, 943, 1021, 1111,	127, 128, 129, 173, 1045,	68, 130, 131, 623, 624, 1008,	171,
Aquatic Vegetation			440,	349, 474, 915, 916, 983, 1021,	17, 492, 578, 597, 620, 742, 942, 943, 1034, 1111,	172, 607, 862,	2, 36, 43, 346, 660, 771, 971, 1119, 1124, 1125, 1126, 1127,	
General Wetlands			71, 143, 803,	72, 74, 75, 76, 291, 455, 566, 796, 930, 1151,	111, 177, 275, 393, 402, 443, 756, 795, 859, 1080,	62, 98, 280, 389, 866, 1059, 1120,	2, 218, 219, 346, 469, 477, 661, 767, 790, 1068, 1069, 1076, 1103,	1067,
Land Use and Management	628,	140, 149, 562, 726, 945, 1003,	64, 65, 69, 71, 81, 180, 253, 836, 837, 951, 1141, 1150,	72, 74, 75, 82, 90, 178, 179, 181, 195, 208, 278, 279, 312, 316, 317, 318, 345, 361, 362, 372, 439, 456, 457, 473, 475, 593, 720, 752, 769, 811, 812, 814, 815, 895, 924, 936, 1135, 1148, 1151,	16, 77, 91, 94, 111, 136, 162, 183, 207, 269, 271, 274, 275, 276, 311, 363, 364, 365, 377, 458, 476, 567, 569, 609, 610, 611, 616, 617, 710, 753, 754, 755, 756, 757, 759, 763, 797, 816, 817, 818, 840, 843, 845, 887, 923, 925, 995, 1026, 1049, 1077, 1105, 1106, 1112, 1117, 1118,	51, 79, 80, 161, 168, 232, 233, 286, 559, 618, 641, 643, 686, 687, 819, 820, 821, 882, 997, 998, 999, 1000, 1078, 1120, 1121, 1129, 1130, 1131, 1149,	44, 159, 160, 215, 320, 366, 619, 661, 688, 729, 824, 858, 1113,	257, 663, 728, 914,
Human Impacts	628, 975,			3, 372, 450, 457, 589, 602, 779, 810, 1053, 1054, 1055, 1056, 1057,	12, 16, 52, 69, 183, 270, 352, 377, 438, 464, 468, 563, 797, 820, 844, 884, 888, 889, 943, 968, 990, 1025, 1026, 1077, 1095, 1096, 1104, 1112, 1117, 1155, 1156,	19, 232, 233, 281, 310, 783, 819, 820, 952, 1028, 1122,	23, 44, 110, 114, 115, 158, 204, 205, 206, 250, 251, 572, 608,	4,
Invasive Species						172, 187, 188, 190, 281, 447, 448, 782, 783, 867,	466, 565, 784, 870, 1042, 1124, 1125, 1126, 1127,	

Research Category	Research Publication Date Range							
	1900-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2007	Undated
Water Quality/Limnology			89, 1044,	73, 78, 147, 148, 351, 367, 368, 369, 370, 371, 437, 439, 798, 810, 835, 918, 921, 1093, 1132, 1148,	12, 266, 268, 323, 461, 464, 468, 494, 495, 563, 595, 646, 648, 651, 768, 794, 797, 965, 990, 1104, 1112, 1156,	230, 245, 260, 288, 289, 306, 307, 403, 582, 607, 770, 952, 1028, 1038,	112, 158, 165, 204, 205, 206, 212, 246, 261, 285, 321, 483, 499, 660, 721, 766, 847, 953, 961, 971, 988, 1136,	
Climate and Climate Change				880, 765,		144, 1023, 1024,	101, 449, 550, 552, 777, 790,	
Phytoplankton/ Zooplankton				798, 799, 810, 1098, 1099,	374, 1025, 1033, 1155, 1156,	245, 259,	391, 392, 575, 660, 766, 767, 865, 1050,	
Macro-Invertebrates			9, 1044,	53, 342, 765,	484, 748, 1033, 1155,	187, 188, 189, 190, 403, 447, 782, 783, 861, 867, 937, 938, 962, 1094,	466, 565, 721, 784, 870,	
Insects			576, 577, 599,	338, 380, 580, 954, 1100,	909, 913, 1101,	63, 229, 667, 668, 669, 670, 671, 672, 804,	61, 174, 624, 625, 789, 832, 833, 964, 973, 985, 986, 1008,	
Terrestrial Geography	628		655,	123, 182, 278, 379, 459, 613, 665, 1001, 1135,	150, 191, 193, 194, 236, 277, 309, 373, 460, 467, 553, 760, 761, 762, 763, 838,	67, 656, 670, 671, 1027, 1028, 1059,	477,	66,
Water Levels		1142,	142, 629, 892, 893, 944,	316, 317, 318, 554, 555, 566, 615, 675, 706, 811, 812, 1001,	238, 319, 556, 557, 558, 578, 727, 843, 1111,	339, 559, 642, 644, 656, 919,	469, 486, 647, 1103,	
Hydrology and Sediments		1142,	462, 629, 654, 891, 1102, 1143,	148, 175, 244, 316, 317, 318, 379, 390, 459, 463, 588, 589, 590, 613, 615, 662, 835, 996, 1022, 1063, 1132,	99, 102, 117, 191, 192, 236, 237, 238, 267, 277, 313, 377, 1986, 727, 806, 843, 965, 967, 991, 1031, 1032,	15, 100, 201, 239, 240, 241, 242, 626, 627, 642, 644, 919, 937, 974, 1027, 1038, 1039, 1040,	24, 25, 70, 106, 112, 243, 499, 725, 939, 1119,	
Weather and Air Quality		355, 356, 357,	560, 944,	10, 505, 880,	591, 693, 809, 970, 982,		141, 449, 1037,	
Forests		355, 356, 357, 562,	723, 1019,		712,	79, 80, 132, 920, 1045,	481, 482, 624, 747, 858, 1116	
General		897,		834, 881,	603, 666, 695, 787, 989,	485, 800, 829, 896, 1075,		657,

Appendix 2 – Annotated Bibliography

Several acronyms are used throughout the annotated bibliography and are listed here:

LP – Long Point
LPBO – Long Point Bird Observatory
LPB - Long Point Bay
BSC – Bird Studies Canada
CWS – Canadian Wildlife Service

1. Adams, M.S. and H.F. Clark. (1958) A herpetofaunal survey of Long Point, Ontario, Canada. *Herpetologica 14: 8-10*

Category	Amphibians, Reptiles
Source	CWS London

2. Albert, D.A. and L.D. Minc (2004) Plants as regional indicators of Great Lakes coastal wetland health. *Aquatic Ecosystem Health and Management 7(2):* 233-247

Study Date	Literature Review
Location	• US Coastal Great Lakes
Findings/Purpose	• Study examines the use of vegetation as indicators of wetland health in U.S. Great Lakes coastal wetlands – although not LP specific, information transfers easily to work in the LPB area • Species identified as being sensitive to different stresses were examined at different GL wetland sites for relationships to these stresses • Discussion includes: variations in wetland type and different forms of degradation affecting Great Lakes coastal wetlands (water level fluctuation, diking, nutrient loading, sedimentation, chemical loading, etc.) • Findings showed some stable relationships, but also that some species show relationships to multiple impacts
Category	Aquatic Vegetation, General Wetlands
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

3. Alison, R.M. Are North American waterfowl in trouble? (1977) p. 112-114. In: Canada's Threatened Species and Habitats (T. Mosquin and C. Suchal, eds.)

Study Date	Review Paper
Location	• Canada
Findings/Purpose	• Species of interest: Canada Goose, Black Duck, Canvasback, Redhead, Greater Scaup, several others are noted, but with less emphasis • Habitat loss across Canada is considered – habitat types of significance, atlantic coast, wintering habitats • Future management and protection: suggested development of an organized wetland preservation program – some reference to US programs is given
Category	Waterfowl, Human Impact
Source	MNR Library CWS London

4. Alison, R.M., D.G. Dennis and G.B. McCullough. (n.d.) Successful Redhead (*Aythya americana*) introduction at Long Point, Ontario. Unpublished report; Canadian Wildlife Service, Ontario Ministry of Natural Resources. 4 pp.

Category	Waterfowl, Human Impact
Source	CWS London

5. Alisauskas, R.T. and C.D. Ankney (1994) Nutrition of female breeding Ruddy Ducks: The role of nutrient reserves. The Condor 96(4): 878-897.

Study Date	1988
Location	• Southern Manitoba – comparison from personal observations to ducks captured at Long Point, but study does not deal directly with the Long Point area
Findings/Purpose	• Nutrient dynamics differed between breeding and non-breeding females • Non-breeding – lower fat content, smaller protein reserves at beginning of season, which then increased and decreased throughout the study • Breeding – higher initial fat and protein reserves and showed a steady decrease throughout study period • Fat in breeding females was put towards egg formation • Clutch size was found to be dependent on mineral reserves • Appears that minimal levels of nutrient reserves are required to initiate breeding in female Ruddy Ducks
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

6. Allair, J. Long Point Bird Observatory 2001 banding summary (2002) Ontario Bird Banding 34: 33-34.

Category	Birds
Source	BSC

7. Allair, J. and M. Hindle. 2002. Atlantic Flyway Review: Long Point Bird Observatory. North American Bird Bander 27(1): 28-29.

Study Date	2001
Location	• LPBO
Findings/Purpose	• Provides a review of migratory passages at LPBO for spring 2001 – general weather (general temperature and weather considerations) • A list of commonly caught birds is given as a table with % age category provided • Season had a slow beginning, picked up through mid-may, and by the end of may had slowed considerably, most birds had passed by June 10th
Category	Birds
Source	BSC Library

8. Allen, M.L., E. Nol, D.J.T. Hussell, K.A. Hobson and L. Wassenaar. 2004. Stable-hydrogen isotope analysis identifies breeding origins of migratory songbirds at Long Point, Ontario. American Ornithologists' Union and Society of Canadian Ornithologists, Quebec City, Quebec, August 2004.

Category	Birds
Source	

9. Anderson, R.C. and R.S. Freeman (1969) Cardiofilaria inornata (Anderson, 1956) from Woodcock with a Review of Cardiofilaria and Related Genera (Nematoda: Filarioidea) Transactions of the American Microscopical Society, Vol. 88, No. 1, pp. 68-79

Study Date	September-October, 1966
Location	• Manotick, Bradford, Cookstown, Brown Hill, and Alliston, ON
Findings/Purpose	• LP mentioned as a location of previous identification of the infective worms • Findings discuss the occurrence (prevelance) and host location of the worms – also discussing the lack of specificity in the selection of hosts • Non-specificity of hosts is linked to the non-selective feeding of the birds

Category	Macro-invertebrates, Waterfowl
Source	BSC – Digital Copy McMaster Libraries

10. Anlauf, K. G., P. Fellin and H. A. Wiebe. (1978) The Nanticoke Canada shoreline diffusion experiment June 1978, A oxidation of sulphur dioxide in a poer plant blue B. ambient concentrations and transport of sulphur dioxide particulate sulphate and nitrate and ozone. *Atmospheric Environment* 16 (3): 455-466 1982

Category	Weather and Air Quality
Source	McMaster Libraries

11. Annual Lower Great Lakes January Waterfowl Survey: 1997 – present. Unpublished data. Long Point Waterfowl and Wetlands Research Fund / Bird Studies Canada & Environment Canada - Canadian Wildlife Service.

Category	Waterfowl
Source	BSC - Not currently available

12. Arden, R.S. and R. Farooqui. (1981) Water temperatures in Nanticoke-Long Point Bay region of Lake Erie. Journal of Great Lakes Research 7: 337-344

Study Date	1970-1978
Location	• W of Centre Creek to Peacock Point in the East – dominantly nearshore, some further offshore • Sampling map in text
Findings/Purpose	• Temperature measurements at 0.5-6m depth along Lake Erie shoreline in proximity to Nanticoke power station • Avg. monthly temperatures peak July through September • Pre- and post-operational temperature monitoring • Findings indicate relatively little impact of Nanticoke power generation plant on temperature regime of near-shore areas • Note: Values recorded May-November – no winter observations
Category	Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

13. Argus, G.W. and D.J. White. (1977) The rare vascular plants of Ontario. National Museum of Natural Sciences, Syllabus No. 14, Ottawa. 63 pp.

Category	Terrestrial Vegetation
Source	McMaster Libraries

14. Argus, G.W., K.M. Pryer, D.J. White and C.J. Keddy. (1987) Atlas of the rare vascular plants of Ontario. National Museum of Natural Sciences, Ottawa.

Category	Terrestrial Vegetation
Source	McMaster Libraries

15. Armstrong, D.H. (1990) Spatial and temporal beach profile variation associated with a longshore sandwave, Long Point, Ontario. M.Sc. thesis, Department of Geography, University of Guelph.

Category	Hydrology and Sediments
Source	University of Guelph Libraries BSC Library

16. Ashenden, J.E. (1980) North beach survey and recreational use study at Long Point National Wildlife Area, summer 1980. Unpublished report to Canadian Wildlife Service.

Category	Land Use and Management, Human Impacts
Source	CWS London

17. Ashenden, J.E. (1981) Vegetation of six inland ponds in the Gravelly Bay area of Long Point. Unpublished report to Canadian Wildlife Service. 25 pp.

Category	Terrestrial Vegetation, Aquatic Vegetation

Source	CWS London

18. Ashenden, J.E. (1983) Movements of nesting Midland Painted Turtles and Blanding's Turtles at Long Point, Ontario. Unpublished report; Dept. of Biology, Wilfrid Laurier University, Waterloo, Ontario. 54 pp.

Category	Reptiles
Source	CWS London

19. Ashley, E. P., and J. T. Robinson (1996) Road mortality of amphibians, reptiles and other wildlife on the Long Point causeway, Lake Erie, Ontario. Canadian Field Naturalist 110:403–412.

Study Date	April-October, 1979, 1980, 1992, 1993 (June sampling start in 1979)
Location	• Big Creek Wetland - 42°35'15" N, 80°27'30" • 5 sampling locations, Long Point causeway – sampled section length 3.56 km • Sampling site map in text
Findings/Purpose	• Traffic volume information • 7 amphibian, 10 reptile, 21 mammal and 62 bird species were identified • 32,000+ individuals identified over 4 years of study • 92.1% amphibians, 2.7% reptiles, 4.3% birds, 0.9% mammals • Leopard frogs accounted for 85.4% of kills • Bird mortality highest in 1979 • Habitat type on E-W sides of road and change between study years recorded • Full species list and counts for each study year • Seasonal trends in mortality
Category	Amphibians, Reptiles, Birds, Mammals, Human Impact
Source	McMaster University, Thode library periodicals

20. Ashley, E.P., G.B. McCullough, and J.T. Robinson. (1998) Morphological responses of white-tailed deer to a severe population reduction. Canadian Journal of Zoology 76 (1): 1-5 Jan

Study Date	1989-1994
Location	• Long Point National Wildlife Area
Findings/Purpose	• Documents morphological changes (mass, hind foot length, antler beam diameter) after the three public hunts held to reduce deer populations in the area (an ~85% decrease in population) • Dressed weights and antler beam width are low for their sub-species • Noticeable increases of these indicators was seen between 1989-1990 and 1990-1994 – most notable in younger animals • Over the study period, male fawns showed a significant increase in mean mass by 46% and yearlings saw an increase of 96% • Similar increases were seen in antler beam width • Findings show that long point deer were not genetically smaller than mainland deer, but rather were restricted due to environmental conditions
Category	Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost MNR Library – Peterborough

21. Ashley, E.P. and N.R. North (2004) From the field: Automated doors for waterfowl banding traps. *Wildlife Society Bulletin* 32(1): 273-275.

Study Date	2000-2002
Location	• Long Point
Findings/Purpose	• Design and description of a waterfowl trap with the addition of an automated door • Field results indicate that use of the automated door reduced

	waterfowl loss to predation by other animals • Waterfowl appeared undisturbed by door movement, and no door-related injuries were found to occur
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

22. Ashley, E.P., N.R. North, S.A. Petrie and R.C. Bailey (2006) Age determination of American Black Ducks in winter and spring. Wildlife Society Bulletin 34: 1401-1410.

Study Date	2001-2004 (Fall and Spring capture periods, year dependent)
Location	• Big Creek National Wildlife Area • 42°35'N, 80°30'E to 42°33'N, 80°03'E
Findings/Purpose	• Develop techniques to identify 'second year' from 'after second year' black ducks • Feather features used as primary determinants – pigment, shape, size • ~90% success rate in establishing age group • Experienced observers had slightly higher accuracy rate than inexperienced observers
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

23. Ashley, E.P., A. Kosloski, and S.A. Petrie (2007) Incidence of intentional herpetile-vehicle collisions at Long Point, Lake Erie. Human Dimensions of Wildlife 12(3): 137-143.

Study Date	July-October 2005
Location	• 3.6 km causeway between Big Creek National Wildlife Area and Long Point Bay
Findings/Purpose	• Determine the frequency of intentional hits by vehicles on the causeway using decoys of both snakes and turtles, a plastic cup and a control were also used to determine accidental hits and intentional hits on wildlife vs an object • Responses categorized into 1) intentional collision 2) avoidance 3) rescue 4) no change • Results indicate 3-way interaction between gender, treatment and fate • Reptile decoys were hit with greater frequency than either the cup or the control • Males were more likely to strike decoys than females, snake decoy was hit more frequently than the turtle decoy, and both genders stopped to rescue the decoys with similar frequency
Category	Reptiles, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

24. Ashton, A.D. and A.B. Murray (2006) High-angle wave instability and emergent shoreline shapes: 1. Modeling of sand waves, flying spits and capes. Journal of Geophysical Research – Earth Surface 111 (F4): Art No.F04011, Dec. 15

Study Date	n.d.
Location	•
Findings/Purpose	• LP references, not LP specific, although model processes are applicable • Numerical model developed to investigate the influence of deepwater angle on sediment transport and the development of shoreline features ranging in size from kms to 100s of kms • Symmetric wave climates: cuspate coasts develop, increasing relative cross-shore amplitude and pointier tips as the proportion of high-angle waves is increased • Asymmetric wave climates: shoreline features migrate in a downdrift

	direction, as subtle along shore sand drift or as flying spits – dependent on proportion of high-angle waves • Conclusion: the proportion of high-angle waves determines the offshore vs. alongshore aspect ratio of self-organized shoreline undulations
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

25. Ashton, A.D. and A.B. Murray (2006) High-angle wave instability and emergent shoreline shapes: 2. Wave climate analysis and comparisons to nature. Journal of Geophysical Research – Earth Surface 111 (F4): Art No.F04012, Dec. 15

Study Date	n.d. uses existing studies and simulations
Location	• Long Point
Findings/Purpose	• High-angle waves create unstable shoreline features • Instability requires alongshore sediment flux is maximized for a given deep-water wave angle (between 35 and 50° for several alongshore sediment transport formula) • Long Point used as a case study for the model • Unstable waves have formed the spit (climate metric evidence) • Small-scale and alongshore sand waves occur along the spit where the wave climate become unstable
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

26. Austen, M.J., H. Blokpoel and G.D. Tessier (1993) Atlas of colonial water birds nesting on the Canadian Great Lakes: 1989-1991. Canadian Wildlife Service, Ontario Region.

Study Date	1991 breeding season
Location	• Various throughout Great Lakes • Long Point and Long Point Bay covered fully in surveys • Survey map in text
Findings/Purpose	• Observation of bird species, age, and mating status throughout study area for each survey square is provided • Specific location data (lat, long) data is found in Appendix 2 for all colonies observed, also includes colony name, I.D and distance from lake. • Maps of bird colonies indicating colony size and species are found in Appendix 4.
Category	Birds, Waterfowl
Source	McMaster University, Thode library periodicals

27. Austin, J. D., S.C. Lougheed, and P.T. Boag (2004) Discordant temporal and geographic patterns in maternal lineages of eastern north American frogs, Rana catesbeiana (Ranidae) and Pseudacris crucifer (Hylidae). Molecular Phylogenetics and Evolution 32 (2004) 799–816

Study Date	n.d.
Location	• Long Point • 42°37'N 80°28'W
Findings/Purpose	• Investigates the impact of recent glacial events on the recent diversification of temperate species • Loss, maintenance or combining lineages in refugia is examined for several locations in the North-Eastern United States and Southern-Ontario • Authors do not feel that majority of current diversification is due to recent events, likely dating back to the Pliocene rather than the Pleistocene
Category	Amphibians

Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

28. Austin, J.W.A., M.D. Cadman, and R.D. James (1994) Ontario Birds at Risk: Status and conservation needs. Federation of Ontario Naturalists and the Long Point Bird Observaory.

Study Date	n.d.
Location	• Various in Ontario
Findings/Purpose	• Provides an index of threatened or endangered birds and birds of concern with small entries describing their territory, current issues and suggestions for conservation.
Category	Birds
Source	MNR Library

29. Austin,J.S., S.C. Lougheed, L. Neidrauer, A.A. Chek, and P.T. Boag. (2002) Cryptic lineages in a small frog: the post-glacial history of the spring peeper, *Pseudacris crucifer* (Anura: Hylidae). Mol Phylogenet Evol. 2002 Nov;25(2):316-29.

Study Date	n.d.
Location	• Various, including LP
Findings/Purpose	• Investigation into the connection between haplotypic variants and post-Pleistocene population dynamics • S-Ontario has a high level of genotypic diversity – possibly due to the pattern of re-introduction from isolated refugia during the Pleistocene
Category	Amphibians
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

30. Badzinski, D.S. and C.M. Francis (2000) Trends in Numbers of Migrant Birds at Long Point Bird Observatory (1961-1999). 1999 Annual Report. Bird Studies Canada. Ontario Ministry of Natural Resources, Wildlife Assessment Program.

Study Date	1999 (trend monitoring 1961-1999)
Location	• LPBO
Findings/Purpose	• Compared to 1998, spring indices were high with ~75% of species increasing • Fall indices showed smaller increases with ~44% of species increasing • These changes could be cause by underlying population changes, but could also be related to weather conditions in comparison to the previous year • 1999 indices do not significantly alter long-term population trends • future research needs are identified including increased ability to account for weather effects, nocturnal monitoring for calibration
Category	Birds
Source	BSC Library

31. Badzinski, D.S. and C.F. Francis (2000) An evaluation of species coverage by the Canadian Migration Monitoring Network. Unpublished Bird Studies Canada report for the Canadian Migration Monitoring Network. 28pp.

Category	Birds
Source	BSC Library

32. Badzinski, D.S. (2002) Southern Ontario Bald Eagle Monitoring Project, 2002 report. Unpublished report by Bird Studies Canada to the Ontario Ministry of Natural Resources and the Canadian Wildlife Service. 16 pages.

Study Date	1980-2002
Location	• S-Ontario with Long Point locations
Findings/Purpose	• Observe existing and locate new nesting sites of Bald Eagles in Southern Ontario • Provides information on the distribution and use of nests – natural

	and artificial platforms, nesting occupancy over several study periods, activity – nesting, nesting with eggs, and productivity (# of eggs laid and raised to fledging) • Eagles appear to be accumulating mercury from the Great Lakes area, investigations are planned to investigate this occurrence • Other recommendations are given for continuation and expansion of the program and eagle conservation efforts
Category	Birds
Source	BSC Library

33. Badzinski, D.S. (2003) Hooded Warbler research in St.Williams Forest, Ontario: An investigation of nest productivity, nest concealment, territory size and species associations. Unpublished Bird Studies Canada report for Canadian Wildlife Service – Ontario Region. 21pp.

Category	Birds
Source	BSC Library

34. Badzinski, D.S. (2005) Trends in numbers of migrant birds at Long Point Observatory (1961-2003). Bird Studies Canada, Unpublished Report. Ontario Ministry of Natural Resources, Wildlife Assessment Program.

Study Date	2003 (trend monitoring 1961-2003)
Location	• LPBO
Findings/Purpose	• 56% of spring migrants showed increasing population trends between 1961-1963, 2001-2003 • Fewer fall migrants had increasing population trends, 45% increased between 1961-1963, 2001-2003 • Species specific population trends are more variable
Category	Birds
Source	BSC Library

35. Badzinski, S.S. and S.A. Petrie (n.d.) Satellite tracking Lesser and Greater Scaup from the Lower Great Lakes. Ongoing research (2005-present). Long Point Waterfowl and Wetlands Research Fund/Bird Studies Canada.

Category	Waterfowl
Source	BSC – not currently available

36. Badzinski, S.S. (2003) Influence of Tundra Swans on aquatic vegetation and staging waterfowl at Long Point, Ontario. Ph.D. dissertation, University of Western Ontario, London, Ontario.

Study Date	
Location	• LP
Findings/Purpose	• Increasing swan populations over last two decades have raised concerns about their impact on aquatic vegetation and waterfowl in important staging areas • Study looks to investigate whether swans reduce seasonal abundance of aquatic plants, determine if the abundance, proximity and foraging habits of swans affect the abundance, activity and feeding methods of waterfowl • Exclosure experiments • Swans were not found to significantly reduce aquatic plants during fall • Swans did not appear to reduce food availability for ducks • Overall swans did not affect the density of waterfowl in large wetland complexes or small ponds, but some ducks showed positive correlations with increasing swan densities • Ducks generally did not avoid swans • Swans rarely attacked ducks (only when foraging)
Category	Waterfowl, Aquatic Vegetation
Source	Library of Canada (http://www.collectionscanada.ca/) University of Western Ontario Libraries

37. Badzinski, S.S. (2003) Dominance relations and agonistic behaviour of Tundra Swans (*Cygnum columbianus columbianus*) during migration. Canadian Journal of Zoology 81: 727-733.

Study Date	Fall 1998, 1999 and Spring 1999
Location	• Long Point • 42°38'N, 80°24'W
Findings/Purpose	• Non-family groups were involved in more interactions – with most occurring between adult pairs and lone adults (may be a result of observed population dynamics) • Group size seemed to dominantly control hierarchy where larger families dominated smaller families, then adult pairs, lone adults, and down to lone juveniles • Hierarchy is dominantly maintained by low-level interactions
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost BSC Library

38. Badzinski, S.S. and S.A. Petrie (2004) Nutrient reserve dynamics of Lesser Scaup during spring migration on the Canadian Lower Great Lakes. Wildlife Society Bulletin, submitted Nov. 2004.

Category	Waterfowl
Source	Not currently available

39. Badzinski, S.S. (2005) Social influences on Tundra Swan activities during migration. *Waterbirds* 28(3): 316-325.

Study Date	Fall 1998, Spring 1999
Location	• Long Point 42°38'N, 80°24'W
Findings/Purpose	• Negative relationship between vigilance and group size – shared work may reduce security concerns – however most research does not support this trend • Parental vigilance was found to be related to brood size – contrary to other research • Young and adults had similar foraging time
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost BSC Library

40. Badzinski, S.S. and S.A. Petrie (2006) Greater and Lesser Scaup diets during fall and spring on the Lower Great Lakes. Wildlife Society Bulletin 34: 664-674.

Study Date	Oct-Nov, 1986
Location	• Prince Edward County – Lake Ontario
Findings/Purpose	• Not LP specific, although compares results from this area to findings in the Long Point area for zebra mussel densities and how this relates to predation • General findings indicate that Scaup consume gastropods when in abundance and only relatively small quantities of amphipods • Diet changes to include zebra mussels may play a role in the increased contaminant loading in Greater and Lesser Scaup in the Lower Great Lakes
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost BSC Library

41. Badzinski, S.S. and S.A. Petrie (2006) Lesser Scaup spring nutrient reserve dynamics on the lower Great Lakes. Wildlife Society Bulletin 34(2): 395-407.

Study Date	Spring 2000
Location	• Lake Erie (LPB), Lake St. Clair (Mitchell's & St. Luke's Bay), Lake Ontario (Bay of Quinte and Wolfe Island)
Findings/Purpose	• Influences of staging within the Lower Great Lakes (LGL) influences fat, protein and nutrient composition and quantity in Lesser Scaup and to determine any sex differences in these parameters • Many relationships were discovered, however other factors including, wintering latitude, arrival time at staging areas, residence time & therefore feeding at staging areas • At Long Point – male fat reserves decreased, female reserves increased, protein in males and mineral reserves in both sexes were relatively constant • Males may lose fat content due to attentions paid to courtship over foraging activities
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost BSC Library

42. Badzinski, S.S. and S.A. Petrie (2006) Diets of Lesser and Greater Scaup During Autumn and Spring on the Lower Great Lakes. *Wildlife Society Bulletin* 34(3): 664-674.

Study Date	Autumn 1999, Spring 2000
Location	• Lake Erie (Long Point) • Lake Ontario • Lake St. Clair
Findings/Purpose	• Dietary composition did not differ between sexes (generally) • No differences in preference for mussel size selection (*Dreissena polymorpha*), although all ate slightly larger mussels in spring than fall • Lesser Scaup: more zebra mussels in spring, more gastropods and plants during autumn • Greater Scaup: diet varied with season and stopover site • Greater Scaup generally ate more gastropods and plant matter than did Lesser Scaup • Study raises/adds to concerns related to foraging of zebra mussels and selenium burdens – particularly in the Lower Great Lakes region
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost BSC Library

43. Badzinski, S.S., C.D. Ankney and S.A. Petrie (2006) Influence of migrant Tundra Swans (*Cygnus columbianus*) and Canada Geese (*Brant canadensis*) on aquatic vegetation at Long Point, Lake Erie. Hydrobiologia 567: 195-211.

Study Date	Fall 1998, 1999
Location	• Long Point (42°38'N, 80°24' W): Teal pond (Turkey Point Marsh), Smith Marsh, mouth of Big Creek, North Pond, Causeway Pond, Little Rice Bay, Bouck's Pond • Location map in text
Findings/Purpose	• Examines the effect of Tundra Swan (particularly) and Canada Geese on below ground biomass availability to smaller waterfowl • Exclosure and control plots were built to exclude only swans and geese • Findings indicated that large waterfowl did not have an additional impact on above or below ground biomass compared to smaller waterfowl (ducks) and abiotic factors • Biomass was seasonally affected in areas heavily used by all waterfowl
Category	Birds, Waterfowl, Aquatic Vegetation
Source	McMaster University, Thode library periodicals

	Available digitally from publisher at cost BSC Library

44. Badzinski, S.S., S.A. Petrie and S. Proracki (2006) Long-term trends in waterfowl hunters, harvest, waterfowl use, and marsh habitat in the Crown Marsh – Long Point, Ontario. Unpublished report; Long Point Waterfowl and Wetlands Research Fund/Bird Studies Canada, Port Rowan, Ontario.

Study Date	1961-2006 (study subsets within this period)
Location	• Crown Marsh – Long Point
Findings/Purpose	• Historic trends in overall waterfowl harvest and numbers of hunters (1961-2005) • Trends in autumn and spring waterfowl abundance at Crown Marsh (1971-2006) • Changes to major habitat types & estimate open water to emergent vegetation ratios (1955, 1964, 1968, 1978, 1985, 1995, 1999) • Hunter numbers and harvest increased into the 1980's, decreasing thereafter, however kills/hunter have not changed • Findings suggest that numbers of several species of ducks in autumn have seen decreases in numbers – may indicate decreasing habitat quality • GIS analysis of habitat showed significant changes and fluctuations from 1955 to 1999 – open water:emergent vegetation showed largest changes largely in response to changes in Lake Erie water level
Category	Waterfowl, Land Use and Management, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost BSC Library

45. Bagg, A.M. and J. Baird (1961) The changing seasons: A summary of the 1961 spring migration. Audubon Field Notes 15(4): 380-389.

Category	Birds
Source	McMaster Libraries

46. Bailey, J.R. (1976) The ecology of White-tailed Deer on Long Point. M.Sc. thesis, University of Western Ontario, London, Ontario. 67 pp.

Category	Mammals
Source	CWS London

47. Bailey, M.L. (2003) Dietary intake of Mute Swans, *Cygnus olor*, in relation to reproduction on the lower Great Lakes. BSc Honours Thesis, University of Western Ontario, London, Ontario.

Category	Waterfowl
Source	Western University

48. Bailey, M., S.A. Petrie and S.S. Badzinski (2007) Diets of Mute Swans, *Cygnus olor*, on the lower Great Lakes. Submitted to Journal of Wildlife Management.

Category	Waterfowl
Source	Not currently available

49. Baillie, J.L. (1950) Ontario – western New York region. Audubon Field Notes 4:272-274

Study Date	1950
Location	• Ontario-western New York
Findings/Purpose	• General inventory of migratory birds and nesting pairs within the area of interest • Historical population/abundance information can be gleaned • Specific observation dates are given for different species
Category	Birds
Source	McMaster University, Thode library periodicals

50. Baillie, J.L. (1954) Ontario – western New York region. Audubon Filed Notes 8:324-344

Study Date	1954
Location	• Ontario-western New York
Findings/Purpose	• General inventory of migratory birds and nesting pairs within the area of interest • Historical population/abundance information can be gleaned • Specific observation dates are given for different species
Category	Birds
Source	McMaster University, Thode library periodicals

51. Bailly, A., G. Francis, J.G. Nelson (1991) Strengthening biosphere reserves in Canada: results of a workshop help at the University of Waterloo, November 1-2, 1990. Heritage Resources Centre. 58pp.

Category	Land Use and Management
Source	McMaster Libraries

52. Bain, G.A.C. (1980) The relationship between preferred habitat, physical condition and hunting mortality of Canvasbacks (*Aythya valisineria*) and Redheads (*Aythya americana*) at Long Point, Ontario. M.Sc. thesis; University of Western Ontario, London, Ontario. 39 pp.

Category	Waterfowl, Human Impacts
Source	Environment Canada Libraries – Saskatoon, SK; Sackville, NB

53. Baker, M.R. and R.C. Anderson. (1975) Seasonal changes in abomassal worms (*Ostertagia* spp.) in White-tailed Deer (*Odocoileus virginianus*) at Long Point, Ontario. Canadian Journal of Zoology 53: 87-96.

Category	Mammals, Macro-Invertebrates
Source	McMaster University Libraries

54. Baldwin, D.H. (1962) Inquiry into the mass mortality of nocturnal migrants in Ontario. Progress Report 1. The Bulletin, Federation of Ontario Naturalists. 97 (Progress Report 1): 23-27.

Category	Birds
Source	

55. Baldwin, D.H. (1963) Enquiry into the mass mortality of nocturnal migrants in Ontario. Progress Report II. The Ontario Naturalist. 1 (Progress Report 1): 7-15.

Category	Birds
Source	McMaster Libraries

56. Baldwin, D.H. (1965) Enquiry into the mass mortality of nocturnal migrants in Ontario. Final Report. The Ontario Naturalist. 3(1): 3-11.

Category	Birds
Source	McMaster Libraries

57. Baldwin, D.H. and R.D. Montgomerie (1965) The spring banding of Redheads at Long Point. Ontario Bird Banding 1(3): 23-30.

Study Date	Spring 1965
Location	• LPBO
Findings/Purpose	• 252 ducks were banded during a coordinated duck banding program of which 242 were redheads • Provided a high recovery rate – since the reducting of hunting, recovery rates had fallen – 29 of the birds caught had previously been banded • Further information regarding redheads – wintering areas, winter banding in Maryland, spring migration information (location and dates of passage), ageing and sexing and a comparison of trapping and handling techniques • Wear to the bands is higher in diving ducks than others because of

	the mechanics of how they walk
Category	Waterfowl
Source	BSC Library CWS London

58. Baldwin, D.H. (1968) Bird banding in Ontario: Analysis of five years records, 1960-64. Ontario Bird Banding 4: 89-132.

Study Date	1960-1964
Location	• Ontario – not LP specific
Findings/Purpose	• Investigation into the granting of permits and sub-permits of banding in Ontario – separating new from existing permits • Banders were categorized based on their nationality, status as professional/amateur, management, academic, administrative or student • Issued permits are broken down based on these categories as well • Evaluation of banding occurrence is also examined based on the types of birds banded (game vs. non-game birds) • Bird recovery rates are evaluated for the study period • Amateurs banded the majority of non-game birds • A bibliography of Ontario bird banding is given at the end of the article
Category	Birds
Source	BSC Library CWS London

59. Baldwin, D.H. (1976) Bird banding in Ontario: an analysis of five years records 1960-64. Unpublished Report to the Canadian Wildlife Service. 87pp +

Category	Birds
Source	CWS London

60. Banfield, A.W.F. (1948) The second record of the Little Short-tailed Shrew in southern Ontario. The Canadian Field Naturalist 62(5): 163-164.

Study Date	1941
Location	• LP
Findings/Purpose	• First observation of a short-tailed shrew – LP, 1927 • Second observation of a short-tailed shrew – LP, 1941 • Despite sample collection at the site between these dates, no specimens had been reported • During the field expedition, no other specimens were found, although an exhaustive search was made • Specimen was entered into the authors collections • Specimen measurements are provided in text
Category	Mammals
Source	BSC Library

61. Banerjee, S.N., M. Banerjee, K. Fernando, J.D. Scott, R. Mann and M.G. Morshed (2000) Presence of spirochete causing Lyme disease, Borrelia burgdorferi, in the blacklegged tick, Ixodes scapularis, in southern Ontario. *Canadian Medical Association Journal,* 162(11) : 1567-1569

Study Date	1997-1998
Location	• Various in S-Ont, including LP
Findings/Purpose	• Reports incidence of lymes disease through ticks • Long Point is cited as a location at which ticks were found with live Borrelia burgdorferi • Incidence of infection are listed and a site map of known tick presence with the infection are given
Category	Insects
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

62. Barco, M., J. DeZwart, K. MacDonald and J. Haggeman (1996) Southern Ontario Wetland Evaluation, Data and Scoring Record – Big Creek at Port Royal (BC14). October 1, 1996. OMNR, Simcoe. 40pp + 2 maps + 1 supp.

Category	General Wetlands
Source	NHIC (Natural Heritage Information Centre)

63. Barker, I.K, G.A. Surgeoner, H. Artsob, S,A, McEwan, L.A, Elliott, G.D. Campbell and J.T. Robinson (1992) Distribution of the Lyme disease vector, Ixodes dammini (Acari: Ixodidae) and isolation of Borrelia burgdorferi in Ontario, Canada. Journal of Medical Entomology 29 (6): 1011-1022 1992

Study Date	1987-1988
Location	• Long Point
Findings/Purpose	• Various tick species were found at Long Point • One species – Ixodes dammini – is not common in Ontario outside of Long Point • A high proportion of white-footed mice (~92%) showed tick infestation • Borrelia burgdoferi from 10 of 151 white-footed mice harvest (Lyme's disease indicator)
Category	Insects
Source	Available from Publisher at Cost McMaster University – Thode Periodicals

64. Barnes, A.S.L. and Black, V.B. (1963) Big Creek Region Conservation Report, 1963 – History. Ontario. Conservation Authorities Branch. 100pp.

Category	Land Use and Management
Source	McMaster Libraries

65. Barnes, A.S.L (1963) Big Creek Region Conservation Report, 1963 – Summary. Ontario. Conservation Authorities Branch. 100pp +

Category	Land Use and Management
Source	McMaster Libraries

66. Barnett, P.J. (n.d.) Quaternary stratigraphy and glacial history of the Lake Erie shorebluffs, Nanticoke to Port Bruce. Ontario Geological Survey, Ministry of Natural Resources. 63pp

Study Date	Review paper
Location	• North Shore Lake Erie
Findings/Purpose	• Description of the geology exposed along the Lake Erie shoreline between Nanticoke and Port Bruce • Based on quaternary geology mapping projects conducted by the author (part of the OGS mapping of Quarternary geology of Southern Ontario) • Broad description of the area, including borehold data, some surficial geomorphological features • Maps of the area in sections are provided in text
Category	Terrestrial Geography
Source	MNR Library – Peterborough

67. Barnett, P. J. (1998) Quaternary geology, Long-Point-Port Burwell. Ontario Geological Survey report 0704-2582 298, 143 p.

Category	Terrestrial Geography
Source	McMaster University Libraries

68. Barney, T. (2007) Seasonal changes in nutritional quality and availability of agricultural waste grains for field-feeding waterfowl near Long Point, Lake Erie. M.Sc. Thesis. University of Western Ontario, London, Ontario.

Category	Waterfowl, Terrestrial Vegetation
Source	University of Western Ontario Libraries

69. Barrett, H.B. (1981) History of human-use impacts on Long Point Bay. Journal of Great Lakes Research 7(2): 81-88.

Study Date	-- Historical Review
Location	• LPB
Findings/Purpose	• Short historical review of human settlement and land use of the LPB area from initial settlement by Natives (successive from nomadic-foragers to more settled agricultural use of the area), to initial 'white' settlement, establishment of the Long Point Company, the beginnings of water-level control and dyking, development of the timber industry, agricultural expansion, and fisheries development • Covers changes up to the development of outboard motors and heavy use of anglers of the LPB area of the 1960s-1970s
Category	Land Use and Management, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

70. Bauer, B.O. and R.G.D. Davidson-Arnott (2003) A general framework for modeling sediment supply to coastal dunes including wind angle, beach geometry and fetch effects. *Geomorphology 49(1-2):* 89-108.

Study Date	n.d.
Location	• Model development based on some observations of dune locations, including LP • No field-data
Findings/Purpose	• Aeolian sediment transport model • Investigates the impact of fetch and wind approach angle on aeolian transport mechanisms in beaches of different geometries
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

71. Bayly, I. (1968) A report for Long Point Marsh. Unpublished report to Long Point Company. 15 pp.

Category	General Wetlands, Land Use and Management
Source	CWS London

72. Bayly, I. (1971) Preliminary Field Report on Long Point Marsh for the Summer of 1970. Unpublished Report. 22pp

Category	General Wetlands, Land Use Management
Source	CWS London

73. Bayly, I. (1976) Preliminary Study of the Nutrient Regime of Marshland at the Big Creek National Wildlife Area. Unpublished report to the Canadian Wildlife Service. 70 pp.

Category	Water Quality/Limnology
Source	CWS London

74. Bayly, I. (1977) Preliminary Report for Long Point Crown Marsh. Unpublished report for Ontario Ministry of Natural Resources. 65 pp.

Category	General Wetlands, Land Use Management
Source	CWS London

75. Bayly, I. (1979). The Marshes of Long Point, Ontario IN: The Lake Erie Peninsulas: Management Issues and Directions (Nelson, J.G. and R.D. Weedham, eds.). Contact 11(1): 37-51.

Category	General Wetlands, Land Use and Management
Source	McMaster Libraries

76. Bayly, I. (1979) Report, Lake Erie and St. Lawrence marshes. Unpublished report; Dept. of Biology, Carleton University, Ottawa, Ontario. 139 pp.

Category	General Wetlands

Source	CWS London

77. Bayly, I. (1980) Land use history and management of Big Creek Marsh: Commentary. Contact 12(3): 13-15.

Category	Land Use and Management
Source	McMaster Libraries

78. Beamish, R.J. (1976). Acidification of lakes in Canada by acid precipitation and the resulting effects on fishes. Water, Air, Soil Pollution 6: 501-514.

Study Date	n.d., Review Paper
Location	• Sudbury (not LP specific)
Findings/Purpose	• Although different fish species show varying levels of acid tolerance, within their range of susceptibility, similar reactions are shown • Prior to extinction, females do not release their ova for fertilization • Found related to an inability to control their serum Ca levels • Not LP specific, however has implications for acid tolerance and susceptibility of fish in other locations
Category	Water Quality/Limnology, Fish
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

79. Beazley, K.F. (1993) Forested Areas of Long Point: Landscape History and Strategic Planning M.A. Thesis in Geography. Heritage Resources Centre. University of Waterloo, Waterloo, Ontario.

Category	Forests, Land Use and Management
Source	University of Waterloo Libraries

80. Beazley, K. and J.G. Nelson (1993) Forested Regions of Long Point – Landscape History and Strategic Planning. Long Point Environment Folio Publication Series (Nelson, J.G. and P.L. Lawrence, editors). (November 1993, 41pp) Heritage Resources Centre, University of Waterloo, Ontario.

Study Date	Historic (geologic time frame) through to modern forests
Location	• LP
Findings/Purpose	• Development of modern forests through various glacial periods and disturbances (climatic, invasive species, etc.) • Current issues are briefly discussed – lands planning, agriculture, modern settlement, lumbering and land clearing • A map of natural areas, study sites, and significant sites is in the text for the area
Category	Forests, Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

81. Beck, T.L., J.H. Ussher, J.H. Lever (1968) Waterfowl management units – Lake Erie district, 1967 (Long Point, Rondeau, Holiday Beach). Ontario Department of Lands and Forests.

Category	Waterfowl, Land Use and Management
Source	MNR Library

82. Beck, T.L (1973) Annual report Long Point Waterfowl Management Unit 1973. Ontario Ministry of Natural Resources.

Category	Waterfowl, Land Use and Management
Source	MNR Library

83. Bell, F.H. (1978) The Piping Plover in Canada: Status report. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 39 pp.

Study Date	1978
Location	• Canada, United States
Findings/Purpose	• Each province is considered separately in terms of the breeding

	status of Piping Plovers – historical overview • Population trends are discussed • General biology • Limiting factors to the success of piping plovers – indirect impact through human activity (cited as main cause for species decline) • 5 of 6 nests at Long Point are cited as having failed (1976,1977) • Recommendations for the preservation and restoration of the species are given
Category	Birds
Source	MNR Library - Peterborough

84. Bellerby, G., D.A. Kirk, and D.V. Weseloh (2000) Staging Little Gulls, *Larus minitus*, on the Niagara River, Ontario: 1987-1996. Canadian Field Naturalist 114(4): 584-590.

Study Date	--
Location	Niagara River, Ontario
Findings/Purpose	• LP referenced in introduction only, study does not encompass LP area.
Category	Birds
Source	McMaster University, Thode library periodicals

85. Berkes, F. and D. Pocock. (1981) Self-regulation of commercial fisheries of the Outer Long Point Bay, Lake Erie. Journal of Great Lakes Research 7(2): 111-116.

Study Date	Fall-winter 1979 (interviews), Spring 1980 (aerial surveys)
Location	• Port-Dover, Outer Long Point Bay
Findings/Purpose	• Investigation of how commercial fishermen self-regulate their practices, and develop potential management guidelines • Rainbow smelt is the primary species of interest, Yellow Perch is secondary • Self-regulation was between fishermen including non-crowding of gillnets, avoidance of gillnet-trawler conflicts, quotas, fish size minimums and gillnet mesh size – partially fishermen controlled, some dominantly industry controlled • A combination of self-regulation and industry regulation is needed • ‘Current’ (at time of publication) regulations need modification for sustaining existing community health, and fish populations
Category	Fish
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

86. Bernstein, N., R. Harris, K. McGowan, G. Miller, G. Moses and M. Schugar (1974) Thirty-eighth breeding bird census. Dune grass-cottonwood beach. American Birds 28:1023-1024.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

87. Berst, A.H. (1951) The Long Point Bay Sports Fishery – 1951.

Study Date	1948-1951
Location	• Long Point Bay
Findings/Purpose	• 1948 Angler-related deaths of fish during attemped catches of other species • 1950 – angling prohibited May-June (Inner Bay) • Reports from anglers that bass populations were being depleted • 1951 – Sport fishery closure: prevent heavy bass mortality, spawning protection • Creel Census 1951: investigated reports of decreasing population • Angling success decreased through season, but remained acceptable • Recommendations for management and research are given
Category	Fish

Source	MNR Library

88. Berst, A.H. (1953) Spawning of smallmouth bass in Long Point Bay, Lake Erie, 1953 Ontario Department of Lands and Forests, 1953

Category	Fish
Source	MNR Library

89. Berst, A.H. and H.R. McCrimmon. (1966) Comparative summer limnology of Inner Long Point Bay, Lake Erie, and its major tributary. J. Fish Res. Board 23: 275-291.

Study Date	May-September, 1962
Location	• Long Point Provincial Park, various within the bay • Transect and sample location map in text
Findings/Purpose	• First limnology study conducted in Inner Long Point Bay • ILPB drainage basin physiography and historical limnological information including bay depth, area, sediment characteristics, aquatic plant community, water temperature, various limnological characteristics (H^+, nitrite, nitrate, alkalinity, etc.) • Seasonal variations are discussed in respect to the above characteristics
Category	Water Quality/ Limnology
Source	McMaster University, Thode library periodicals

90. Big Creek Region Conservation Authority (1972) Long Point Conservation Report – a supplement to Big Creek Conservation Report, 1972. Ministry of the Environment, Conservation Authorities Branch

Category	Land Use and Management
Source	McMaster Libraries

91. Big Creek Marsh Management Committee. (1982) Conceptual management plan, Big Creek marsh complex. Unpublished report. 6 pp.

Category	Land Use and Management
Source	CWS London

92. Bigelow, H.B. (1907) On hybrids between the Mallards *Anas boschas* and certain other ducks. Auk 24(4): 382-388.

Category	Waterfowl
Source	McMaster Libraries

93. Bildfell, R. (1980) A small mammal survey of Long Point National Wildlife Area conducted during the summer of 1980. Unpublished report to Canadian Wildlife Service.

Category	Mammals
Source	CWS London

94. Biosphere Reserve Nomination – Long Point (1985) January. 8pp + 10 maps

Category	Land Use and Management
Source	McMaster Libraries

95. Birchall, A. (2004) The effect of food abundance during egg formation on clutch size, and on intra-annual clutch size trends in Tree Swallows *Tachycineta bicolor*. Honours B.Sc. thesis Mount Allison University.

Category	Birds
Source	BSC Library Mount Allison University

96. Bishop, C.A., D.V. Weseloh, N.M. Burgess, J. Struger, R.J. Norstrom, R. Turle, K.A. Logan (1992) Atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988). Volume I: Accounts by Species and Locations. Technical Report Series No. 152. Ontario Region. Canadian Wildlife Service

Study Date	1970-1988

Location	• Various throughout Great Lakes • LP Specific sampling location
Findings/Purpose	• Eggs collected from Long Point for examination • Records of species sampled, number of samples and compounds analyzed are noted • Tables of contaminant analysis are extensive in the rear of the study • Appear to be no significant contaminant occurrences at LP sample location
Category	Birds
Source	MNR Library - Peterborough McMaster University, Thode library periodicals

97. Bishop, C.A., D.V. Weseloh, N.M. Burgess, J. Struger, R.J. Norstrom, R. Turle, K.A. Logan (1992) Atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988). Volume II: Accounts by Chemical. Technical Report Series No. 152. Ontario Region. Canadian Wildlife Service

Study Date	1970-1988
Location	• Various throughout Great Lakes • LP Specific sampling location
Findings/Purpose	• Eggs collected from Long Point for examination • Information is organized by chemical contaminant rather than by location as in the previous volume. • Maps of sample locations included
Category	Birds
Source	MNR Library - Peterborough McMaster University, Thode library periodicals

98. Bishop, C.A., M.D. Koster, A. Chek, D.J.T. Hussell, and K. Jock (1995) Chlorinated hydrocarbons and mercury in sediments, Red-winged Blackbirds (*Agelaius phoeniceus*) and Tree Swallows (*Tachycineta bicolor*) from wetlands in the Great Lakes - St. Lawrence River Basin. Environmental Toxicology and Chemistry 14: 491-501.

Study Date	April-May 1991 (sample Collection)
Location	• 4 sampling locations along LP: LP Tip, Mud Creek, Big Creek Marsh, Port Rowan Sewage Lagoon • Map in text
Findings/Purpose	• Red-winged blackbird eggs, Tree Swallow chicks & eggs, and sediment samples were collected for chlorinated hydrocarbon and total mercury analysis • Biota had concentrations 1-2 orders of magnitude higher than sediment samples • Concentrations were high in Mud Creek samples • Similarities in contaminant concentrations within geographic areas indicates that these can be used as biomonitors for persistent chemicals • Tree swallow chicks appear to be the best indicators
Category	Birds, General Wetlands
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

99. Bishop, C.T. and T.M. Dick. (1980) Preliminary sand budget calculations for the reach from Port Burwell to Long Point Creek, Lake Erie. Unpublished report; NWRI Hydr. Div. Tech. Note 80-24. 3 pp.

Category	Hydrology and Sediments
Source	CWS London

100. Blasco, S.M. and L.D. Keyes. (1999) Lakebed disturbance features, Long Point area, eastern Lake Erie. International Association for Great Lakes Research: Great Lakes, Great Science, Great Cities. Programs and Abstracts. p. A-9.

Category	Hydrology and Sediments

Source	

101. Blaustein, A.R., L.K Belden, D.H. Olson, D.M. Green, T.L. Root, and J. M. Kiesecker. (2001) Amphibian breeding and climate change. Conservation Biology 15 (6): 1804-1809 December, 2001

Study Date	1980-1981, 1988-1998
Location	• Long Point
Findings/Purpose	• Investigates the influence of climate change on breeding initiation and population dynamics • Results indicate that climate change has not influenced the timing of breeding in North America • Fowler's Toad was examined at Long Point did not show a trend towards earlier breeding (although it was found at other sites for other species, but was not statistically significant) they instead showed a strong (but statistically insignificant) trend towards breeding later • Long-term data sets are required to better understand the impact of climate change and breeding activities of anurans
Category	Amphibians, Climate Change
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

102. Bloesch, J. (1982). Inshore-offshore sedimentation differences resulting from resuspension in the Eastern Basin of Lake Erie. Canadian Journal of Fish and Aquatic Sciences 39: 748-759.

Category	Hydrology and Sediments
Source	McMaster Libraries

103. Blokpoel, H. and G.B. McKeating (1978) Fish-eating birds nesting in Canadian Lake Erie and adjacent waters. Canadian Wildlife Service Program Note No. 87. 12 pp.

Category	Birds, Waterfowl
Source	Environment Canada Libraries – Gatineau, QC

104. Blokpoel, H. and G.D. Tessier (1996) Atlas of colonial water birds nesting on the Canadian Great Lakes: 1989-1991. Part 3. Cormorants, gulls and island-nesting terns on the lower Great Lakes system in 1990. Technical Report Series Number 225. Canadian Wildlife Service, Ontario Region.

Study Date	1990 breeding season
Location	• Various throughout Great Lakes • Long Point included
Findings/Purpose	• Observation of bird species, age, and mating status throughout study area for each survey square is provided • Specific location data (lat, long) data is found in Appendix 2 for all colonies observed, also includes colony name, I.D and distance from lake. • Maps of bird colonies indicating colony size and species are found in Appendix 5. • Common tern only species noted for LP
Category	Birds
Source	MNR Library - Peterborough McMaster University, Thode library periodicals

105. Boardman, R. (1992) Hooded Oriole at Long Point, Ontario. Birders Journal 1:228-229.

Category	Birds
Source	

106. Boegman, L., M.R. Loewen, P.F. Hamblin, and D.A. Culver (2001) Application of a two-dimensional hydrodynamic reservoir model to Lake Erie. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 858–869

Study Date	May-September, 1994

Location	• Lake Erie
Findings/Purpose	• An existing, public domain model was modified to test whether it could accurately predict season vertical and longitudinal changes in water levels in Lake Erie, and its thermal regime • Calibration and validation data from dates listed above • Accurately predicted water level fluctuations without adjustment • To accurately predict longitudinal currents, adjustments to the algorithm used were required • Thermal structure predictions were reasonably accurate • Importance? Nutrient loading – plankton, invasive species (zebra mussels)
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

107. Bolton, R.J., Brooks, R.J. (2005) Nest-site selection and embryo hatch success in Eastern Spiny Softshells at Long Point National Wildlife Area (Interim Report – Year 1). 12 pp.

Category	Amphibians
Source	

108. Bolton, R.J., Brooks, R.J. (2005) Nest-site selection and nesting behaviour in Eastern Spiny Softshells at Long Point National Wildlife Area. Report to Wildlife Preservation Trust. 15 pp

Category	Amphibians
Source	

109. Bolton, R.M. and Brooks, R.J. (2006) Nest-site Selection and Embryo Hatch Success in Spiny Softshells at Long Point National Wildlife Area and Rondeau Provincial Park. Final Report for the Endangered Species Recovery Fund of the World Wildlife Fund Canada. 29 pp.

Category	Amphibians
Source	

110. Bolton, R.M. (2007) Effects of Anthropogenic Disturbance, Nest-site Selection, and Dipteran Infestation on Spiny Softshells (*Apalone spinifera*). M.Sc. Thesis, University of Guelph, Guelph, Ontario. 93 pp.

Category	Amphibians, Human Impacts
Source	

111. Bookhout, T.A., K.E. Bednarik and R.W. Kroll. (1989) The Great Lakes Marshes in Habitat Management for Migrating and Wintering Waterfowl in North America. Texas Tech University Press, Lubbock, Texas.

Category	General Wetlands, Land Use and Management, Waterfowl
Source	

112. Borgmann, U., W.P. Norwood, T.B. Reynoldson and F. Rosa (2001) Identifying cause in sediment assessments: bioavailability and the Sediment Quality Triad. *Canadian Journal of Fisheries and Aquatic Sciences,* 58: 950–960.

Study Date	1996-1998
Location	• Sudbury area lakes
Findings/Purpose	• Long Point used as a 'clean sediment' control • Study examines the bioavailability of various metals in solid and dissolved phases to benthic invertebrates • Solid phase metals did not bioaccummulate in the same manner as dissolved metals – which were more readily available • Decreased abundances of some benthic invertebrates were noted in relation to increased metal concentrations
Category	Water Quality/Limnology, Hydrology and Sediments

Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

113. Boughner, L.J. (1898) Notes on the flora of Long Point Island, Lake Erie, Province of Ontario, Canada. Canadian Field Naturalists 12: 105.

Category	Terrestrial Vegetation
Source	McMaster Libraries

114. Bowen, J.B. (2004) Incidence of artifact ingestion in Mute Swans, *Cygnus olor*, and Tundra Swans, *Cygnus columbianus*, on the lower Great Lakes. B.Sc. Honours Thesis. University of Western Ontario. London, Ontario.

Category	Waterfowl, Human Impacts
Source	Western University Libraries

115. Bowen, J.E., and S.A. Petrie (2007) Incidence of artefact ingestion in Mute Swans and Tundra Swans on the lower Great Lakes. Ardea: In Press

Category	Waterfowl, Human Impacts
Source	Not Currenty Available

116. Bowles, J. (1993) Is Long Point Recovering from Deer Pressure? Long Point Bird Observatory Newsletter 25(3): 5.

Category	Mammals
Source	BSC Library

117. Boyce, F.M., F. Chiocchio, B. Eid, F. Penicka and F. Rosa. (1980) Hypolimnion flow between the Eastern basins of Lake Eerie during 1977 (Interbasin hypolimnion flows). *Journal of Great Lakes Research,* 6(4): 290-306

Study Date	1977
Location	• Lake Erie, Central and Eastern Basins • Sample location maps in text • Extensive sampling in vicinity of Long Point
Findings/Purpose	• Pennsylvania ridge divides the central basin (shallow) from the eastern basin (deep), extending from Long Point to Pennsylvania • Both basins are stratified in summer • Hypolimnion, central basin becomes O_2 depleted • Flow between this and the mid thermocline waters of the eastern basin – important source of O_2 • Strong correlation found between wind and mean flux of water • Effects of this water transport are restricted to the eastern half of the central basin
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

118. Bradstreet, M.S.W. (1969) Consecutive nesting of female Tree Swallows at Long Point, Ontario. Ontario Bird Banding 5:68-71.

Study Date	1965-1967 breeding seasons (smaller degree of research in 1964)
Location	• LP
Findings/Purpose	• Investigate the occurrence and behaviour of consecutive nesting in areas by female Tree Swallows • Nesting females were captured and identified for the study years • 1 female nested for 4 consecutive years, 1 for 3 consecutive years, and 6 for 2 consecutive years • Only certain females returned and this is considered as relating to their success in the previous year at the site in question (where success is measured as their ability to raise 1+ young to free-flight stage) – based on study data, this appears to be a good theory
Category	Birds
Source	BSC Library

	CWS London

119. Bradstreet, MSW. (1969). Summer report. Long Point Bird Observatory Newsletter. 1(2): 4-6

Category	Birds
Source	CWS London

120. Bradstreet, M.S.W. and G.W. Page (1969) Thirty-third breeding-bird census. Sand dunes with cottonwoods. Audubon Field Notes 23:739.

Findings/Purpose	See: Loery, T. (1969)
Category	Birds
Source	McMaster University

121. Bradstreet, M.S.W and G.L Holroyd (1971) Long Point Bird Observatory, ten year report: 1960-69. Long Point Bird Observatory. Port Rowan, Ontario. 66pp

Category	Birds
Source	CWS London

122. Bradstreet, M.S.W. (1972) A method for ageing and sexing Tree Swallows. EBBA news.

Category	Birds
Source	

123. Bradstreet, M.S.W. (1977) The Biological Environment of Long Point, Lake Erie. Unpublished Report. The Nature Conservancy of Canada. 159 pp.

Category	Terrestrial Geography
Source	CWS London

124. Bradstreet, M.S.W., G.W. Page and W.G. Johnston (1977) Shorebirds at Long Point, Lake Erie, 1966-1971: Seasonal occurrence, habitat preference, and variation in abundance. Canadian Field Naturalist 91: 225-236.

Study Date	1966-1971
Location	• Long Point – interface between beach and lake, shallow pools edges on the beach • easternmost 8 km of S-beach – 1966-67 • easternmost 20 km of S-beach – 1968-1971 • Location map in paper
Findings/Purpose	• Differential age migration • Influence of habitat quality in maintaining shorebird pop. at migration staging areas • Immature/adult differentiation • Feeding habitat preferences • Sighting counts by species and month
Category	Birds
Source	McMaster University, Thode library periodicals

125. Bradstreet, M.S.W., G.W. Page and W.G. Johnston (1977) Shorebird occurrence and habitat use at Long Point IN: Long Point Bird Observatory 1975 Annual Report (J.M. Speirs ed.).

Category	Birds
Source	CWS London

126. Bradstreet, M.S.W, G.L Holroyd and J.D. McCracken (1981) Breeding birds of long point, Lake Erie: A study in community succession. Booklet. Canadian Wildlife Service.

Category	Birds
Source	McMaster Libraries

127. Bradstreet, M.S.W., J.M. Bowles (1995) Monitoring Vegetation and Breeding Bird Communities After a Reduction in Deer Browsing at Long Point, Lake Erie: 1995. Unpublished report for the Canadian Wildlife Service, Ontario Region.

Study Date	1991-1995
Location	• Long Point
Findings/Purpose	• Summary of changes found in shrub stem counts and ground vegetation in 15 breeding bird census plots examining effects of reduced deer browsing • Shrub stem counts increased in most plots • Tree seedling counts also increased for several species 1992-1994, seedling counts were down in 1995, however browsing was not an apparent cause of mortality • Browsing of Sassafras was increasing 1993-1994, but following a deer cull, appear to be recovering in 1995 • A consistent increase in total vegetation cover in all successional stages was noted
Category	Terrestrial Vegetation, Mammals, Birds
Source	BSC Library

128. Bradstreet, M.S.W., J.M. Bowles (1996) Monitoring Vegetation and Breeding Bird Communities After a Reduction in Deer Browsing at Long Point, Lake Erie: 1996. Unpublished report for the Canadian Wildlife Service, Ontario Region.

Study Date	1991-1996
Location	• Long Point
Findings/Purpose	• 6th year of study investigating changes found in shrub stem counts and ground vegetation in 15 breeding bird census plots on Long Point • Shrub stem counts increased in most plots although some quadrats were affected by high water levels in 1996 causing declines • Tree seedling counts continue to be slow • Overall total vegetation ground cover except in early successional plots (those affected by high water levels) was noted
Category	Terrestrial Vegetation, Mammals, Birds
Source	BSC Library

129. Bradstreet, M.S.W., J.M. Bowles (1999) Monitoring Vegetation and Breeding Bird Communities After a Reduction in Deer Browsing at Long Point, Lake Erie: 1999. Unpublished report for the Canadian Wildlife Service, Ontario Region.

Study Date	1991-1999
Location	• Long Point
Findings/Purpose	• 8th year of study - Summary of changes found in shrub stem counts and ground vegetation in 15 breeding bird census plots examining effects of reduced deer browsing • Shrub stem numbers continue to increase • Tree species recruits are dominantly small (<0.5m) • Tree seedling counts fluctuate by year, but those over 0.5m has increased since 1996 • Increased vegetation cover is noted at the late successional plots, a slight increase at many moderate successional plots is also present, however no trend of increasing vegetation exists at the early successional plots – they fluctuate with water level
Category	Terrestrial Vegetation, Mammals, Birds
Source	BSC Library

130. Bradstreet, M.S.W. and J.M. Bowles. (2002) Monitoring Vegetation After a Reduction in Deer Browsing at Long Point, Lake Erie: 2002 Unpublished Bird Studies Canada report For Canadian Wildlife Service, Ontario Region. Bird Studies Canada 15p.

Study Date	1991-2002
Location	• Long Point
Findings/Purpose	• 12th year of study - Summary of changes found in shrub stem counts and ground vegetation in 15 breeding bird census plots examining effects of reduced deer browsing • Shrub and tree stem numbers have generally increased since study

	began however 2002 saw a reduction in counts – possibly due to drought conditions • Tree seedling counts fluctuate by year, but have generally increased • Increased vegetation cover is noted at the late successional plots (1991-2001), with a decrease in 2002, a slight increase at many moderate successional plots is also present, however no trend of increasing vegetation exists at the early successional plots – they fluctuate with water level
Category	Terrestrial Vegetation, Mammals
Source	BSC Library

131. Bradstreet, M.S.W. and J.M. Bowles. (2003) Monitoring Vegetation After a Reduction in Deer Browsing at Long Point, Lake Erie: 2003 Unpublished Bird Studies Canada report For Canadian Wildlife Service, Ontario Region. Bird Studies Canada 58p.

Study Date	1991-2003
Location	• Long Point
Findings/Purpose	• 13th year of study - Summary of changes found in shrub stem counts and ground vegetation in 15 breeding bird census plots examining effects of reduced deer browsing • Shrub and tree stem numbers have generally increased since study began however have fluctuated since 1997 • Shrubs in middle successional plots have shown the most consistent increase • Tree species recruits in the two largest size classes have continued to increase over the study period • Ground cover has decreased since 2001 – probably resulting from continuing drought conditions
Category	Terrestrial Vegetation, Mammals
Source	BSC Library

132. Brenner, D.M. (1993) A Comparison of Total Counts Versus a Sampling Method for Estimating Tree Cover at Long Point, Lake Erie. Unpublished report for the Canadian Wildlife Service, Ontario Region. 6 pp.

Category	Forests
Source	

133. Brenner, D.M. (1994) Breeding bird census #52: white pine-white cedar savannah. Journal of Field Ornithology 65 (Supplement): 72-73.

Category	Birds
Source	McMaster University, Thode library periodicals Available free online from publisher

134. Brenner, D.M. (1994). Breeding bird census #96: sedge-tamarack dune pond. Journal of Field Ornithology 65 (Supplement):103.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

135. Bridge, D and M. Bridge (1965) Twenty-ninth Breeding Bird Census. *Audubon Field Notes* 19: 583-630

Study Date	1965
Location	• Various. Those of interest listed below. • 1 mi from tip of LP, 42°33' N, 80°04' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Sand dunes with cottonwoods, • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds

Source	McMaster University, Thode library periodicals

136. Bridger, K.C. (1980) Rehabilitation of the Long Point ecosystem: Initiating a process: Commentary. Contact 12(3): 150-154.

Category	Land Use and Management
Source	McMaster Libraries

137. Brooks, R.J. and E. Nol (1978) The Piping Plover (*Charadrius melodus*) and the Killdeer (*Charadrius vociferus*) on Long Point, Ontario. Unpublished report to Canadian Wildlife Service. 37 pp.

Category	Birds
Source	Environment Canada Libraries – Gatineau, QC

138. Brooks, R.J. and E. Nol (1980) Factors affecting nesting success of shore-birds on Long Point, Ontario. Unpublished report to Canadian Wildlife Service. 36 pp.

Category	Birds
Source	CWS London

139. Brooks, R.J. and R.M. Bolton (2005) Nest Site Selection and Embroyo Hatching Success in Spiny Softshells *(Apalone spinifera)* Ontario, Canada (Interim report – Year 1). World Wildlife Fund, Environment Canada, Ontario ministry of Natural Resources, Wildlife Preservation Canada.

Study Date	2005
Location	• Long Point, Rondeau Provincial Park, Lake Champlain, Thames River
Findings/Purpose	• Examine the impact of human disturbance on nesting success and predation by flesh fly and flesh fly larvae on nesting success and embryo hatch success of Spiny softshell turtles • Spiny Softshells are highly particular about nesting areas which results in a high degree of disturbance from human activities • Depredation by flesh fly larvae is also a significant threat to Spiny Softshell populations – more than 50% of eggs monitored failed to hatch because of flesh fly larvae depredation, egg infertility or late-term mortality
Category	Reptiles
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

140. Bruce, J.P., R.M. Lewis, A.H. Richardson (1958) Big Creek Region Conservation Report, 1858 – Water. Ontario, conservation branch.

Category	Land Use and Management
Source	McMaster Libraries

141. Brulfert, G.; Galvez, O.; Yang, F., and J.J. Sloan (2007) A regional modelling study of the high ozone episode of June 2001 in southern Ontario. Atmospheric Environment 41 (18): 3777-3788 JUN 2007.

Category	Weather and Air Quality
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

142. Bryant, J.E. (1965) Great Lakes water levels and migratory waterfowl, Ontario. Unpublished report to Canadian Wildlife Service and Dept. of Northern Affairs and National Resources (IJC on Great Lakes levels), Windsor, Ontario. 7 pp.

Study Date	1962-1964
Location	• Southern Ontario – lake St. Clair and lake Erie shorelines
Findings/Purpose	• Determining location, ownership, and management of private marshes in Southern Ontario that were deemed important to waterfowl • 37 private marshes found with 85% of marsh acreage in study area

	privately owned • 54% is owned by Canadians, but only 14% of it is primarily operated by Canadians (being leased to US citizens) • Hunting intensity was light • Study suggests that privately owned marshes provide a significant contribution to marsh protection and conservation in the area
Category	Water Levels, Waterfowl
Source	MNR Library

143. Bryant, J.E. (1965) Private marshes in south-western Ontario. Unpublished report; Canadian Wildlife Service. 65 pp.

Category	General Wetlands
Source	CWS London

144. Bunting M.J., H.C. Duthie, D.R. Campbell, B.G. Warner and L.T. Turner (1997) A paleoecological record of recent environmental change at Big Creek Marsh, Long Point, Lake Erie. Journal of Great Lakes Research 23 (1997), pp. 349–368.

Study Date	June 6, 1994; February 9, 1995
Location	• Big Creek Marsh • Sample Locations: 42°35'76''N, 80°27'60''W; 42°34'N, 80°28'W • Site map in text
Findings/Purpose	• Reconstruct the development history of Big Creek Marsh over last few centuries and investigate the role of anthropogenic impacts on the area using two cores taken from the Big Creek Marsh area • Various indicators suggest that Big Creek Marsh has existed for < a millennium – findings in agreement with development history of LP spit • Possible evidence of cyclic water level fluctuations • Initial settlement activities showed little impact on marsh development, however more recent construction and human use shows a marked effect on the Big Creek Marsh system
Category	Climate Change
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

145. Burke, P.S. (1992) Breeding bird census #79, red oak-white pine savannah. Journal of Field Ornithology 63 (Supplement): 83-84.

Study Date	1991
Location	• Long Point National Wildlife Area • 42°34'N, 80°08'W
Findings/Purpose	• Vegetation information at observation plot – trees, shrubs and other major vegetation cover (relative cover, dominance, etc.) • Topography and elevation • Weather • Detailed list of bird species within the plot (residents and 'visitors')
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

146. Burke, P. (1993) Violet-green Swallow: new to Ontario. Ontario Birds 11:6-10.

Category	Birds
Source	BSC Library

147. Burns, N.M. and C. Ross (1972) Project Hypo: An intensive study of the Lake Erie central basin hypolimnion and related surface water phenomena. CCIW, Paper No. 6; USEPA Tech. Rep. TS-05-71-208-24.

Study Date	June-August, 1970 – some studies contained within the paper have data collected from outside of this timeframe
Location	• Lake Erie central basin

Findings/Purpose	• The central basin was extensively researched in order to increase our understanding of hypolimnaic and other surface water processes • This document consists of a number of different studies covering topics which include: oxygen depletion, physical water processes, diffusions characteristics, and nutrient regeneration • This work focuses on the central basin, and so has little impact on the LPB area
Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals

148. Burns, N.M. et al (1976) Processes within Lake Erie. *Journal of the Fisheries Research Board of Canada* 33(3): 622-638.

Category	Water Quality/Limnology, Hydrology and Sediments
Source	McMaster Libraries

149. Bush, C.E. (1958) Big Creek Region conservation report: water. Ontario Department of Planning and Development, Conservation Branch. 71pp.

Category	Land Use and Management
Source	CWS London

150. Byrne, M.L (1986) Morphology and sedimentology of vegetated Canadian coastal sand dunes. M.Sc. Thesis. McMaster University. 232 pp

Study Date	June-August , 1985
Location	• Pinery Provincial Park and Prince Edward Island
Findings/Purpose	• Some elements may be applicable to similar coastal structures, but does not include direct study of the LPB area • Study seeks to link sedimentary structures to dune morphology • Structure formation, vegetation characteristics, stability and collapse are considered
Category	Terrestrial Plants, Terrestrial Geography
Source	McMaster University, Thode library periodicals

151. Cadman, M.D., P.F.J. Eagles and F.M. Helleiner (eds.) (1987) Atlas of the Breeding Birds of Ontario. University of Waterloo Press, Waterloo, Ontario. 617 pp.

Category	Birds
Source	McMaster Libraries

152. Caldwell, S.S.A. and A.M. Mills (2006) Comparative spring migration arrival dates in the two morphs of White-throated Sparrow. *The Wilson Journal of Ornithology* 118(3): 326-332.

Study Date	1985-1986, 1991-1994
Location	• Long Point Bird Observatory • 42°35'N, 80°15'W
Findings/Purpose	• Investigating dimorphism in plumage (white-striped vs. tan-striped) as it affects migration patterns and timing • White-striped sparrows migrated ~ 2 days before tan-striped – when only birds sexed were considered, they appeared to migrate ~4 days earlier • White-striped females appear to migrate earlier than tan-striped females, but no statistical difference in when males migrated • White-striped bird wings were ~2% longer than tan-striped in both sexes
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

153. Campbell, C.A. (1975) Reproduction and ecology of turtles and other reptiles and amphibians of Lakes Erie and St. Clair in relation to toxic chemicals. Unpublished report to Canadian Wildlife Service.

Category	Reptiles, Amphibians
Source	Environment Canada Libraries – Gatineau, QC

154. Campbell, C.A. (1977) Range, requirements and status of the Eastern Spiny Softshell (*Trionyx spiniferus spiniferus*) in Canada. Unpublished report to Canadian Wildlife Service. 43 pp.

Category	Reptiles
Source	CWS London

155. Campbell, C.A. (1978) Reproduction and ecology of turtles and other reptiles and amphibians of Lakes Erie and St. Clair in relation to toxic chemicals Part II: Results, discussion and conclusion. Unpublished report to Canadian Wildlife Service.

Category	Reptiles, Amphibians
Source	CWS London

156. Campbell, C.A. (1979) Preliminary Herpetological Survey and Evaluation of Proposed Habitat Alterations at Big Creek National Wildlife Area, Port Rowan, Ontario. Unpublished report to the Canadian Wildlife Service.

Category	Reptiles, Amphibians
Source	CWS London

157. Campbell, C.A. and G.R. Donaldson (1980) A status report of the Eastern Spiny Softshell Turtle (*Trionyx spiniferus spiniferus*) in Canada. Edited and Revised in 1985 by M.E. Obbard, unpublished report to the Ontario Ministry of Natural Resources. 50pp

Category	Reptiles
Source	

158. Cambell, L.M., A.T. Fisk, X. Wang, G. Köck, D.C. G Muir (2005) Evidence for biomagnification of rubidium in freshwater and marine food webs. Canadian Journal of Fisheries and Aquatic Sciences. Ottawa: May 2005. Vol. 62, Iss. 5; pg. 1161, 7 pgs

Study Date	2002
Location	• Long Point Bay, 42°47'N, 80°11'W • Lake Hazen (81°40'N,73°0'W), Resolute Lake (74°43'N, 94°58'W)
Findings/Purpose	• A subset of fish was taken from LPB to compare alkali Rb analogues (Cs, K) to Rb concentrations in bird, mammal and fish species from Resolute Lake • Found that Rb biomagnifies in diverse ecosystems, and should be considered in multi-element biomagnification studies
Category	Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

159. Canadian Biosphere Reserves Association (2004) Long Point Biosphere Reserve. Viewed August 31, 2007. Online: http://www.biosphere-canada.ca/reserves/long_point/default.asp

Study Date	n.d. (various)
Location	• Long Point Biosphere Reserve (LPBR)
Findings/Purpose	• Website provides access to updated information about the reserve including periodic articles about projects and research • Reports are available through links on the website • A link to the LP portfolio is present, but not yet active
Category	Land Use and Management
Source	Online resource (see link in bibliographic information)

160. Canadian Biosphere Reserves Association (2000) Long Point Biosphere Reserve: Periodic Review Report, 2000. 77pp.

Study Date	November 24-25, 2000 (site visit specific to this report) Literature review with data from various other time-periods
Location	• Long Point Biosphere Reserve (LPBR)

Findings/Purpose	• Three sections – 1) major findings and conclusions of the reviewers, 2) account of activities related to the reserve since its creation, 3) Periodic Review Form • Background justification (split into specific criteria with description for LP application/occurrence) and history of the development of the LPBR • Reviewers Conclusion: LPBR should continue to maintain membership in the world network
Category	Land Use and Management
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

161. Canadian Man and Biosphere (MAB) Committee (1990) Biosphere Reserves in Canada. MAB Secretariat, Canadian Commission for UNESCO, Ottawa, Ontario.

Category	Land Use and Management
Source	

162. Canadian Wildlife Service. (1983) Long Point National Wildlife Area Management Plan. Environment Canada, Ottawa, Ontario.

Category	Land Use and Management, Mammals
Source	

163. Canadian Wildlife Service (1989) A Bibliography for Long Point, Lake Erie, Ontario. Conservation and Protection Branch, Environment Canada, London, Ontario.

Study Date	Up to 1989
Location	• Long Point area
Findings/Purpose	• Resources from this bibliography are included in this larger bibliography • Very short (one line) descriptions of each resource is given – historical, useful, peripheral information, etc. • Location of resource provided where available
Category	--
Source	BSC (MMP hardcopy)

164. Canadian Wildlife Service (1992) Atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes Volumes I, II.

Category	Birds
Source	McMaster Libraries

165. Carrick, H. (2004) Algal Distribution Patterns in Lake Erie: Implications for Oxygen Balances in the Eastern Basin. J. Great Lakes Res. 30(1):133–147

Study Date	October 1997-August 1998
Location	• 5 stations in Eastern Lake Erie Basin (sites in other basins as well – cords not included here) • None in LPB proper • 42°49'99''N, 78°55'35''W; 42°45'11''N, 79°09'43''W; 42°38'02''N, 79°29'77''W; 42°35'81''N, 79°36'17'W; 42°31'08''N, 79°69'64''W
Findings/Purpose	• Reduction in phosphorous loading and the invasion of *Dreissenid mussels* may have a significant impact on primary producers, potentially affecting the oxygen balance of the system • Phytoplankton biomass was greater in deep waters (15-40m depth) compared to surface phytoplankton • All sediment samples collected in the Eastern Basin, however species composition indicates they likely settled out of water column • Rate of hypolimnetic oxygen depletion in E-basin has not changed – suggesting physical factor involvement in mediating process
Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

166. Cartar, R, E. Dick, J. McCracken, G. Miller and P. Roy (1975) Thirty-ninth breeding bird census. Red oak-sugar maple forest. American Birds 29:1094.

Findings/Purpose	See: Van Velzen, W.T. (1975)
Category	Birds
Source	McMaster University

167. Cartar, R. (1976) The status of the Piping Plover at Long Point, Ontario: 1966-1975. Ontario Field Biol. 30: 42-45.

Study Date	1966-1975
Location	• Long Point Spit
Findings/Purpose	• Number of nests found per year (0-4), known nestings (0-5) and estimated minimum pairs (0-4) are listed by year of observation • Estimated rates of breeding success are provided including the number of downy young and juveniles • Nest numbers decreased 1966-1973 than in a previous 6-year period • Nesting appears to have increased from 1972 as human access was reduced • Increased predation by gulls appears to have a major impact on breeding success
Category	Birds
Source	MNR Library – Peterborough

168. Carty, S. (1997). Leading Edge '97: the edge & the point : Niagara Escarpment & Long Point world biosphere reserves. Proceedings of the Leading Edge Conference October 16th-18th, 1997, Holiday Inn, Burlington, Ontario, Canada. Niagara Escarpment Commission. 391 p.

Category	Land Use and Management
Source	

169. Cassone, B. (2002) Moult intensity and chronology of Lesser Scaup during spring and fall migration on the Lower Great Lakes. B.Sc. Honours Thesis. University of Western Ontario. London, Ontario.

Category	Waterfowl
Source	

170. Catling, P.M. (1976) *Spiranthes magnicamporus Sheviak*, an addition to the orchids of Canada. Canadian Field Naturalist 90: 467-470.

Study Date	
Location	• Various – includes Long Point
Findings/Purpose	• Preference to calcareous sandy meadows, and sand spits (LP) – refers to area as a 'littoral meadow' • Species associations • Nature of littoral meadows of drought-inundation patterns influences abundance and stability of plant community
Category	Terrestrial Vegetation
Source	McMaster University, Thode library periodicals

171. Catling, P.M. and A.A. Reznicek. (n.d.) Long-Point – the flora. Unpublished 10pp.

Category	Terrestrial Vegetation
Source	

172. Catling, P.M. and Z.S. Porebski (1995) The spread and current distribution of European Frogbit, *Hydrocharis morsus-ranae* L., in North America. Canadian Field Naturalist 109(2): 236-241.

Study Date	1942-present (uses existing data, and other study findings, no field work)
Location	• Great Lakes Basin
Findings/Purpose	• Contour map of spread of this invasive species from 1942-1995 in 10-12 year intervals • Dot map of 'current' (1994) occurrence – includes LP location

	• Early establishment/introduction, recent changes, rate of spread, extrapolation to future distribution • Rate of spread varies by area, related to nutrient conditions, landscape connectivity • Common plant associations given • Prefers mesotrophic wetland conditions
Category	Invasive Species, Aquatic Vegetation
Source	McMaster University, Thode library periodicals

173. Catling, P.M. (1997) The decline and current status of the dune race of Dwarf Cherry, *Prunus pumila*, var. pumila, on the Canadian shores of the lower Great Lakes. Canadian Field Naturalist 111(2): 187-193.

Study Date	1994
Location	• Great Lakes shores (Cdn) including LP • LP locations (Table 1 in text) - Base: 44°34'00'' N 80°09'00'' W, Mid: 42°33'00" N 80°06'00'' W, Tip: 42°33'00" N 80°03'00'' W (Note: locations are from various studies cited in this work)
Findings/Purpose	• Occurrence has declined along the Canadian Great Lakes shores • High occurrence at Long Point 1800-1978 • Present, but rare on outer portions of LP & Gravelly Bay area – 1960s • None found in 1994 survey at LP • Causes for decline are discussed (incl. Deer grazing, nutrient loading, changes in depositional rates), water levels
Category	Terrestrial Vegetation
Source	McMaster University, Thode library periodicals

174. Catling, P.M. (2001) Decline of gomphus Fraternus Fraternus (Odonata: Gomphidae) in Lake Erie. Great Lakes Entomologist 34(1): 1-7.

Study Date	1999-2000 (peak and late flight periods)
Location	• Lake Erie Shoreline – Including LPB
Findings/Purpose	• *G. fraternus* was abundant prior to 1960 • No reports of occurrence post 1960 • Study did not find any occurrences of *G. fraternus* • Conclusion that species has experienced a substantial decline and may be extirpated from the lake • Decline likely 1950-1960 and related to oxygen-depletion, species introduction and development pressures
Category	Insects
Source	Library of Canada

175. Chamberlain, D. (1976) The Acute and subacute effects of underwater rock blasting, dredging and other construction activity on the fishes in the Nanticoke Region of Long Point Bay, Lake Erie. Report No. 1, Construction Phase 1. march-November 1975. Ministry of Natural Resources.

Study Date	1975
Location	• Nanticoke
Findings/Purpose	• Objectively evaluate the immediate damage to the fisheries resource • Produce data with which allowing prediction of the impact of this type of development • Blasting caused varying degrees of damage including hemorraging, ruptured swim bladders and other organs, tissue rupture and various other internal injuries • Type of blast and species influenced the severity of the damage • The first blast has the highest mortality rate – likely removing the local populations • Dredging increased turbidity, which in some cases changed feeding habits and reduced growth rates
Category	Fish, Hydrology and Sediments
Source	BSC Library

	Waterloo Heritage Resource Centre

176. Chamberlain, D. (1979) Status report on Kirtland's Warbler (*Dendroica kirtlandii*) in Canada, 1978. Committee on the Status of Endangered Wildlife in Canada. 18 pp.

Study Date	1978
Location	• Canada (various – 1 LP sighting)
Findings/Purpose	• Assigned endangered status in Canada, 1979 • Considered one of the world's most critically endangered birds • Individuals have been found in few locations in Canada (Petawawa, Quebec) but the potential for a breeding population is low • Species has undergone continual decline and faces likely extirpation • Habitat loss, cowbird parasitism and other unidentified factors are influencing populations • Long Point Sighting: 42°36'N, 80°24'W (1941)
Category	Birds
Source	MNR Library

177. Champagne, A. (1981) Proceedings of the Ontario Wetlands Conference.

Category	General Wetlands
Source	McMaster Libraries

178. Chanasyk, V (1972) The Haldimand-Norfolk Environmental Appraisal 1970. Volume 1 - Inventory and Analysis. Ministry of Treasury, Economics and Intergovernmental Affairs, Toronto, Ontario.

Category	Land Use and Management
Source	McMaster Libraries

179. Chanasyk, V (1972) The Haldimand-Norfolk Environmental Appraisal 1970. Volume 2 - Synthesis and recommendations. Ministry of Treasury, Economics and Intergovernmental Affairs, Toronto, Ontario.

Category	Land Use and Management
Source	McMaster Libraries

180. Chandler, R.E. and D.G. Dennis (1968) Proposed National Wildlife Areas, Ontario: A preliminary description of potential acquisition areas in Ontario. Unpublished report to the Canadian Wildlife Service.

Category	Land Use and Management
Source	CWS London

181. Chandler, R.E. and D.G. Dennis (1972). A proposal for the acquisition of the Hahn Marsh, near Long Point, Ontario, as part of the Big Creek National Wildlife Area. Unpublished report; Canadian Wildlife Service. 18 pp.

Category	Land Use and Management
Source	CWS London

182. Chapman, L.J. and D.F. Putnam (1973) The Physiography of Southern Ontario. 2nd edition. University of Toronto Press for the Ontario Research Foundation. Toronto, Ontario. 386pp + maps.

Category	Terrestrial Geography
Source	CWS London

183. Cheskey, T. (1981) A study of programmes of government agencies in the Long Point Bay area from the perspective of ecosystem rehabilitation. Unpublished report. University of Waterloo, Environmental Studies, 80pp.

Category	Land Use and Management, Human Impacts
Source	

184. Cheskey, T. (1994) Conservation of Significant Birds of the Long Point Area: Description, Issues and Direction. Long Point Environmental Folio Publication Series - Technical Paper 6. Heritage Resources Centre, University of Waterloo. 84 pp.

Study Date	Review
Location	• Long Point
Findings/Purpose	• Provide an overview of the importance of landbirds within our environment • The role of the LPBO is considered in terms of conservation and protection • A list of birds found in LP Biosphere Reserve and adjacent areas is given – with notes on abundant or important species • Significance of the LP area in migratory bird staging, as habitat and the quality of habitat are discussed • Threats to vulnerable species are considered and detailed • Reccommendations at the landscape and site level • Institutional and policy and research suggestions are also made
Category	Birds
Source	BSC Library

185. Cheskey, T (1996) Birds of the Long Point Area: Chapter 8. Long Point Environmental Folio Publication Series. Heritage Resources Centre, University of Waterloo, Waterloo, ON. 16 pp

Study Date	n.d.
Location	• LP
Findings/Purpose	• LPBO is discussed – migration monitoring • Characteristics of LP that make it an important staging area and bird habitat are discussed • Species lists of endangered and extirpated birds, important breeding birds are given • Habitat locations for rare and important habitat types are shown on maps in text • Threats to bird populations and habitat concerns are discussed briefly
Category	Birds
Source	BSC Library Waterloo Heritage Resource Centre

186. Chu, C., N.C. Collins, N.P. Lester and B.J. Shuter. (2006) Population dynamics of Smallmouth Bass in response to habitat supply. *Ecological Modelling* 195(2006): 349-362.

Study Date	n.d. (studies for basis of validation from 1989 – published date)
Location	• Inner-Outer LPB • Lake Opeongo
Findings/Purpose	• Model developed to linking habitat to population dynamics of smallmouth bass with density-dependent effects on habitat use, growth and survival • Sub-models were divided into nesting and juvenile/adult with differing habitat variables and different sensitivity levels to each variable • Model validated with data from Inner and Outer LPB and Lake Opeongo (Algonquin Park) • Sensitivity analyses indicated that management practices should focus on parameters that influence Young of Year (YOY) survival as the model showed this to have the most prominent impact on population dynamics • Results suggest use of model in smallmouth bass management as favourable
Category	Fish
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

187.Claxton, W.T., A. Martel, R.M. Dermott, and E.G. Boulding. (1997) Discrimination of field-collected juveniles of two introduced dreissenids (Dreissena polymorhpa and Dreissena bugensis) using mitochondrial DNA and shell morphology. *Canadian Journal of Fisheries and Aquatic Sciences*54: 1280-1288.

Study Date	September, October - 1994
Location	• Long Point Bay, offshore of Port Dover • Nanticoke, offshore of Port Colborne • Western Basin • Near Ottawa
Findings/Purpose	• Study develops molecular markers to distinguish *Dreissena polymorpha* and *bugensis* • Once established, molecular marker identification was tested on post-metamorphic and juvenile stages of the species • Specific differences between two species are listed • Juveniles of 300-700μm shell length can be identified using shell overlap characteristics on their own
Category	Macro-Invertebrates, Invasive Species
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

188.Claxton, W.T., et al. (1997) A genetic and morphological comparison of shallow- and deep-water populations of the introduced dreissenid bivalve *Dreissena bugensis*. *Canadian Journal of Zoology – Revue Canadienne du Zoologie. 76(7)*: 1269-1276

Category	Macro-Invertebrates, Invasive Species
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

189.Claxton, W.T. and E.G. Boulding (1998) A new molecular technique for identifying field collections of zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*) veliger larvae applied to eastern Lake Erie, Lake Ontario, and Lake Simcoe. Can. J. Zool., 76:194-198 (1998).

Category	Macro-Invertebrates, Invasice Species
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

190.Claxton, W.T. and G.L. Mackie (1998) Seasonal and depth variations in gametogenesis and spawning of *Dreissena polymorpha* and *Dreiseena bugensis* in eastern Lake Erie. Canadian Journal of Zoology 76: 2010-2019.

Study Date	1994-1995
Location	• 9 sites, LPB • Sites 1-3: ~5m offshore – Nanticoke station, 42°43.00'N, 80°12.30'W; 42°44.80'N, 80°09.40'Wp; 42°45.80'N, 80°03.10'W @ ~1.5 m depth • Sites 4-6: 15km S of Nanticoke Station, 42°38.80'N, 80°06.40'W; 42°40.20'N, 80°03.90'W; 42°41.60'N, 80°00.50'W @ ~12m depth • Sites 7-9: 30 km S of Nanticoke Station, 42°37.50'N, 80°04.80'W; 42°39.10'N, 80°02.40'W; 42°40.20'N, 79°59.80'W
Findings/Purpose	• Mussels in the wave zone spawned simultaneously, one week earlier than *D. bugensis* in the hypolimnion • In the hypolimnion, *D. bugensis* spawned at 9°C, compared to the accepted minimum temperature of 12°C for spawning – possible explanation for their proliferation in this zone • Gametogenic timing was significantly correlated with temperature • In the epilimnion and hypolimnion - correlated to protein, chlorophyll Ψ respectively • *Dreissena polymorpha* did not spawn in the hypolimnion when transplanted – suggesting they cannot successfully colonize in this zone
Category	Macro-Invertebrates, Invasive Species
Source	McMaster University, Thode library periodicals

	Available digitally from publisher at cost

191. Coakley, J.P. (1981) Long Point: Modern or relict coastal feature? Int. Assoc. Great Lakes Res. Abst. Ohio. 32 pp

Category	Terrestrial Geography, Hydrology and Sediments
Source	CWS London

192. Coakley, J.P., T. M. Dick and M.G. Skafel. (1978) Littoral processes and shore protection options in the vicinity of the Long Point lighthouse, Lake Erie. CCIW Hydraulics Research Div. Tech. Rep. No. 78-15. 14 pp.

Category	Hydrology and Sediments
Source	CWS London

193. Coakley, J.P. (1983) Sub - surface sediments and late Quaternary history of Long Point, Lake Erie. Unpublished report; NWRI Hydr. Div. Tech. Note 80-24. 50 pp.

Category	Terrestrial Geography
Source	CWS London

194. Coakley, J.P. (1984) Evolution of Lake Erie Based on the Postglacial Sedimentary Record Below the Long Point, Point Pelee, and Pointe-aux-Pins Forelands. Ph.D. thesis, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario. 362 pp.

Category	Terrestrial Geography
Source	CWS London

195. Coates, B. (1978) An assessment of the national significance of Long Point peninsula, Port Rowan, Ontario. Unpublished report; Parks Canada. 25 pp.

Category	Land Use and Management
Source	CWS London

196. Collier, B. and G.E. Wallace (1989) Aging *Catharus* thrushes by rectrix shape. J. Field Ornith. 60(2): 230-240.

Study Date	March 1986 - May 1987
Location	• LPBO
Findings/Purpose	• Using rectrix shape to identify age-groups of *Catharus* thrushes • Pointed shape indicates hatch-year to second-year birds • Rounded shape indicates after-hatch/after second-year birds • Use of rectrix shape to identify age was found to be more efficient than other techniques in use at time of publication
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

197. Collier, B. (1991) Long Point Bird Observatory - 1990 recoveries. Ontario Bird Banding 23:17-19.

Study Date	1990
Location	• LPBO
Findings/Purpose	• Reports bird recoveries from the raptor banding program and migratory bird banding programs • Overall, numbers were down slightly from 1989, however 1990 still provided a good banding recovery year • A table of recovered birds with information including band #, age, sex, location banded, etc. is provided
Category	Birds
Source	BSC Library

Collier, B. (N.D) A Herpetofaunal Survey of the Long Point Causeway or Death on the
198. Highway. 4pp.

Category	Reptiles, Amphibians
Source	

199. Commission of Environmental Cooperation (1999) North American Important Bird Areas A Directory of 150 Key Conservation Sites. Published by the Communications and Public Outreach Department of the CEC Secretariat. ISBN NO. 2-922305-42-2 358pp.

Category	Birds
Source	

200. Cone, D.K. and R.M. Overstreet (1998) Species of Myxobolus (Myxozoa) from the bulbus arteriosus of Centrarchid fishes in North America, with a description of two species. *The Journal of Parasitology* 84(2): 371-374.

Category	Fish
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

201. Conliffe-Reid, H.E. (1991) Wave refraction modelling and characteristics of the distal bayside of Long Point, Lake Erie, Ontario. M.Sc. thesis, Department of Geography, University of Guelph, Guelph, Ontario.

Category	Hydrology and Sediments
Source	

202. Cook, F.R. (1970) Rare or endangered Canadian amphibians and reptiles. Canadian Field Naturalist 84: 9-16.

Study Date	Review of species occurrence and protection issues, no field work
Location	• Various, LP considered generally
Findings/Purpose	• Loss of species in their northern range extremes in Canada • Economic impacts reported as relatively low • Conservation issue – vehicular mortality, habitat drainage, development / land-use modification • Annotated list of endangered species
Category	Amphibians, Reptiles
Source	McMaster University, Thode library periodicals

203. Cook, F.R. (1977) Review of the Canadian herpetological scene p 117-221. In T. Mosquin & C. Suchal (editors). Canada's threatened species and habitats.

Category	Amphibians, Reptiles
Source	CWS London

204. Cooke, S. J. and J. F. Schreer (2002) Determination of fish community composition in the untempered regions of a thermal effluent canal: The efficacy of a fixed underwater videography system. *Environmental Monitoring and Assessment* 73 (2): 109-129

Study Date	February-July 1999
Location	• LPB – Nanticoke Power Station, thermal discharge canals
Findings/Purpose	• Study focuses on area above the zone of tempering influence • Videography employed to examine fish community composition and abundance patterns were compared against angling surveys, visual observations from the surface, and two netting procedures • Videography was the most successful in identifying species and individuals • Approach limitation: varying visibility with a range of 3-9m^3 depending on conditions • Suggested improvements: infrared lighting for low-light conditions, variable-depth cameras
Category	Fish, Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

205. Cooke, S.J., C. M. Bunt, Christopher, and R. S. McKinley (2000) Winter residency of smallmouth bass in a thermal discharge canal: Implications for tempering pump operation North American Journal of Fisheries Management 20(1): 288-295

Study Date	January – March 1998

Location	• Nanticoke generating station discharge canal
Findings/Purpose	• Monitor behaviour of fish living within the discharge canal upstream of the tempering pumps • Most fish remained within 25m of initial capture-release site • Those fish with larger movements generally sought cover and shelter from high velocity waters • Relatively little influence of the tempering influence was noted on smallmouth bass in the study as they dominantly remained upstream of these inputs • Management issues: fish entrainment and impingement in tempering pump areas and discharge canals
Category	Fish, Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

206. Cooke, S. J. and J. F. Schreer (2003) Environmental monitoring using physiological telemetry: A case study examining common carp responses to thermal pollution in a coal-fired generating station effluent. Water Air and Soil Pollution 142 (1-4): 113-136

Study Date	Winter 1998-1999
Location	• Nanticoke thermal generating station discharge canal
Findings/Purpose	• Carp movement characteristics were monitored using electromyogram telemetry of the axial musculature • Carp were generally more active during periods of rising/falling temperature than stable temperature periods • The size of temperature fluctuation was not correlated with activity level • Results suggest that small fluctuations in temperature are sufficient to alter activity – likely due to fine scale behavioural thermoregulation • This stimulation may result in increased energy expenditure in areas with frequent temperature fluctuations such as thermal canals
Category	Fish, Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

207. Cooper, J. (1980) Planning and management of Long Point and Turkey Point Provincial Parks. Contact 12(3): 31-48.

Category	Land Use and Management
Source	McMaster Libraries

208. Cooper, J.N. and R. Thompson (1974) Long Point Inner Bay – Turkey Point study area: recreational directional statement. Unpublished report. OMNR, Simcoe. 39pp

Category	Land Use and Management
Source	CWS London

209. Corbus, M, T. Davis, G. Fairfield, G. Holroyd and R. Montgomery (1965) Twenty-ninth breeding bird census. Sand dunes with scattered cottonwoods. Audubon Field Notes 19:630.

Findings/Purpose	See: Bridge & Bridge (1965)
Category	Birds
Source	McMaster University

210. Cosens, S.E. (1984) The status of the King Rail (*Rallus elegans*) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 55 pp.

Study Date	n.d. Review paper
Location	• Canada & United States (reference) • Species location is limited to Southern Ontario
Findings/Purpose	• Possible ecological association between wild rice and King Rails • Threats to populations include: habitat loss, possible exposure to toxics

	• Hunting not seen as a major contributor to declining numbers • Distribution maps (including sightings) for Southern Ontario are included (LP specific data) • Recommendations on the protection of the species are given • General information about the species (biology, preferred habitat, size, etc.) is also given
Category	Birds
Source	MNR Library

211. COSEWIC (2002) COSEWIC update and assessment status report on the spiny softshell turtle (*Apalone spinifera*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa *vii* + 17pp.

Study Date	Review of existing work on species (up to 1999)
Location	• Canada-wide, Southern Ontario, occurrences in LPB area
Findings/Purpose	• Review of species characteristics, habitat requirements, and current status of the species within Canada • Includes information on reproduction, movements, and nutrition, behaviour/adaptability amongst others
Category	Reptiles
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

212. Course, C. (2007) Contaminant burdens, nutrient-reserve dynamics, and artefact ingestion in fall-migrating Common Loons (*Gavia immer*) at Long Point, Lake Erie. B.Sc. Honours Thesis. University of Western Ontario, London, Ontario.

Category	Water Quality/Limnology, Waterfowl
Source	

213. Craig, B.E. (1993) Fisheries of Lake Erie and the Long Point Area: Past and Present. Long Point Environmental Folio Publication Series - Technical Paper 4. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

Study Date	From historical development to the 1990s
Location	• LP
Findings/Purpose	• More detailed investigation of the fisheries industry and composition of Long Point Bay through history than is provided in Craig, B.E. (1996) Fisheries of Lake Erie and the Long Point Area (Reference #214) • Breaks down sport from commercial fisheries and discussion of pressure and influences on the evolution of the fisheries
Category	Fish
Source	BSC Library

214. Craig, B.E. (1996) Fisheries of Lake Erie and the Long Point Area: Chapter 6. Long Point Environmental Folio Publication Series. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 12pp.

Study Date	From historical development to the 1990s
Location	• LP
Findings/Purpose	• Brief examination of the existence of the fisheries in Lake Erie and stresses on Great Lakes fisheries are listed • A historical timeline of the Norfolk County fisheries is given in tabular format with information on the market stimulation that caused the change, accompanying changes to technology and how it changed the fish communities • The Inner and Outer bays are considered separately – a timeline of community changes of the Inner bay is given as a table • Brief overview of other studies conducted of the LP fisheries is given
Category	Fish
Source	BSC Library Waterloo Heritage Resource Centre

215. Craig, B., G. Whitelaw, J. Robinson, and P. Jongerden (2003) Community-based Ecosystem Monitoring: A tool for developing and promoting ecosystem-based management and decision making in the Long Point World Biosphere Reserve. Proceedings of the Fifth Science and Management of Protected Areas Association Conference [Web Page]. URL http://www.sampaa.org/PDF/ch4/4.4.pdf [2006].

Study Date	n.d.
Location	• LPBR
Findings/Purpose	• Investigate the effectiveness of community-based monitoring initiatives within the framework of ecosystem-based management and decision making • Discusses common obstacles and issues with management practices and of community-based management efforts • History and development of program and conceptual framework are presented
Category	Land Use and Management
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

216. Craigie, O, and S.A. Petrie (2003) Moult intensity and chronology of Tundra Swans during spring and fall migration at Long Point, Lake Erie, Ontario. Canadian Journal of Zoology 81:1057-1062.

Study Date	Spring 1999, 2000
Location	• LP
Findings/Purpose	• Examine differences in moulting intensity due to age and sex • Birds classified as adult, sub-adult, and juvenile based on 20-feather areas • Males and females for all age categories showed similar moulting characteristics • Moulting was more intense in fall than in spring – possibly related to larger fat stores and nutritional differences
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

217. Craigie, G.E., S.T.A. Timmermans and J.W. Ingram (2003) Interactions between marsh bird population indices and Great Lakes water levels: A case study of Lake Ontario hydrology. Unpublished report for the International Joint Commission Environmental Technician Working Group.

Study Date	1995-2001
Location	• Lake Ontario focused
Findings/Purpose	• Investigate: how occurrence and abundance of marsh birds at Lake Ontario coastal marshes differ from non-Lake Ontario marshes; correlations between lake levels and species abundance during breeding seasons; directional agreement between changes in lake level and species abundance indices; temporal patterns of lake levels and their relationship to marsh habitat indices • In general, species abundance was lower at lake Ontario than combined Great Lakes values • Relationship between water level and species abundance existed, however given habitat preference for dry vs. wet conditions, species specific differences were found • Proportional habitat coverage did not appear to track lake levels – however basic nature of habitat assessment may not provide accurate enough information to determine this relationship
Category	Birds, Waterfowl
Source	BSC Library

218. Crewe, T.L. and S.T.A. Timmermans (2003) Marsh Monitoring Program: 2003 volunteer habitat workshop summary. Unpublished report for the Canadian Wildlife Service, Environmental Conservation Branch, Ontario Region.

Study Date	2003
Location	• Port Rowan, Ontario
Findings/Purpose	• Determine the level of precision and accuracy of habitat assessment within the Marsh Monitoring Program (MMP) protocols • Volunteers were selected from an existing list of MMP participants to represent various levels of experience and geographic location • A one day workshop was held to compare the habitat assessment protocols of the MMP conducted by volunteers at pre-selected sites against more detailed and accurate transect vegetation surveys • The goal was to determine how accurately volunteers assess habitat • Volunteer-derived habitat cover did not differ significantly from transect studies across each test sites • Variations did occur – open water was generally overestimated at some sites, underestimated at others • Sight-identification tests were also conducted for common vegetation species and bird species with varying degrees of success in identification • Overall, volunteers conduct meaningful data with a reasonable level of accuracy
Category	General Wetlands
Source	BSC

219. Crewe, T.L. and S.A. Timmermans (2005) Assessing Biological Integrity of Great Lakes Coastal Wetlands Using Marsh Bird and Amphibian Communities. Project # WETLAND3-EPA-01 Technical Report. Marsh Monitoring Program, Bird Studies Canada.

Study Date	1995-2003
Location	• Great Lakes Basin
Findings/Purpose	• Identify categories of land use to rank wetland disturbance and link these with monitored numbers and site use by marsh birds and amphibians to develop well defined, standardized indicators of habitat health • Determine the power with which these indicators can be used to classify wetlands within disturbance categories and make recommendations for refining and strengthening marsh bird and amphibian IBIs (Indices of Biotic Integrity) • Indices were investigated at four spatial scales to investigate the relative scope of impacts • Smaller spatial scales showed more consistent changes in amphibians and marsh birds • High water years also showed more consistent changes than low water years • The development and testing of these findings are given, as well as recommendations for future development of IBIs
Category	General Wetlands, Birds, Waterfowl, Amphibians
Source	

220. Crewe, T.L. (2006) Trends in numbers of migrant birds at Long Point Bird Observatory (1961-2004) and Thunder Cape Bird Observatory (1995-2004). Unpublished Bird Studies Canada report for the Ontario Ministry of Natural Resources. 45pp.

Study Date	2004
Location	• LPBO (Tip, Breakwater, Old Cut) • Thunder Cape Bird Observatory (TCBO)
Findings/Purpose	• 44th year of observation at LPBO, 10th for TCBO • Overall, the number of migrant experiences declining trends increased in the last 10 years compared to long-term population trends (1967-1969 to 2002-2004) and to the mean population change

	(1961-1995 to 1995-2004) • Over past ~ decade, fewer significant increasing trends and an increased number of significant declining trends have been observed (LPBO) • Trends of migrants through TCBO have also been predominantly negative • Similar trends are evident in the MNR Wildlife Population Program Monitoring Plan's habitat features • Although declining populations are apparent, the mean population is still apparently above mean annual indices • Further years of research are required to determine if populations will continue to decline, or if number of species with declining trends will continue to rise
Category	Birds
Source	OMNR Library – Peterborough: Digital copy BSC – 1 Hardcopy

221. Crossman, E.J. (1962) The grass pickerel Esox americanus vermiculatus LeSueur in Canada. Roy. Ont. Mus., Life Sci. Div., Cont. 55: 29 pp.

Category	Fish
Source	CWS London

222. Crossman, E.J. and E. Holm (2005) COSEWIC status report on the grass pickerel *Esox americanus vermiculatus* in Canada, in COSEWIC assessment and status report on the grass pickerel *Esox americanus vermiculatus* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 1-27 pp.

Study Date	2005 and ealier – review
Location	• Lake St. Louis, QC – Lake Huron, ON
Findings/Purpose	• Grass Pickerel given new status as a species of special concern in light of the new status report in May 2005 • This species prefers shallow waters with high proportions of aquatic vegetation • A 22% decrease in the area of occupancy has been observed • Decline appears to be related to degredation and loss of habitat – dredging, channelization in suitable wetland habitat • Species known to be found between Lake St. Louis, QC and Lake Huron, ON • Criteria and recommendations are provided in text, occurrence maps, etc. also available in report
Category	Fish
Source	COSEWIC website BSC – digital copy

223. Crowder, A.A. and J.M. Bristow (1988) The future of waterfowl in the Canadian Lower Great Lakes Wetlands. Journal of Great Lakes Research 14(1):115-127 International Association of Great Lakes Research.

Study Date	Lit Review – data dominantly from 1970-80's
Location	• Various wetlands across Great Lakes, including LP
Findings/Purpose	• Eutrophication leading to increased filamentous algae, planktonic biomass, submergent macrophytes • Subsequent loss of submergent, floating and emergent weedbeds, • Increase in *Typha* marsh coverage followed by decline • Anoxic bare-mud substrates result in botulism bird deaths • Management and restoration requires significant changes in non-point source pollution management (e.g. farming) as well as point source management
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

224. Cruise, J.E. (1969) A floristic study of Norfolk County. Transaction of the Ontario Royal Canadian Institute. University of Toronto Press, Toronto, Ontario.

Category	Terrestrial Vegetation
Source	CWS London

225. Cruise, J.E. (1970) Rare and interesting plant species present in some of the Strategic Ecological Reserves in Haldimand-Norfolk Region. 6-1, 6-2, & 6-3 Long Point and Turkey Point. Dunelands and Marshlands. 5 pp.

Category	Terrestrial Vegetation
Source	

226. Cruise, J.E. and P.M. Catling. (1974) Distribution of Sundews (*Drosera* spp.) in Ontario. Ontario Field Biol. 28(2): 47-48.

Category	Terrestrial Vegetation
Source	CWS London

227. Curry, B. and K.A. McLaughlin (2000) The November 1999 Cave Swallow Invasion in Ontario and Northeastern North America. Ontario Birds 18:13-27.

Category	Birds
Source	

228. Curry, C., G.A. Reese, K. Suns (1981) Organochlorine contaminant declines and their present geographic distrubtion in Great Lakes Spottail Shiners *(Notropis hudsonius).* Ontario Ministry of the Environment.

Category	Fish
Source	McMaster Libraries

229. Curson, S. (1990) Report on the Butterflies of Long Point – 1990. In: Long Point Bird Observatory Newsletter, Volume 27(3): 14-16.

Category	Insects
Source	BSC Library

230. Dahl, J.A. et al. (1995) Lake Erie 1993, western, west central and eastern basins: change in trophic status, and abundance, biomass and production of the lower trophic levels. Fisheries and Oceans Canada. 118 pp

Study Date	1993 (active field research) + past data
Location	• 3 eastern basin sampling sites E of LP • 42°46’46’’ N, 80°08’42’’ W • 42°37’35’’ N, 80°03’16’’ W • 42°42’49’’ N, 80°13’46’’ W
Findings/Purpose	• Further examine the changing limnological conditions of Lake Erie • Biomass and productivity generally decreased from W to E • Biomass declined 49% from 1983-1985 accompanied by a decrease in photosynthesis of 50% • Zoo plankton communities also decreased in abundance and diversity
Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals

231. Daigle, C., P.Galois and Y. Chagnon (2002) Nesting activities of an Eastern Spiny Softshell turtle, Apalone spinifera. *The Canadian Field-Naturalist* 116 (1):104-107.

Study Date	1998 nesting season
Location	• Riviere Brochets, Lac Champlain/Lac Grande Baie
Findings/Purpose	• Daily activities were monitored in relation to weather, time of day, etc. • Short distance movements were made in the morning with basking • Long distance movements (2-3km) were made in the afternoon • Evenings showed a settling down and seemingly, a search for a good nesting site • Turtle observed travelled 7km in three days for nesting

Category	Reptiles
Source	MNR Library – Peterborough

232. Dakin, S. and Skibicki, A. (1994) Human History of the Long Point Area. Long Point Environment Folio Publication Series (Nelson, J.G. and Lawrence, P.L., editors). (August 1994 40pp) Heritage Resources Centre, University of Waterloo, Waterloo, ON.

Study Date	n.d.
Location	• Long Point
Findings/Purpose	• Extended paper of Reference #232 (Dakin, S and Skibicki, A (1996))
Category	Land Use and Management, Human Impacts
Source	BSC Library Waterloo Heritage Resource Centre

233. Dakin, S. and Skibicki, A. (1996) Human History of the Long Point Area. Chapter 3. Long Point Environment Folio Publication Series. Heritage Resources Centre, University of Waterloo, Waterloo, ON. 19pp.

Study Date	n.d.
Location	• Long Point
Findings/Purpose	• Human historical influence on the LP area • Begins with native Canadian use through early settlement, the development of stationary land management practices (agriculture, mining, town development, etc.) and continues to modern industrial development • Maps of settlement or regular use locations are provided
Category	Land Use and Management, Human Impacts
Source	BSC Library Waterloo Heritage Resource Centre

234. Dauphine, T.C. (1976) Managing muskrats on the National Wildlife Areas in Ontario. Canadian Wildlife Service Memorandum. 4 pp.

Category	Mammals
Source	CWS London

235. Dauphine, T.C. (1978) Deer exclosures at Long Point. Canadian Wildlife Service Memorandum. 5 pp.

Category	Mammals
Source	CWS London

236. Davidson-Arnott, R.D.G., B. Greenwood, J.P. Coakley and A.J. Zeman (1982) Coastal sediments and geomorphology of the Canadian Lower Great Lakes. 11th International Congress on Sedimentology.

Category	Terrestrial Geography, Hydrology and Sediments
Source	McMaster Libraries

237. Davidson-Arnott, R.D.G. and C.J. Stewart (1987) The effects of longshore sand waves on dune erosion and accretion, Long Point, Ontario. Proceedings of the Canadian Coastal Conference, 1987. p.131-144.

Category	Hydrology and Sediments
Source	McMaster Libraries

238. Davidson-Arnott, R.G.D. and M.N. Law (eds.) (1988) Impact of Great Lakes Shore Water Levels on Shore Processes. Workshop Summary. Internation Joint Commission.

Study Date	Various
Location	• Various within Great Lakes
Findings/Purpose	• Conference abstracts with a common theme of the impacts of Great Lakes water level fluctuations on shorelines processes • Topics Include: coastline zone ecology, protected shorelines, bluffs, wetland group workshop (how water levels impact wetlands – vegetation change is of particular note)

Category	Water Levels, Hydrology and Sediments
Source	MNR Library

239. Davidson-Arnott, R.G.D. and M.N. Law (1990) Seasonal patterns and controls on sediment supply to coastal foredunes, Long Point, Lake Erie. Coastal Dunes: Form and Process (ed. K.F. Nordstrom, N.P. Psuty and R.W.G. Carter). p. 177-200.

Category	Hydrology and Sediments
Source	McMaster Libraries

240. Davidson-Arnott, R.G.D. and J.D. Fisher (1992) Spatial and temporal controls on overwash occurrence on a Great Lakes barrier spit. Journal of Canadian Earth Science 29(1): 102-117.

Category	Hydrology and Sediments
Source	McMaster Libraries

241. Davidson-Arnott, R.G.D. and H.E. Conliffe Reid (1994) Sedimentary processes and the evolution of the distal bayside of Long Point, Lake Erie. Canadian Journal of Earth Sciences 31(9): 1461-1473.

Category	Hydrology and Sediments
Source	McMaster Libraries

242. Davidson-Arnott, R.G.D. and M.N. Law (1996) Measurement and prediction of long-term sediment supply to coastal foredunes. Journal of Coastal Research 12(3): 654-663.

Category	Hydrology and Sediments
Source	McMaster Libraries

243. Davidson-Arnott, R. G. D., and Van Heyningen, A. G. (2003) Migration and sedimentology of longshore sandwaves, Long Point, Lake Erie, Canada. *Sedimentology 50*: 1123-1137.

Study Date	1985-1992
Location	• Long Point Spit
Findings/Purpose	• Formation, migration and sedimentology of sandwaves along the distal end of Long Point • Size characteristics of sandwaves are discussed with supporting literature references • Sandwave migration is described by two methods: 1) a migratory jump, 2) downdrift accretion • Migratory jump is a large shift of 200-500 m in a year – causing the melding of a sandwave with a nearshore sand bar and the emergence of a new bar • These large shifts may immediately following years because of the material removal from the system • Downdrift accretion causes 50-150m shifts in a year and are caused by refraction of waves and their transported materials – this migration mechanism appears to happen less frequently – possibly in response to low sediment availability • Incidence of oblique and acute wave angles and water level are also discussed
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

244. Day, J.C. and J.A. Fraser (1979) Flood and erosion hazard adjustments near Rondeau and Long Point: A perceptual approach. Contact 11(1): 117-136.

Category	Hydrology and Sediments
Source	McMaster Libraries

245. Day, K.E., R.S. Kirby and T.B. Reynoldson (1995) The effects of manipulations of freshwater sediments on responses of benthic invertebrates in whole-sediment toxicity tests. *Environmental Toxicity and Chemistry 14(8)*: 1333-1343.

Study Date	Summer 1991 (sample collection for lab experiment)
Location	• LP, Hamilton Harbour
Findings/Purpose	• LP samples used as 'clean' samples – as lacking major contaminants/contamination compared to those from Hamilton Harbour • All samples had native benthic inverts. Removed, were populated with three desired species of study • Each benthic invertibrate species responded differently to sterilization (autoclaving), irradiated, or left in original condition ranging from death of species within sample to variations in population survival and reproduction
Category	Water Quality/Limnology, Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

246. DeBruyn, J.M., J.A. Leigh-Bell, R.M.L. McKay, R.A. Bourbonniere, and S.W. Wilhelm (2004) Microbial distributions and the impact of phosphorus on bacterial activity in Lake Erie. Journal of Great Lakes Research 30(1): 166-183.

Study Date	July 2002 (sample collection)
Location	• 2 sampling stations within LPB • 45 sampling locations in total
Findings/Purpose	• Investigation of the impact of increased phosphorous loading on bacterial growth within each of Lake Erie basin • Conducted in concern of relaxed regulations on phosphorous input to the lake • Following 72-hour incubation experiment: Large increase in different size classes of phytoplankton, increase in bacterial production (not considered bacterial abundance in many cases) • Results from each basin indicates they will respond uniquely • Also indicate that given phosphorous loading, phytoplankton and bacteria become limited by nitrogen and carbon respectively
Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

247. Dean, J. (1981) Breeding birds of the Bluff Point study area, Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service. 19 pp.

Category	Birds
Source	CWS London

248. Dean, J. (1981) Breeding birds of the proposed Gravelly Bay Walking Trail, Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service. 34 pp.

Category	Birds
Source	CWS London

249. Demal, L. (1977) The hoop and seine net fishery of Inner Long Point Bay, Lake Erie. Unpublished report; Ontario Ministry of Natural Resources. 55 pp.

Category	Fish
Source	McMaster Libraries

250. Demandi, M. (2004) Lead shot incidence in Greater and Lesser Scaup on the lower Great Lakes, one year after the ban of lead shot in Canada. B.Sc. Honours Thesis. University of Western Ontario. London, Ontario.

Category	Waterfowl, Human Impacts
Source	

251. Demendi, M., and S. A. Petrie (2006) Shot ingestion in scaup on the lower Great Lakes after nontoxic shot regulations in Canada. Wildlife Society Bulletin 34: 1101-1106.

Study Date	Autumn 1999 - Spring 2000
Location	• Canadian side Lake Erie, Lake St. Clair
Findings/Purpose	• 1991 – US ban of lead shot for waterfowl hunting • 1999 – Canadian ban of lead shot for waterfowl hunting • Prior to the ban, 11% and 8% of greater and less Scaup harvested in the LGL had ingested lead shot respectively • Study examines any change in shot ingestion after 1 year of banning • 0.6% had ingested lead shot, 3.1% had ingested non-toxic shot • Findings suggest that shot quickly becomes unavailable in lacustrine environments of the LGL • Study suggests that given findings, lead toxicity potential is low in the LGL due to lead shot ingestion • Previous numbers may be high because of bias collection samples • Recent changes to diet may also have been the cause of the large reduction of shot ingestion & a high compliance of hunters with the lead shot ban
Category	Waterfowl, Human Impacts
Source	MNR Library – Peterborough

252. Deming, M. (2006) Contaminant burdens in Mute Swans throughout the annual cycle on the lower Great Lakes. B.Sc. Honours Thesis. University of Western Ontario. London, Ontario.

Category	Waterfowl
Source	

253. Dennis, D.G. (1969) Proposed Big Creek National Wildlife Area, Norfolk County, Ontario. Priority 1. Unpublished report; Canadian Wildlife Service.

Category	Land Use and Management
Source	CWS London

254. Dennis, D.G. and R.E. Chandler. (1974) Waterfowl use of the Ontario shorelines of the southern Great Lakes during migration. IN: Waterfowl studies in eastern Canada (H. Boyd ed.). Canadian Wildlife Service rep. ser. No. 29. p. 58-65.

Category	Waterfowl
Source	CWS London

255. Dennis, D.G., G.B. McCullough, N.R. North and R.K. Ross. (1983) An updated assessment of migrant waterfowl use of the Ontario shoreline of the southern Great Lakes. Canadian Wildlife Service rep.

Category	Waterfowl
Source	CWS London

256. Dennis, D.G. and N.R. North. (1989) Changes in Waterfowl Use of the Long Point Marshes from 1969-1988. Canadian Wildlife Service Waterfowl Studies in Ontario.

Category	Waterfowl
Source	

257. Dennis, D.G., K.L. Fischer and G.B. McCullough. (n.d.) Hunting club kill records as an indicator of the change in status of Mallards and Black Ducks in southwestern Ontario. Unpublished report; Canadian Wildlife Service. 7 pp.

Category	Land Use and Management, Waterfowl
Source	CWS London

258. Derbyshire, P (1992) Breeding bird census #78, intergrading dune-swale savannah. Journal of Field Ornithology 63 (Supplement): 82-83.

Study Date	1991
Location	• Long Point National Wildlife Area

	• 42°33'N, 80°04'W
Findings/Purpose	• Vegetation information at observation plot – trees, shrubs and other major vegetation cover (relative cover, dominance, etc.) • Topography and elevation • Weather • Detailed list of bird species within the plot (residents and 'visitors')
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

259. Dermott, R. (1994) Benthic invertebrate fauna of Lake Erie 1979: distribution, abundance and biomass. Canadian department of fisheries and oceans. 82pp

Study Date	October 1979
Location	• Detailed sampling maps in text • Lake Erie, including several sample locations in LPB
Findings/Purpose	• Provides information on the numerical abundance, biomass and species composition of benthic fauna present in Lake Erie and LPB (1979 specific) • Results also indicated graphically on maps, with coverage of the LPB area
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals

260. Dermott, R. and D. Kerec (1995) Changes in the deep-water benthos of eastern Lake Erie between 1979 and 1993. Proceedings of the Fifth International Zebra Mussel and Other Aquatic Nuisance Organisms Conference, Toronto, Ontario, Canada, February 1995. pp. 57-64.

Category	Water Quality/Limnology
Source	

261. De Solla, S.R., M.L. Fletcher, and C.A. Bishop (2003) Relative Contributions of Organochlorine Contaminants, Parasitism, and Predation to Reproductive Success of Eastern Spiny Softshell Turtles (Apalone spiniferus spiniferus) from Southern Ontario, Canada. Volume 12, Numbers 1-4 261-270

Study Date	1998
Location	• Long Point Wildlife Area • Rondeau Provincial Park
Findings/Purpose	• Hatching success, predation rates, parasitism rates, sex ratio and egg viability • Pesticides were simultaneously monitored at the study sites • No correlation was found between hatching success, parasitism and depredation rates, or the proportion of male hatchlings with total PCBs or individual pesticides • Positive correlation between egg viability and concentrations of total PCBs and with 5 individual pesticides • No evidence that organochlorine contamination is affecting reproductive success
Category	Water Quality/Limnology, Reptiles
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

262. De Steven, D. and D.J.T. (1977) The Tree Swallow breeding season. Long Point Bird Observatory 1975 Annual Report. pp11-12.

Category	Birds
Source	CWS London

263. De Steven, D. (1978) The influence of age on the breeding biology of the Tree Swallow, *Iridoprocne bicolor*. Ibis 120: 516-523.

Category	Birds

Source	CWS London

264. De Steven, D. (1980) Clutch size, breeding success and parental survival in the Tree Swallow (*Iridoprocne bicolor*). Evolution 34: 278-291.

Study Date	1976
Location	• Long Point
Findings/Purpose	• Female Tree Swallows were observed, clutch laying times were noted and the number of eggs recorded • Clutch weight and sizes of hatchlings were monitored • Studied broods hatched during main breeding period • Low mortality rates and high fledging rates were observed – indicating that there was no food constraints, or that they were not sufficient to impact nesting success • Fledgling health and female health parameters are discussed • No apparent relationship was found between post-fledging mortality and brood size • Overall more young were fledged from larger broods
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

265. Dewey, K. (1981) Muskrat Management Considerations for Big Creek National Wildlife Area. Canadian Wildlife Service unpublished report.

Category	Mammals
Source	CWS London

266. Dewey, K. (1981) Fish inventory, hydrographic mapping, biolimnological sampling, bird, reptile, amphibian and large mammal utilization of six inland ponds in the Gravelly Bay area of Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service. 79 pp.

Category	Fish, Water Quality/Limnology, Birds, Reptiles, Amphibians, Mammals
Source	CWS London

267. Dewey, K. (1981) Surficial examination of five ponds adjacent to the western portion of the proposed Gravelly Bay Walking Trail, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service. 15 pp.

Category	Hydrology and Sediments
Source	CWS London

268. Dewey, K. (1981) Acid precipitation readings from Gravelly Bay, Long Point National Wildlife Area, summer 1981. Unpublished report; Canadian Wildlife Service.

Category	Water Quality/Limnology
Source	CWS London

269. Dewey, K. (1982) Inventory, Site Evaluation and Management Options for the Northeast Corner of Big Creek National Wildlife Area. Canadian Wildlife Service unpublished report. 105 pp.

Category	Land Use and Management
Source	CWS London

270. Dewey, K. (1982) Road kills on a 1.55 km section of the Causeway, Long Point 1982. Unpublished report; Canadian Wildlife Service. 32 pp.

Category	Human Impacts
Source	CWS London

271. Dewey, K., J. Ashenden and M. Wiercinski (1982) Initial inventory of the Thoroughfare Point Unit, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service. London, ON. 42pp

Category	Land Use and Management

Source	CWS London

272.Dewey, K. (1983) Factors affecting muskrat density in a section of Big Creek National Wildlife Area. Unpublished report; Canadian Wildlife Service.

Category	Mammals
Source	CWS London

273.Dewey, K. (1983) The northern pike spawning run, Big Creek National Wildlife area, 1983. Unpublished Report. Canadian Wildlife Service. London, ON. 20pp

Category	Fish
Source	CWS London

274.Dewey, K. (1983) An initial environmental evaluation of management proposals for Big Creek National Wildlife Area. Draft. Unpublished report to the Canadian Wildlife Service. London, Ontario. 32pp.

Category	Land Use and Management
Source	CWS London

275.Dewey, K. and G.B. McKeating (1983) An environmental screening statement on the marsh management development proposals, Big Creek National Wildlife Area. Unpublished Report. Canadian Wildlife Service. London, ON. 55pp + appendices

Category	General Wetlands, Land Use and Management
Source	CWS London

276.Deyne, G.A. (1977) Summer resources inventory of the Lee Brown Waterfowl Management Area. Unpublished report for Long Point Region Conservation Authority. 102 pp.

Category	Waterfowl, Land Use and Management
Source	CWS London

277.Dick, T.M. (1980) Erosion at the tip of Long Point near the Long Point Lighthouse, Lake Erie. CCIW Hydraulics Research Div. Tech. Rep. No. 80-18. 11 pp.

Category	Hydrology and Sediments, Terrestrial Geography
Source	CWS London

278.Dickins, T. et al (1979) Big Creek Watershed Background Study. Long Point Region Conservation Authority. 10 parts + maps.

Category	Terrestrial Geography, Land Use and Management
Source	

279.Dittmer, S.J. (1979) Public environmental education programs at Point Pelee, Rondeau and Long Point. M.A. Thesis, University of Waterloo. 255pp.

Category	Land Use and Management
Source	CWS London

280.Dodge, D. and R. Kavetsky (1995) Aquatic habitat and wetlands of the Great Lakes. Environment Canada, Environmental Protection Agency. 1994 State of the Lakes Ecosystem Conference.

Category	General Wetlands
Source	McMaster Libraries

281.Doherty, F. G., D. W. Evans and E. F. Neuhauser (1993) An assessment of total and leachable contaminants in zebra mussels (Dreissena polymorpha) from Lake Erie. Ecotoxicology and Environmental Safety 25 (3): 328-340 1993

Study Date	1990, 1991
Location	• Nanticoke Generating Station • Dunkirk Steam Station
Findings/Purpose	• Mussels testing for leaching of metals and other contaminants • Mussels did not release contaminants above levels dictated by water

	quality guidelines • Detectable levels of several contaminant however, were found • Whole body tests did not provide detectible levels of herbicides and pesticides
Category	Invasive Species, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

282. Doka, S.E; Minns CK. (1999) A yellow perch habitat model for Long Point Bay, Lake Erie, Pages A-27-28. IN: IAGLR '99. International Association for Great Lakes Research: Great Lakes, Great Science, Great Cities. Program and Abstracts.

Study Date	n.d.
Location	• Long Point Bay
Findings/Purpose	• Habitat loss can significantly hinder species populations • Links habitat availability to productivity • Habitat contiguity important for various life stages • Nearshore, vegetated and thermally suitable habitat is hypothesized as being critical to yellow perch populations
Category	Fish
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

283. Doka, S.E; Minns, CK (2001) A spatially-explicit, habitat-based population model approach Abstracts from the 44th Conference on Great Lakes Research, June 10-14, 2001. Great Lakes Science: Making it Relevant. pp. 29-30. 2001.

Category	Fish
Source	McMaster University Libraries

284. Doka. S.E. (2004) Spatially-explicit habitat characterization, suitability analysis, verification, and modelling of the yellow perch Perca flavescens (Mitchell 1814) population in Long Point Bay, Lake Erie. Ph.D. Thesis, McMaster University Hamilton, Ontario.

Study Date	Various data sets and dates, field data 1998
Location	• LPB
Findings/Purpose	• Thesis contains 4 chapters covering: habitat characterization, habitat assessment at different life stages, assessment of predictive capability of habitat quality/availability for fish distributions, whether habitat can be linked to population dynamics (for yellow perch) • Methods of study include: sediment analysis, radar and remote sensing imagers, GIS modelling, and habitat quality indices amongst others • General broad finding: habitat selection mechanisms and life history theory are essential in determining limits to fish production
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

285. Domske, H.M (2003) Botulism in Lake Erie Conference Proceedings. New York SeaGrant, Ohio SeaGrant and Pennsylvania SeaGrant. April 3, 2003. Buffalo New York.

Study Date	Status discussions, not a findings paper
Location	• Dominantly Lake Erie, some Lake Ontario references – LP highlited, but not detailed information
Findings/Purpose	• Review of past and current issues related to botulism-related mortality in birds – particularly focusing on fish-feeders • Canada-focused portion is included (although focus is US) in which LP is highlighted with confirmed outbreaks of botulism • Suggestions for moving forward with concerns and research conducted to understand transfer and infection pathways are discussed

Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

286. Dow, A., J. Gard and A. Kjerulf (1993) Lessons from Chesapeake Bay: Population, Growth and Development: The Maryland Solution; Land Trusts: Applications in Maryland and Ontario; Conservation and Management of the Critical Area in the Chesapeake Bay Watershed. Long Point Environmental Folio Publication Series - Working Paper 4. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 31 pp.

Study Date	n.d
Location	• Long Point • Chespeak Bay, Maryland
Findings/Purpose	• Current pressures to the are: population growth, industrial development, decline in traditional industries (e.g. fishing), tourism and recreational pressures, pollution, infilling, fragmentation and loss of wetlands, bird and wildlife losses • These impacts are examined using Chesepeak Bay as a case study example of management issues and practices applicable to Long Point
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

287. Dow, D.D. (1967) Aerial observations of large concentrations of diving ducks at Long Point, Ontario. Unpublished report; University of Western Ontario, London, Ontario. 10 pp.

Category	Waterfowl
Source	CWS London

288. Downey, A.M., S. Radovic and P.L. Lawrence (1994) Water Quality of Long Point Bay: Issues and Areas of Concern for Planning and Management. Long Point Environmental Folio Publication Series - Technical Paper 7. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 35 pp.

Study Date	Review Paper
Location	• Long Point Bay Area • Lake Erie
Findings/Purpose	• Expanded paper of Reference # 290 (below) • LPB water quality is influenced by cultural stresses (human-induced erosion & sedimentation), thermal and salt loading, climate change, eutrophication, toxic substrates • Management strategies with the goal of maintaining and improving water quality need to simultaneously address these issues • Areas of concern focus on chronic problems – salt and phosphorous loading, nitrate contamination, etc. • Areas of concern: Turkey Point, North shore of the Inner Bay, Port Rowan, Big Creek Watershed, Big Creek Marsh, Long Point Community, and the Inner Bay
Category	Water Quality/Limnology
Source	BSC Library

289. Downey, A.M., S. Radovich and P. Lawrence (1996) Water Quality of Long Point Bay: Issues and Areas of Concern for Planning Management. Chapter 13: Long Point Environmental Folio. Heritage Resource Centre, University of Waterloo, Waterloo, ON. 7pp.

Study Date	Review Paper
Location	• Long Point
Findings/Purpose	• Broad overview of the Long Point Bay watershed – major tributaries feeding into the bay, general natural characteristics including water quality parameters

	• Monitoring and research efforts are reviewed and recommendations for areas of expansion/conservation/improvement are given
Category	Water Quality/Limnology
Source	BSC Library Waterloo Heritage Resource Centre

290. Downing, S.C. and D.H. Baldwin (1961) Sharp-Shinned Hawk Preys on Red Bat. Journal of Mammalogy, 42(4): 540

Category	Birds
Source	McMaster Libraries

291. Dubsky, H.L. (1977) Marsh inventory for southwestern Ontario. M.Sc. thesis, York University, Toronto, Ontario.

Category	General Wetlands
Source	CWS London

292. Dufour, K.W. and C.D. Ankney (1995) Hunting mortality of mallards *Anas platyrinchos* in relation to time of day, flocking behaviour, and individual condition. Wildlife Biology 1(2): 89-96.

Category	Waterfowl
Source	

293. Dunn, E.H. (1976) Giant Canada Goose population survey IN: Long Point Bird Observatory 1974 Annual Report (D.A. MacLulich ed.). p. 14-15.

Category	Waterfowl
Source	CWS London

294. Dunn, E.H. and E. Nol (1977) Fortieth breeding bird census. Cattail Marsh. American Birds 31:83.

Findings/Purpose	See: Van Velzen, W.T. (1977)
Category	Birds
Source	McMaster University

295. Dunn, E.H. (1979) Age of effective homeothermy in nestling Tree Swallows, *Iridoprocne bicolor*, according to brood size. Wilson Bull. 91: 455-457.

Study Date	1977
Location	• Port Rowan, Ontario
Findings/Purpose	• Examine the establishment of homeothermy in Tree Swallow broods • Single bird broods developed capacity later than those greater than 1 • No significant differences was found between small and large brood development of thermoregulation in individuals • Age of effective homeothermy is generally younger with larger brood sizes
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

296. Dunn, E.H. (1979) Nesting biology and development of young in Ontario - Black Terns. Canadian Field Naturalist 93: 276-281.

Study Date	1975, 1976
Location	• N-side of Long Point, 15 ha marsh • 42°35' N 80°24' W
Findings/Purpose	• Nesting groups were identified, and nests were monitored • Broods and adults were monitored and measured during research • Nest materials, characteristics, and locations are discussed • Consecutive studies (tagged birds) suggest that adults do return to the same general location in consecutive years to nest • Chick growth and development are compared and monitored
Category	Birds

Source	McMaster University, Thode library periodicals

297. Dunn, E.H. and E. Nol. (1980) Age-related migratory behaviour of warblers. Journal of Field Ornithology. 51(3): 254-269.

Study Date	1965-1977
Location	• LPBO
Findings/Purpose	• High percentage of young birds found on islands and peninsulas in Great Lakes • Young appear to be more hesitant about flight over large water bodies and land at closer land-sites • Lighted structures appear to influence migratory decisions as well where they attract larger proportions of adult birds at shore locations – perhaps more influential at times of poor weather/visibility and no-moon conditions
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

298. Dunn, E.H., J. Siderius and D.J.T. Hussell (1981) The Ontario heronry inventory: A catalogue of information on colony sites of Ontario's colonially-breeding herons. Volumes 1 and 2. Unpublished; Long Point Bird Observatory. 15 pp.

Study Date	1978-1981
Location	• Various in Ontario
Findings/Purpose	• Provides records of sightings within Ontario for the Great Blue Heron, Black-crowned Night Heron, Great Egret and Cattle Egret with location information, local disturbances to the area. • Summary information and a key to the inventory sheets if provided at the beginning of volume 1 • Volume 2 is a continuation of inventory sheets
Category	Birds
Source	MNR Library

299. Dunn, E.H. (2003) Recommendations for fat scoring. North American Bird Bander 28(2): 58-63.

Study Date	Review
Location	• Non-specific
Findings/Purpose	• Evaluates the application of fat scoring as a means of predicting mean fat reserves of birds • At the individual scale, not an accurate prediction • At a much larger scale, mean value provide a good estimate • Current issues with using technique flow around the differences in scoring methods used – ranging from qualitative to more quantitative methods • Considers the use of weight as a means for estimating energy reserves, but finds that while useful, cannot replace fat scores in all cases • A fat-scoring method with little room for interpretation is required • A key issue is the development of an easy to use system that banders can readily learn
Category	Birds
Source	BSC Library

300. Dunn, E.H., Hussell, D.J.T., Francis, C.M., and J.D. McCracken (2004) A comparison of three count methods for monitoring songbird abundance during spring migration: capture, census and estimated totals. Studies in Avian Biology No. 29: 116-122.

Category	Birds
Source	

301.Dunn, E. H., K. A. Hobson, L. I. Wassenaar, D. J. T. Hussell, and M. L. Allen (2006) Identification of summer origins of songbirds migrating through southern Canada in autumn. Conservation and Ecology of birds - Écologie et conservation des oiseaux 1(2): 4.

Category	Birds
Source	

302.Dunn, E.H. (2000) Temporal and spatial patterns in daily mass gain of Magnolia Warblers during migratory stopover. AUK 117 (1): 12-21

Study Date	May-June; August-October 1980-1996
Location	• LP – three station locations • Study site map in text
Findings/Purpose	• Migrant mass gain is a function of site quality at stopover location • Common analysis uses regression at first capture to hour of day • Study expands to multiple regression against hour of day, date and year • Three stop-over sites compared on LP • Fall migration – mass gain sufficient for net gain over 24 hours • Spring migration – two of three sites showed net gains over 24 hours • High variability between date in the season, over the course of the day and between years
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

303.Dunn EH. (2001) Mass change during migration stopover: A comparison of species groups and sites. Journal of Field Ornithology 72 (3): 419-432 SUM 2001

Study Date	1980-1996
Location	• LP – three station locations • Study site map in text
Findings/Purpose	• Hourly mass gain of 48 species at 3 stations at LP (same stations as previous entry above) estimated using mass at capture and regression of size-corrected mass • Fall mass gain was well above required for maintaining daily energy balance for all species • Spring – two sites closer to main-land significantly above daily energy requirements, LP tip station was below requirements – possibly due to cold lake temperatures and exposure reducing site quality
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

304.Dunn, E.H. (2002) A Cross-Canada Comparison of mass change in birds during migration stopover. *Wilson Bulletin*, 114(3), 2002, pp. 368–379

Study Date	Late 1990s, with some late 1980 data from LPBO
Location	• LPBO and other stations
Findings/Purpose	• Mean mass gains for both spring and fall were 0.40 and 0.53% respectively • Relatively few statistical differences between sites • Some sites consistently low may be related to factors reducing local food availability • Swainson's Thrushes had consistently low mass gains • S.Ontario migrants could completely refuel in 2-3 day stopovers based on findings although likely longer
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

305. Dunn, E.H. (2002) Using decline in bird populations to identify needs for conservation action. *Conservation Biology* 16(6): 1632-1637.

Study Date	1974-1998
Location	• Not LP specific
Findings/Purpose	• Not LP specific, deals with migration and population monitoring which is applicable to LP as a major monitoring location • Large declines in population often used as the key indicator in deciding if a species warrants special conservation action • Guidelines differ significantly between organizations • Study examines how many of 200 Canadian species would qualify as needing special conservation effort based on several of these conservation alert parameters • Results indicate that population should not be used to identify species at risk or as a basis for conservation action (indirect or direct) • Species alert categories are a useful monitoring technique • Evaluation of trend patterns and persistence is very important • Deciding when intervention is required is the most difficult conservation question
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

306. Dunstall, T. G., J. C. H. Carter. B.P. Monroe, G.T. Haymes, R. R. Weiler and G. Hopkins (1990) Influence of upwellings storms and generating station operation on water chemistry and plankton in Nanticoke region of Long Point Bay, Lake Erie. Canadian Journal of Fisheries and Aquatic Sciences 47 (7) : 1434-1445.

Study Date	April – mid November 1969-1983
Location	• Nanticoke region, LPB, W of the Steel company of Canada to Peacock Point to the E over an area ~10km x 4km on N-shore of LPB (~7km of lake frontage) • 4 sampling stations were located 0.5-4.0 km from shore at 12 locations along the coast • Sample location map in text
Findings/Purpose	• Purpose: determine the effects of industrial development at Nanticoke on the aquatic environment • Localized changes in zooplankton distributions due to generating station cooling water are described • Zooplankton, phytoplankton and water quality samples were collected + water temperature, wind and storm occurrence data • Make-up and abundance of zooplankton was temporally and spatially variable (seasonally and more frequently) – affected by storms and upwellings (relatively fast decreases in temperature)
Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals

307. Dunstall, T. G., D. W. Lawler, R. Farooqui, and G.T. Haymes (1990) Variation in lake water temperature in the Nanticoke region of Long Point Bay, Lake Erie during the open-water season. Canadian Journal of Fisheries and Aquatic Sciences 47 (7) : 1427-1433 1990

Study Date	Open water seasons 1971-1983
Location	• N-shore LPB (see above study) – Stelco site to Peacock point • Study are map in text
Findings/Purpose	• Water temperatures varied considerably over study period during the open water season (lake warming cycle) • Upwellings with temperature decreases of 5-10°C over 2-3d were common mid-May – mid-August • Surface temperature rebounded within 6 d in summer, longer in spring • Wind direction influences upwelling occurrence

Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals

308. Eadie, J.M., T.D. Nudds and C.D. Ankney (1979) Quantifying interspecific variation in foraging behaviour of syntopic *Anas* (Anatidae). Canadian Journal of Zoology 57: 412-415.

Study Date	October 2 – November 13, 1977
Location	• LPB ponds – closed to hunting
Findings/Purpose	• Foraging behaviour of male puddle ducks of 6 species were observed • Statistical analysis revealed species differences not fully accounted for by differences in foraging behaviour • Time spent in 'tip-ups' and time between 'tip-ups' was used as basis for differentiation
Category	Waterfowl
Source	McMaster University, Thode library periodicals

309. Eagles, P.F.J., ed. (1980) Big Creek Site Description pp 168-170. In: Environmentally Sensitive Areas of Brant County. Second Edition. *xiv* + 285pp + maps

Category	Terrestrial Geography
Source	

310. Ecological Services for Planning Ltd. (1991) Environmental Analysis for Proposed Marina Trailer Park Development: Inner Bay of Long Point.

Category	Human Impact
Source	

311. Ecologistics Ltd. (1983) Lee Brown Waterfowl Management Area master plan. Long Point Region Conservation Authority. 41 pp.

Category	Land Use and Management
Source	CWS London

312. Edwards, Y. (1972) The future of Long Point. Unpublished Report. Canadian Wildlife Service, 24pp

Category	Land Use and Management
Source	CWS London

313. Elzawahry, A.E. (1985) Advection, diffusion and settling in the coastal zone of Lake Erie. PhD Thesis, McMaster University. 251pp.

Category	Hydrology and Sediments
Source	McMaster Libraries

314. Element Occurrence Database – Natural Heritage Information Centre (2007) Online Resource, Accessed August 30 2007. URL: http://nhic.mnr.gov.on.ca/MNR/nhic/species/species_jur.cfm OR: http://nhic.mnr.gov.on.ca/MNR/nhic/species.cfm

Study Date	n.d.
Location	• Various
Findings/Purpose	• Provides resources for identifying and reporting species of concern and endangered species within Canada • Species can be searched by region, municipality, or by name (common or scientific) • Some information is location-sensitive and cannot be accessed online – it can, in some cases, be requested (based on request) • Links to reports are found under species
Category	Birds, Waterfowl, Amphibians, Reptiles, Mammals
Source	Online Resource (see link in bibliographic entry)

315. Emery, A.R. and G. Teleki (1978) European Flounder (*Plutichthys flesus*) captured in Lake Erie, Ontario. Canadian Field Naturalist 92(1): 89-91.

Study Date	July 3, 1974 (1st specimen – LP), January 3, 1976 (2nd specimen – Port Burwell)
Location	• Off Nigger Rd., Long Point
Findings/Purpose	• Habitat usually oceanic or estuarine • Possible introduction through ship ballast • Not thought to be a range extension
Category	Fish
Source	McMaster University, Thode library periodicals

316. Environment Canada (1975) Canada/Ontario Great Lakes Shore Damage Technical Report. Canada – Environment Canada, Ontario – Ontario Ministry of Natural Resources. Booklet.

Category	Water Levels, Hydrology and Sediments, Land Use and Management
Source	McMaster Libraries

317. Environment Canada (1976) Canada-Ontario Great Lakes shore damage survey: coastal zone atlas. 250pp – chiefly colonial maps

Category	Water Levels, Hydrology and Sediments, Land Use and Management
Source	McMaster Libraries CWS London

318. Environment Canada (1979) Shore property hazards. Environment Canada and Ontario Ministry of Natural Resources. 14 pp.

Category	Water Levels, Hydrology and Sediments, Land Use and Management
Source	McMaster Libraries

319. Environment Canada (1985) Great Lakes Water Levels. Pamphlet.

Category	Water Levels
Source	McMaster Libraries

320. Environment Canada, Canadian Wildlife Service, OMNR, OMOE (2004) How much habitat is Enough? A framework for guiding habitat rehabilitation in the great lakes areas of concern. Canada-Ontario Remedial Action Plan Steering Committee. 2nd Edition. 76pp + maps

Study Date	n.d.
Location	• --
Findings/Purpose	• Provides guidelines for the protection and rehabilitation of important habitats within Canada • Information includes wetlands, riparian and forest habitats • Guidelines for % land cover for each habitat type, location, size and shape, water quality guidelines, impervious ground cover etc. • Working document to aid conservation groups and land stewards to better manage their lands
Category	Land Use and Management
Source	MNR Library

321. Environment Canada (2000) Contaminants in water and precipitation from the Canadian Great Lakes: 10 years of monitoring levels. Great Lakes fact sheet. 12pp

Category	Water Quality and Limnology
Source	McMaster Libraries

322. Environment Canada (2006) Recovery strategy for the Piping Plover (*Charadrius melodus circumcinctus*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa, vi + 30pp

Study Date	Uses existing literature
Location	• Great Lakes – Northern Great Plains
Findings/Purpose	• Provides biology, ecology, population distribution information • Examines threats to species existence (habitat loss, predation, etc.) and considers action plans to protect existing populations and plans

	for population recovery • LP is suggested as a probable location for the re-introduction of breeding pairs in the Canadian Great Lakes area
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

323. Esterby, S.R. and A.H. El-Shaarawi (1984) Coliform concentrations in Lake Erie - 1960-1970. Hydrobiologia 111: 133-146.

Study Date	1966-1970
Location	• Lake Erie
Findings/Purpose	• Total coliform was measured spatially throughout Lake Erie between 1966-1970 • Seasonal and spatial patterns appeared in coliform levels • Higher concentrations related to proximity to urban centres and lake currents
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

324. Evans, H.E. and R.N. Roecker (1951) Notes on the herpetology of Ontario, Canada. *Herpetologica, 7:69-71*

Category	Amphibians, Reptiles
Source	McMaster Libraries

325. Evans, J.E (1973) Thirty-seventh breeding bird census. Dry juniper-cottonwood savannah. American Birds 27:986-987.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

326. Evans, J.E. (1973) Thirty-seventh breeding bird census. White pine-white cedar forest. American Birds 27:980-981.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

327. Evans, J.E. and D.J. Nakashima (1973) Thirty-seventh breeding bird census. Blue grass-milkweed grassland. American Birds 27:1013.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

328. Evans, J.E. and D.J. Nakashima (1973) Thirty-seventh breeding bird census. Dry cottonwood sand dune. American Birds 27:986.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

329. Evans, J.E. (1974) Thirty-eighth breeding-bird census. Recreational dune area. Am. Birds. 28:1024.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

330. Fairfield, G.M. (1965) Twenty-ninth breeding bird census. Sand dunes with cottonwoods. Audubon Field Notes, 19: 630.

Findings/Purpose	See: Bridge & Bridge (1965)
Category	Birds

Source	McMaster University

331. Fairfield, G.M. (1967) Thirty-first breeding bird census. Sand dunes with cottonwoods. Audubon Field Notes, 21:657-659.

Findings/Purpose	See: Loery, T. (1967)
Category	Birds
Source	McMaster University

332. Fairfield, G.M. (1968) Thirty-second breeding bird census. Sand dunes with cottonwoods. Audubon Field Notes, 22:721-722.

Findings/Purpose	See: Lineham (1968)
Category	Birds
Source	McMaster University

333. Fairfield, G.M. (1969) Long Point Breeding Bird Census. Ontario Bird Banding 5: 1-6.

Study Date	1965-1968
Location	• LPBO • A site map is included in text
Findings/Purpose	• Provides a summary of data from the first 4 years of the breeding-bird census of the 'Sand Dunes and Scattered Cottonwoods" at LP • Data from 1966 was previous lost, and is reported here for the first time • General site information – major vegetation species present, height, etc., site size, landforms, elevation a.s.l • Photo of the site is in text • Population appears to double between 1966 – 1967, however trend is likely exaggerated based on intensity of sampling/observation • Species information, nest box use, transient vs. regular residents
Category	Birds
Source	BSC Library

334. Fairfield, G.M. (1969) Thirty-third breeding bird census. Sand dunes with cottonwoods. Audubon Field Notes, 23:739.

Findings/Purpose	See: Loery, T. (1969)
Category	Birds
Source	McMaster University

335. Fairfield, G.M. (1974) Study of breeding Kingbirds. Long Point Bird Observatory 1972 Annual Report. p. 13.

Category	Birds
Source	CWS London

336. Fairfield, G.M. (1976) Study of kingbird territorial fidelity. Long Point Bird Observatory 1974 Annual Report. pp. 16-17.

Category	Birds
Source	CWS London

337. Falls, J.B. (1953) Activity and local distribution of deer mice in relation to certain environmental factors. Ph.D. thesis, University of Toronto, Toronto, Ontario. 168 pp.

Category	Mammals
Source	

338. Falls, J.B. (1970) Odonata of Long Point. In: Long Point Bird Observatory Newsletter. 27(3) 17-19.

Category	Insects
Source	

339. Farid, C., J. Jackson, K. Clark (1997) The fate of the Great Lakes: sustaining or draining the sweetwater seas. Canadian Environmental Law Association, Great Lakes United

Category	Water Levels
Source	McMaster Libraries

340. Fazio V., D. Shepherd and T. Woodrow (1985) A Seasonal Checklist of the Birds of the Long Point Area. Long Point Bird Observatory.

Category	Birds
Source	CWS London

341. Ferguson, R.G. (1965) Bathymetric Distribution of American Smelt, (*Osmerus mordax*) in Lake Erie. Great Lakes Research Division, Univ. Michigan Publ. 13: 47-60.

Study Date	1963, 1964
Location	• Eastern Lake Erie
Findings/Purpose	• YOY were abundant in spring-summer near-shore for 1963, 1964, moving to deeper water in ~October • Observation revealed a vertical distribution of adult smelt • Day: concentrated near bottom at ~150 ft; Late aftgernoon: dispersal away from bottom; Night: remain dispersed and invaded hypolimnion • Amounts and types of organisms eaten at different times and depths – suggesting vertical interchange within the population • Findings suggest a preference of temperature ~43°F
Category	Fish
Source	MNR Library

342. Fick, W. (1979) A preliminary study of the aquatic macro-invertebrates in the Big Creek Marsh. Unpublished report to Canadian Wildlife Service. 17 pp.

Category	Macro-invertebrates
Source	CWS London

343. Field, M.H. (1965) Aging and sexing of Blue-winged Teal in early fall. Ontario Bird Banding 1(3):31-32.

Study Date	1965
Location	• LPBO
Findings/Purpose	• August-September 1965, 3,000+ were aged and sexed • Describes a method of determining age and sex quickly based on physical characteristics: for sex foot colour, bill spotting and greater wing coverts, tail feathers indicate age
Category	Birds
Source	BSC Library

344. Field, M.H. (1965) Banding of Blue-winged Teal at Long Point, Ontario, 1963. Ontario Bird Banding 1(1):45-51.

Study Date	1965
Location	• LPBO
Findings/Purpose	• Long Point is an important staging area for Blue-winged Teal • Traps were used to catch Blue-winged Teal • Daily catch records are given in text • Age and sex composition are given • Averages of physical characteristics (weight by age and sex) • Casualties during the capture and banding process are also given • Study indicates that the population of Blue-winged Teal was larger in 1965 than 1962 • Other ducks were caught in the traps in smaller numbers (Mallard, Black and Wood Ducks)
Category	Birds
Source	BSC Library

345. Finkleman, M. (1974) Sensitive areas survey. Unpublished Report. Ontario Ministry of Natural Resources, Simcoe District.

Category	Land Use and Management

Source	

346. Finkelstein, S.A. and A.M. Davis (2005) Modern pollen rain and diatom assemblages in a Lake Erie coastal marsh. *Wetlands* 25(3): 551-563.

Study Date	September, October – 2001, 2002
Location	• Rondeau Provincial Park – coastal wetland
Findings/Purpose	• Study investigates the relationship between dominant vegetation cover and pollen-diatom assemblages and moisture availability • Aims to improve prediction from fossil sequences • Marsh classification success based on pollen and diatom assemblages decreased as moisture availability decreased • Abundance of pollen generated proportional to species abundance impacted predictive capabilty
Category	General Wetlands, Aquatic Vegetation
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

347. Fletch, A.L. and L. Karstad (1968) An Intraerythrocytic protozoan parasite of the garter snake Thamnophis sirtalis. Bull. Wildlife Disease Assoc. Vol. 4, January, 1968 9-11

Study Date	July 1968
Location	• Long Point Provincial Park
Findings/Purpose	• Snakes were noted to be lethargic, unable to hunt and dying • Blood was taken from lethargic and non-infected snakes and tested • Some of the infected were killed, and their organs examined • When chicks and chicken embryos were infected, the parasited did not take or cause death • Stage in the life cycle of the parasite is in question – early to intermediate
Category	Reptiles
Source	MNR Library – Peterborough

348. Flinn, T. (2004) Spring Warbler Migration in Ontario: 2004. Toronto Ornithological Club, Toronto, ON. 38 pp.

Category	Birds
Source	

349. Flynn, C.A. (1979) The identification and mapping of aquatic vegetation in the Big Creek Marsh. Unpublished report to Canadian Wildlife Service. 15 pp.

Category	Aquatic Vegetation
Source	CWS London

350. Flynn, S. (1980) Big Creek marsh muskrat house count. Unpublished report; Canadian Wildlife Service.

Category	Mammals
Source	CWS London

351. Foster, J. and B. Ansley (1976) The differential influence of water turbidity on predation success of Largemouth Bass and Grass Pickerel at Long Point IN: Long Point Bird Observatory 1974 Annual Report (D.A. MacLulich ed.). p 9-11.

Category	Water Quality/Limnology, Fish
Source	CWS London

352. Foster, J.R. and T.J. Wheaton (1981) Losses of Juvenile and adult fishes at the Nanticoke thermal generating station due to entrapment, impingement and entrainment. *Journal of Great Lakes Research 7(2):* 162-170

Study Date	April 1976 – June 1977
Location	• Nanticoke Thermal Generating Station
Findings/Purpose	• Fish mortality, species, and fish health was monitored at Nanticoke • Examinations were done for those trapped in the western intake,

	impinged on the travelling screens, and entrained in the tempering pumps • Study indicates that the cooling system traps and kills many fish species – valuable for commercial and sport fisheries • Mortality dominantly caused by entrainment in the tempering pumps • Transient schooling species had highest mortality
Category	Fish, Human Impacts
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

353.Fox. W.H. (1968) Blue-winged Teal banding and recovery: Long Point Provincial Park. Ontario Bird Banding 4: 42-49.

Study Date	1963-1965
Location	• Long Point Provincial Park
Findings/Purpose	• Trapping methods and trap construction are described • Age and sex for each study year are provided – both numbers and % of total banded • Of greater than 3,000 banded, 225 had been recovered at the time of writing, 93 locally
Category	Birds
Source	BSC Library

354.Fox, W. and C. Holdsworth (1970) Distribution and mortality of Redheads banded at Long Point. p. 6-13 IN: Long Point Bird Observatory 1970 Annual Report (C. Holdsworth ed.).

Category	Waterfowl
Source	CWS London

355.Fox, W.S. and J.H. Soper (1952) The distribution of some trees and shrubs of the Carolinian zone of southern Ontario. Part I. Trans. Roy. Can. Inst. 29: 65-84.

Category	Terrestrial Vegetation, Forests
Source	McMaster Libraries

356.Fox, W.S. and J.H. Soper (1953) The distribution of some trees and shrubs of the Carolinian zone of southern Ontario. Part II. Trans. Roy. Can. Inst. 30: 3-32.

Category	Terrestrial Vegetation, Forests
Source	McMaster Libraries

357. Fox, W.S. and J.H. Soper (1954) The distribution of some trees and shrubs of the Carolinian zone of southern Ontario. Part III. Trans. Roy. Can. Inst. 30: 99-130.

Category	Terrestrial Vegetation, Forests
Source	McMaster Libraries

358.Francis, C.M. (1996) Trends in Numbers of Migrant Birds at Long Point (1961-1995) and Thunder Cape (1991-1995). Bird Studies Canada. Summary Report fot ehe Ontario Ministry of Natural Resources.

Study Date	1995 (trend monitoring 1961-1995; 1991-1995 for Thunder Cape)
Location	• LPBO, Thunder Cape
Findings/Purpose	• Correlations between indices at LPBO and Thunder Cape were strong however, may be somewhat coincidental as they are monitoring different components of migratory populations • Overall indices were up
Category	Birds
Source	BSC Library

359.Francis, C.M. (1997) Trends in Numbers of Migrant Birds at Long Point (1961-1996) and Thunder Cape (1991-1996). Bird Studies Canada. Summary Report fot ehe Ontario Ministry of Natural Resources.

Study Date	1996 (trend monitoring 1961-1996; 1991-1996 for Thunder Cape)
Location	• LPBO, Thunder Cape

Findings/Purpose	• Fall indices were low, but not consistently across all species • These changes could be cause by underlying population changes, but could also be related to weather conditions in comparison to the previous year • Migration monitoring stations are able to detect long term trends in population changes
Category	Birds
Source	BSC Library

360. Francis, C.M. (1999) Trends in Numbers of Migrant Birds at Long Point (1961-1998) and Thunder Cape (1991-1998). Bird Studies Canada. Summary Report fot ehe Ontario Ministry of Natural Resources.

Study Date	1998 (trend monitoring 1961-1998; 1991-1998 for Thunder Cape)
Location	• LPBO, Thunder Cape
Findings/Purpose	• Compared to 1997, spring indices were lower • These changes could be cause by underlying population changes, but could also be related to weather conditions in comparison to the previous year • 1998 indices do not significantly alter long-term population trends, changing trend significance in few cases • from 1991-1998 trends have shown a majority moving towards decreases rather than increases at both sites • Future research needs are identified including increased ability to account for weather effects, nocturnal monitoring for calibration and integrating data from other programs/locations
Category	Birds
Source	BSC Library

361. Francis, G.R. (1979) Rehabilitation and restoration for the Great Lakes: Some institutional considerations. Contact 11(1): 177-185.

Category	Land Use and Management
Source	McMaster Libraries

362. Francis, G.R., J.J. Magnuson, H.A. Regier and D.A. Talhelm (1979) Rehabilitating Great Lakes ecosystems. Great Lakes Fishery Commission Technical Report No. 37. 99 pp.

Category	Land Use and Management, Fish
Source	CWS London

363. Francis, G.R. (1980) Mapping the governmental institutional structure for ecosystem rehabilitation for the Canadian side of the Great Lakes. Unpublished progress report. 11 pp.

Category	Land Use and Management, Fish
Source	CWS London

364. Francis, G.R., Grima A.P., Reiger, H.A. and T.H. Whillans (1985) A Prospectus for the Management of the Long Point Ecosystem. Great Lakes Fishery Commission Technical Report No. 43, Ann Arbor, Michigan.

Category	Land Use and Management
Source	CWS London

365. Francis, G. R. (1985b). Long Point Biosphere Reserve Nomination. Ottawa, Ontario: Submitted to the Man and the Biosphere Programme, Canadian Commission for UNESCO.

Category	Land Use and Management
Source	

366. Francis, G.R. and G. Whitelaw (2001) Long Point Biosphere Reserve: periodic review. Canadian Biosphere Reserves Association; Unpublished report for the Canadian Commission for UNESCO 79pp.

Category	Land Use and Management
Source	

367. Frank, R., K. Montgomery, H.E. Braun, A.H. Berst and K. Loftus (1974) DDT and Dieldrin in watersheds draining the tobacco belt of southern Ontario. Pesticides Monitoring Journal 8(3): 184-201.

Category	Water Quality/Limnology
Source	

368. Frank R., K. Ishida and P. Suda (1976) Metals in agricultural soils of Ontario. *Canadian Journal of Soil Science 56(3)*: 181-196.

Category	Water Quality/Limnology
Source	McMaster Libraries

369. Frank R., K.I. Stonefield, and P. Suda (1979) Metals in agricultural soils of Ontario 2. *Canadian Journal of Soil Science 59(2)*: 99-103

Category	Water Quality/Limnology
Source	McMaster Libraries

370. Frank, R., H.E. Braun, K. Ishida, *et al.* (1976) Persistent organic and inorganic pesticide-residues in orchard soils and vineyards of southern Ontario. *Canadian Journal of Soil Science 56(4)*: 463-484.

Category	Water Quality/Limnology
Source	McMaster Libraries

371. Frank, R., H.E. Braun, J.V. Sirons, M.H.V. Holdrinet, B.D. Ripley, D. Onn and R. Coote (1978) Stream flow quality-pesticides in eleven agricultural watersheds in southern Ontario, Canada 1974-1977. PLUARG Technical Report, International Joint Commission, Windsor, Ontario.

Category	Water Quality/Limnology
Source	McMaster Libraries

372. Fraser, M.E., J.C. Day, R.D. Kreutzwiser and R.J. Turkheim (1977) Residents' utilization of Coastal Hazard Assistance Programs in the Long Point Area, Lake Erie. Canadian Water Resources Journal 2(2): 37-50.

Category	Land Use and Management, Human Impacts
Source	McMaster Libraries

373. Friend, P.J. (1981). The Historical geomorphology of Long Point, Lake Erie. Ottawa. 49 p.

Category	Terrestrial Geography
Source	

374. Ganon, J.E. (1980) Changes in zooplankton populations in Lakes Erie and Ontario. Bull. Buffalo Soc. Nat. Sci. 25: 21-40.

Category	Zooplankton and Phytoplankton
Source	

375. Gallivan, G.J., I.K. Barker, Ian K.; H. Artsob, L.A. Magnarelli, J.T. Robinson and D.R, Voight. (1998) Serological survey for antibodies to *Borrelia burgdorferi* in white-tailed deer in Ontario. Journal of Wildlife Diseases 34 (2): 411-414

Study Date	1985-1989
Location	• Long Point • 44°34’N, 80°10’W • Deer were also collected from motor-vehicle collisions for sampling throughout S. Ontario
Findings/Purpose	• Serum samples collected from deer to test for *Borrelia burgdoferi* antibodies • Some samples were tested using a second detection method

	• Antibodies were prevalent throughout S Ontario samples (3-47% occurrence) • At LP, antibodies were found in 5-7% of deer despite high tick infestation rates and high infection of adult ticks • Results indicate that deer are not a good sentinel species for the spread of *Borrelia burgdoferi*
Category	Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

376. Gartshore, M.E. (1987) The amphibians and reptiles of the regional municipality of Haldimand-Norfolk. DRAFT.

Category	Amphibians, Reptiles
Source	

377.Gartshore, M.E., D.A. Sutherland and J.D. McCracken (1987) Final Report of the Natural Areas Inventory of the Regional Municipality of Haldimand – Norfolk 1985-1986. Volume 1 and 2. Norfolk Field Naturalists, Simcoe, Ontario.

Study Date	1985-1986
Location	• Haldimand-Norfolk County (many sites within, including LP specific)
Findings/Purpose	• Using a set of pre-determined criteria, significant sites and significant natural areas were determined and investigated • Descriptions of each site are given (a total of 41 significant natural areas with sites within them) • Selection criteria are provided and site descriptions include the soils, hydrology, landforms, plant communities, flora, fauna, disturbances and conditions, and the site ranking within each set criteria • Site location maps are in text, with some site photos • Volume II: is the annotated bibliographies
Category	Land Use and Management, Terrestrial Vegetation, Hydrology and Sediments, Mammals, Birds, Human Impacts
Source	MNR Library http://www.kwic.com/nfn/naiorder.htm - access to annotated checklists online & document for purchase ($45)

378.Gebauer, M.B. and D.V. Weseloh (1993) Accumulation of organic contaminants in sentinel mallards using confined disposal facilities at Hamilton Harbour, Lake Ontario, Canada. Archives of Environmental Contamination and Toxicology 25(2): 234-243.

Study Date	1990
Location	• Hamilton Harbour Confined Disposal Facility (HHCDF) • Winowna Sewage Lagoons (WSL) • Big Creek Marsh
Findings/Purpose	• Organochlorine tests on adults and juveniles of farm-raised mallards released and collected at 3 experimental sites • HHCDF and WSL are known to be contaminated sites, Big Creek Marsh is representative of a relatively non-contaminated location • All 3 sites are used as feeding and stopover locations for waterfowl • Ducks were collected 10, 30 and 70 days after release • All ducks collected at HHCDF had PCB concentrations above health guidelines for Canada and the US • Significantly elevated levels of several toxins were found in ducks collected from WSL • Big Creek Marsh ducks had much lower concentrations than others • Unclear whether bioaccummulation would pose problems for resident and migrating ducks – diving ducks and those in greater contact with contaminated sediments would likely be at higher risk
Category	Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

379. Gelinas, P.J. and R.M. Quigley. (1973) The influence of geology on erosion rates along the north shore of Lake Erie. 16th Conf. Great Lakes Research Proc. P. 421-430.

Category	Terrestrial Geography, Hydrology and Sediments
Source	McMaster Libraries

380. Gibo, D.L. and M.J. Pallett (1979) Soaring flight of Monarch Butterflies *Danus plexippus* (Lepidoptera: Danadae), during the late summer migration in southern Ontario. Canadian Journal of Zoology 57(7): 1393-1401

Study Date	1977
Location	• Erindale Campus, University of Toronto • Turkey Point Provincial Park • Long Point Provincial Park
Findings/Purpose	• Adult monarchs often exhibit soaring flight during their late summer migrations • To achieve this, they use both ascending currents and thermals, sustained soaring was associated with tail winds • Butterflies appear to be very efficient and vary their flying techniques when they encounter different types of lifts • When weather is favourable, soaring is the mail mode of flight and they can achieve heights of >300m • Mechanical function of butterflies adapted to soaring is examined in 18 specimens • The energetic advantages of utilizing soaring flight in terms of extension of maximum range is discussed
Category	Insects
Source	BSC Library McMaster University Library – Thode periodicals

381. Gibson, A.R. and J.B. Falls (1975) Evidence for multiple insemination in the Common Garter Snake, *Thamnophis sirtalis*. Canadian Journal of Zoology 53: 1362-1368.

Study Date	July-August 1972
Location	• LP – Courtright ridge (main site)
Findings/Purpose	• LP has both melanistic and striped garter snakes • Morph of litter of melanistic females was recorded • Results indicate that multiple insemination occurs in natural populations • Evidence for copulatory plugs in recently mated females
Category	Reptiles
Source	McMaster University, Thode library periodicals CWS London

382. Gibson, A.R. (1978) Ecological significance of a colour polymorphism in the Common Garter Snake , *Thamnophis sirtalis* (L.). Ph.D. thesis, University of Toronto, Toronto. 434 pp.

Category	Reptiles
Source	

383. Gibson, A.R. (1979) Thermal biology of the Common Garter Snake, *Thamnophis sirtalis* I. Temporal variation, environmental effects and sex differences. Oecologia 43: 79-97.

Study Date	1971-1974
Location	• E-end of Long Point (42°33'N 80°03'W)
Findings/Purpose	• Body temperature of snakes was coolest and most variable a) early and late in the day b) early in the season • Females generally 1°C warmer than males in mid-summer (sunny days) – this difference does not exist on cloudy-cool days • Study suggests that males are less accurate in thermoregulation • Air-ground temperatures and snout length are poor indicators of differences

	• Females show little differences between gravid and non-gravid individuals
Category	Reptiles
Source	McMaster University, Thode library Available digitally from publisher at cost

384. Gibson, A.R. (1979) Thermal biology of the Common Garter Snake, *Thamnophis sirtalis* II. The effects of melanism. Oecologia 43: 99-109.

Study Date	August-October, 1976
Location	• E-end of Long Point (42°33'N 80°03'W)
Findings/Purpose	• Melanistic snakes were found to maintain warmer body temperatures (~1.24°C) than striped garters • Common results were found in both living snakes and excised skin in laboratory and field experiments • Some evidence also indicates that melanism protects from over-heating
Category	Reptiles
Source	McMaster University, Thode library Available digitally from publisher at cost

385. Gibson, A.R. and J.B. Falls (1985) Melanism in the Common Garter Snake: A Lake Erie phenomenon. Presented at the 9th Biosciences Colloq., Ohio.

Category	Reptiles
Source	CWS London

386. Gibson, G. (1994) Breeding bird census #108: sedge-rush swale II. Journal of Field Ornithology 65 (Supplement): 110-111.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

387. Gibson, G. (1994) Breeding bird census #107: sedge-rush swale I. Journal of Field Ornithology 65 (Supplement): 110.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

388. Gibson, G. (1994) Breeding bird census #73: intergrading dune-swale savannah. Journal of Field Ornithology 65 (Supplement):85-86.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

389. Gillespie, D. et al (1991) Wetlands for the World: Canada's Ramsar Sites. Environment Canada 40pp

Study Date	Various – 1975 (establishment of the Ramsar convention)
Location	• Various – Including a special section on Long Point and Lake St. Clair
Findings/Purpose	• Introduction provides a brief overview of wetland importance and the Ramsar convention • Long Point Section: physical description of habitat and development of the spit • Highlights rare, endangered or threatened species, counts of species at Long Point – waterfowl, other birds, reptiles, anurans • Issues related to site disturbance, and mention of the existing LPBO and the establishment of the LPWWRF
Category	General Wetlands
Source	MNR Library

390. Gillie, R.D. (1974) The nearshore morphology of sand beaches on the Great Lakes shoreline of southern Ontario. MSc. Thesis. McMaster University.

Category	Hydrology and Sediments
Source	McMaster Libraries

391. Gillis, P.L., P. Chow-Fraser, J.F. Ranville, P.E. Ross, and C.M. Wood (2004) *Daphnia* need to be gut-cleared too: The effect of exposure to and ingestion of metal-contaminated sediment to the gut-clearance patterns of *D. magna*. Aquatic Toxicology 71(2): 143-154.

Study Date	n.d.
Location	• Reference sediments (non-contaminated) were taken from Long Point Bay (42°33'54" N, 80°02'28'' W) • Contaminated sediments from: Clear Creek CO, USA (39°44'54" N, 105°23'55''W)
Findings/Purpose	• *Daphnia magna* ingest sediments, and can therefore cause overestimation of metals in whole-body tissue-analysis if the gut is not emptied thus overestimating the bio-availability of a sediment-related contaminant • *Daphnia magna* exposed to metal-contaminated sediments had fuller guts than those exposed to clean sediments • Purging *Daphnia magna* in clean water following exposure did not significantly reduce gut fullness (up to 48 hrs) • Purging *Daphnia magna* in clean water with algae following exposure for 8 hrs significantly reduced gut contents, and is recommended as a procedure before use in contaminant bioavailability testing
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

392. Gillis, P.L., C.M. Wood, J.F. Ranville, and P. Chow-Fraser (2006) Bioavailability of sediment-associated Cu and Zn to *Daphnia magna*. Aquatic Toxicology 77(4): 402-411.

Study Date	n.d.
Location	• Reference sediments (non-contaminated) were taken from Long Point Bay (42°33'54" N, 80°02'28'' W) • Contaminated sediments from: Clear Creek CO, USA (39°44'54" N, 105°23'55''W)
Findings/Purpose	• Collected contaminated sediments were acutely toxic to *Daphnia magna* without treatment • Findings indicate that dissolved Cu was more directly related to mortality • Particulate Cu, Zn and dissolved Zn did not have the same impact • Findings indicate that resuspension of the contaminated sediments could cause acute toxicity in the water column of the site
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

393. Glooschenko et al. (1988) Provincially and Regionally Significant Wetlands in Southern Ontario. Interim Report – 1987.

Category	General Wetlands
Source	

394. Goff, G.P. (1984) The reproductive behaviour and ecology of Smallmouth Bass (*Micropterus dolomieui*) in Long Point Bay, Lake Erie. Ph.D. thesis, University of Western Ontario, London, Ontario. 108 pp.

Category	Fish
Source	CWS London

*395.*Goff, G.P. (1984) Brood care of Longnose Gar (*Lepisosteus osseus*) by Smallmouth Bass (*Micropterus dolomieui*). *Copeia 1:* 149-154.

Study Date	May-June 1982 (and laboratory time following initial field investigation)
Location	• Long Point Bay, Lake Erie (80°19' E, 42°35' N)
Findings/Purpose	• Unidentified eggs were found in smallmouth bass nests and were incubated in lab to determine their species – Longnose Gar • Longnose Gar eggs were found in 10 or 69 nests observed • Male bass provided brood-care to both bass and gar eggs and larvae • Nests with both species had a higher success rate than sole-bass nests
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London

396. Goff G.P. (1985) Environmental-influences of annual variation in nest success of smallmouth bass, *Micropterus dolomieui*, in Long Point Bay, Lake Erie. *Environmental Biology of fishes 14 (4):* 303-307

Study Date	May-July, 1982,1983
Location	• Inner Long Point Bay, Lake Erie • Site specific information is provided in text (no co-odinates)
Findings/Purpose	• Nesting success was between 33 and 88 % between two years of study • 6 variables were recorded at successful nests: male age, degree-days, water depth, vegetation height, vegetation cover, windy hours • Study indicates that dominant difference between years/sites was windy hours and degree days where fewer windy hours during offspring development increased success, and more degree-days were observed in the more success year
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London

397.Goff, G.P. (1986) Reproductive success of male smallmouth bass in Long Point Bay, Lake Erie. *Transactions of the American Fisheries Society* 115: 415–423.

Study Date	May-July, 1982,1983
Location	• Inner Long Point Bay, Lake Erie • Site specific information is provided in text (no co-odinates, sample location map in text)
Findings/Purpose	• Reproductive success of individual males considered the number of offspring to reach free-swimming larvae • Effect of 13 variables on reproductive success were investigated: Date, water temperature, windy-hours, fork length, age, nest diameter, nest material, *chara* height – nest, general, vegetation cover – nest, general, sediment density, water depth • Accumulated hours of strong winds during embryo development had the largest impact • Material at bottom affected nest success to a lesser degree
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

398.Goodlet, D., P. Roberts, G. Miller and J.E. Evans (1974) Thirty-eighth breeding bird census. Recreational dune area. American Birds 28:1024.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

399. Goodwin, C.E. (1980) The nesting season: June 1 – June 31, 1980, Ontario – western New York region. *American Birds 29(6): 963-967*

Study Date	May-July 1975
Location	• Ontario and western New York – not particularly LPB specific
Findings/Purpose	• Nesting and breeding success is evaluated based on observations by various individuals (compiled in article) • Birds are categorized generally, and specific cases of interested are noted • Some broad migratory/mortality information is also provided
Category	Birds
Source	McMaster University, Thode library periodicals CWS London

400. Goodwin, C.E. (1977) Rare and threatened birds of Canada *in* Mosquin, T. and C. Suchal. Eds. Canada's threatened species and habitats. Can. Nat. Fed. Ottawa pp. 85-87. (note, citation is good but this document is cited very different under Allison 1977).

Category	Birds
Source	

401. Goodyear, R.C. (1993) Breeding bird census #29: dry cottonwood sand dune. Journal of Field Ornithology 64 (Supplement):51.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

402. Gracie, A., H. Maxwell and J. Strybosch (1984) Wetland Data Record and Evaluation – Peripheral Marshes West of Long Point (Dedrick's Creek). August 10, 1984. Long Point Foundation for Conservation & OMNR, Simcoe.

Category	General Wetlands
Source	NHIC (Natural Heritage Information Centre)

403. Graham, D.M. (1996) Assessment of the abundance, biomass, and production of the lower trophic levels in the eastern basin of Lake Erie, 1994. Bayfield Institute, Canadian department of Fisheries and Oceans, Great Lakes Laboratories for Fisheries and Aquatic Sciences.

Study Date	1994
Location	•
Findings/Purpose	• Focus is on the eastern basin of Lake Erie • Same sampling sites used in 1993 study • Biomass increased substantially from 1993 (56%), however chlorophyll and phytoplankton photosynthesis were not significantly higher • Changes in the *Dreissena* population (and therefore phytoplankton consumption) seem to have been a dominant influence in these changes • Finding are presented graphically on maps, and figures and also in tabular format
Category	Water Quality/Limnology, Macro-invertebrates
Source	McMaster University, Thode library periodicals

404. Graham, D., S. Timmermans and J. McCracken (2001) A comparison of abundance of colonial marsh birds between 1991 and 2001 in the Canadian portions of Lakes Huron, St. Clair, Ontairo and Erie. Unpublished report to Environment Canada, Environmental Conservation Branch, Ontario Region. 33 pp.

Study Date	1991-2001
Location	• Canadian Great Lakes coastal marshes
Findings/Purpose	• 10 km squares were surveyed for colonial marsh birds • 95% of Ontario's Forster's Tern population occurs in Walpole Island wetlands

	• Black Tern numbers dropped considerably in Lakes St. Clair and Erie in 2001 with smaller decreases in Lakes Huron and Ontario • Little Gulls – not found in the 1991 survey, two found in the 2001 survey • Conservation considerations for these birds: nest and breeding habitat protection, moderate cattail density, provide artificial nesting platforms where insufficient natural substrates exist
Category	Birds
Source	BSC Library

405. Grasman, K.A. (2002) Lake Erie LaMP beneficial use impairment assessment: animal deformities and reproduction impairment. Canadian Wildlife Service, Ontario division. 77pp.

Category	Mammals
Source	McMaster Libraries

406. Great Lakes Fisheries Commission (1985) Lake Erie fisheries report 1984: Lake Erie committee meeting, Great Lakes Fishery Commission, Ann Arbor, Michigan, March 21-22 1985.

Category	Fish
Source	McMaster Libraries

407. Great Lakes Fisheries Commission (1998) Lake Erie fisheries report 1997: Lake Erie committee meeting, Great Lakes Fishery Commission, Niagara Falls, Ontario, March 25-26 1998.

Category	Fish
Source	McMaster Libraries

408. Green, D.M. (1981) Theoretical analysis of hybrid zones derived from an examination of two dissimilar zones of hybridization in toads, genus *Bufo*. Ph.D. thesis, University of Guelph, Guelph, Ontario.

Category	Amphibians
Source	

409. Green, D.M. (1981) Hybridization in sympatry between the toads Bufo americanus and B. fowleri in southern Ontario. *American Zoologist* 21: 936

Study Date	Nd
Location	• Not included
Findings/Purpose	• Very short (<250 words) abstract of study conducted looking at genetic differences in hybrid toads • Hybrid appears to be a stable condition that does not indicate permanent genetic changes in parental species • Hybrids occur where environmental conditions allow
Category	Amphibians
Source	McMaster University, Thode library periodicals

410. Green, D.M. (1982) Mating call characteristics of hybrid toads (*Bufo americanus* x *B. fowleri*) at Long Point, Ontario. *Canadian Journal of Zoology* 60: 3293-3297

Study Date	May 5, 1981
Location	• LP – swamp on northern side of the point btwn Brant Parkway and Pines Parkway
Findings/Purpose	• Mating calls of 18 male toads were recorded, toads were then captured • Species specific choruses were noted with hybrid toads occurring between species specific choruses or during mixed choruses • Call frequency appears to vary inversely with body size • Call differences may dominantly be mechanical in pulse-modulation
Category	Amphibians
Source	McMaster University, Thode library periodicals

	CWS London

411. Green, D.M. (1984) Sympatric hybridization and allozyme variation in the toads *Bufo americanus* and *B. fowleri* in southern Ontario. Copeia 1984(1): 18-20

Study Date	1977-1980
Location	• Long Point, Lake Erie
Findings/Purpose	• Investigation into the hybridization of *Bufo americanus* and *B. fowleri* • Hybridization indicators were similar to other studies, however indicators of geographical divergence were not evident as has been reported elsewhere • Hybrids found were of intermediate morphology and geotype – appeared to be first generation progeny • Hybridization appears widespread, but does not appear to influence maintenance of the two individualized species
Category	Amphibians
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost CWS London

412. Green, D.M. (1985) The biology and population status of *Bufo woodhousii fowleri* (Fowler's Toad) in Canada. Unpublished report for Committee on Endangered Wildlife in Canada (COSEWIC) and World Wildlife Fund Canada. 42 pp.

Category	Amphibians
Source	

413. Green, D.M. (1989) The toads of Long Point: a tale of two species. Long Point Bird Observatory Newsletter 21(2):17.

Category	Amphibians
Source	

414. Green, D.M. (1989) Fowler's Toad (*Bufo woodhousii fowleri*) in Canada: biology and population status. Canadian Field-Naturalist 103:486- 496

Study Date	Review of existing literature, no field work
Location	• Various along Lake Erie (Northern extent of Fowler's Toad habitat)
Findings/Purpose	• Review of existing information on Fowler's Toads including: nomenclature, habits, predation, reproduction & growth, habitat, distribution, and hybridization • Canada-specific information examines 'current trends' in population & distribution as well as protection/conservation issues • LP: Pop. has been stable ~50yrs, considered relatively common in early research (1920's-1950's)
Category	Amphibians
Source	McMaster University, Thode library periodicals

415. Green, D.M. and Z.S. Porebski (1991) Breeding activity of Fowler's Toads, *Bufo woodhousii fowleri* at Long Point, Ontario, in 1990. Report to Ontario Ministry of Natural Resources and Canadian Wildlife Service.

Category	Amphibians
Source	

416. Green, D.M., C.W. Zeyl and A. El-Yassir (1991) Spring emergence and abundance of Fowler's Toads, *Bufo woodhousii fowleri* at Long Point, Ontario, in 1991: implications for conservation. Report to Ontario Ministry of Natural Resources, Canadian Wildlife Service, and World Wildlife Fund Canada.

Category	Amphibians
Source	

417. Green, D.M. (1992) Fowler's toads, *Bufo woodhousii fowleri* at Long Point, Ontario: changing abundance and implications for conservation. pp. 37-45. in C.A. Bishop and

K.E. Pettit (Eds.), Declines in Canadian Amphibian Populations: designing a national monitoring strategy. Canadian Wildlife Service, Ottawa.

Category	Amphibians
Source	

418. Green, D.M., A. Valachovic, G. Tambasco and A. Kelner (1993) Spring Emergence, Age Structure, and Abundance of Fowler's Toads, *Bufo woodhousii fowleri*, at Long Point, Ontario, in 1992. Report to Ontario Ministry of Natural Resources and Canadian Wildlife Service.

Category	Amphibians
Source	

419. Green, D.M. and H.S. Chan Tang (1994) Breeding Activity and Growth Rate in Fowler's Toads (*Bufo woodhousii fowleri*) at Long Point, Ontario in 1993. Ontario Ministry of Natural Resources, Canadian Wildlife Service, and World Wildlife Fund Canada.

Category	Amphibians
Source	

420. Green, D.M., M. Ouellet, and C. Saumure (1995) Breeding Activity and Growth Rate in Fowler's Toads (*Bufo woodhousii fowleri*) at Long Point, Ontario in 1994. Ontario Ministry of Natural Resources, Canadian Wildlife Service, and World Wildlife Fund Canada.

Category	Amphibians
Source	

421. Green, D.M. (1996) Variation in Abundance and Age Structure in Fowler's Toads, Bufo fowleri, at Long Point, Ontario. Froglog 16:4.

Category	Amphibians
Source	

422. Green, D.M., and J. Rabinowitz. (1996) Spring Emergence, Age Structure, and Abundance of Fowler's Toads, *Bufo fowleri*, at Long Point, Ontario, in 1995.Ontario Ministry of Natural Resources, Canadian Wildlife Service, and World Wildlife Fund Canada.

Category	Amphibians
Source	

423. Green, D.M. (Ed.) (1997) Amphibians in Decline. Canadian Studies of a GlobalProblem. Herpetological Conservation. Vol. 1. Soc. Stud. Amphib. Rept., St.Louis.

Category	Amphibians
Source	

424. Green, D.M. (1997) Population Ecology of Fowler's Toads, *Bufo fowleri*, at Long Point, Ontario. World Wildlife Fund, Endangered Species Recovery Fund.

Category	Amphibians
Source	

425. Green, D.M. (1997) Temporal variation in abundance and age structure in Fowler's toads (*Bufo woodhousii fowleri*) at Long Point, Ontario. Herpetological Conservation 1:45-56.

Category	Amphibians
Source	

426. Green, D.M., and J. Hensley (1998) Age Structure, and Abundance of Fowler's Toads, *Bufo fowleri*, at Long Point, Ontario, in 1997.Ontario Ministry of Natural Resources, Canadian Wildlife Service, and World Wildlife Fund Canada Endangered Species Recovery Fund.

Category	Amphibians
Source	

427. Green, D.M. (1999) Population ecology of Fowler's Toads, *Bufo fowleri*, at Long Point, Ontario, in 1999. World Wildlife Fund Canada Endangered Species Recovery Fund.

Category	Amphibians
Source	

428. Green, D.M., and L. Bol (1999) Population ecology of Fowler's Toads, *Bufo fowleri*, at Long Point, Ontario, in 1998. Ontario Ministry of Natural Resources, Canadian Wildlife Service, and World Wildlife Fund Canada Endangered Species Recovery Fund.

Category	Amphibians
Source	

429. Green, D.M. (1999) Update Status Report on the Fowler's Toad, *Bufo fowleri*, in Canada. in COSEWIC assessment and update status report on the Fowler's Toad, *Bufo fowleri*, in Canada Committee on the Status of Endangered Wildlife in Canada. Ottawa. 25 pp.

Category	Amphibians
Source	

430. Green, D.M. (1999) How Do Amphibians Go Extinct? IN L. M. Darling, editor. 2000. Proceedings of a Conference on the Biology and Management of Species and Habitats at Risk, Kamloops, B.C., 15 - 19 Feb.,1999. Volume One. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. and University College of the Cariboo, Kamloops, B.C. 490pp.

Study Date	Literature Review – state of the science discussions
Location	• Long Point, Lake Erie – a focused study for discussion
Findings/Purpose	• Amphibians often considered highly susceptible to environmental changes and are noted for their limited dispersal abilities, bi-phasal life histories, and permeable skin • However, they also have large variations and can maintain large populations • Discussions of two kinds of declines are considered: 1) downward trend of kinds of individuals within a populations; 2) downward trend in numbers of populations • Definition of what a decline is and differences in responses and indicators are discussed
Category	Amphibians
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

431. Green, David M., and Smith, M. Alex (2000) Population ecology of the Fowler's toad (*Bufo fowleri*) at Long Point, Ontario. A report for the World Wildlife Federations Endangered Species Recovery Fund.

Category	Amphibians
Source	

432. Green, D.M. and M.A. Smith (2000) Ecology and Viability of Fowler's Toads (*Bufo fowleri*) populations. World Wildlife Fund Canada Endangered Species Recovery Fund.

Category	Amphibians
Source	

433. Green, D.M. (2000) A Population Viability Analysis of Fowler's Toads, *Bufo fowleri*, in Canada. Unpublished report for Committee on the Status of Endangered Wildlife in Canada.

Category	Amphibians
Source	NHIC (Natural Heritage Information Centre) Reference # 77826

434. Green, D., M., and Smith M. Alex (2002) Dispersal and Viability of Fowler's Toads (*Bufo fowleri*) Populations in Canada. Presented at the annual meeting of the Canadian Amphibian and Reptile Conservation Network 2002.

Category	Amphibians

Source	

435. Green, D.M. and M.A. Smith (2003) Spatial ecology of Fowler's toad (*Bufo fowleri*) populations in Canada. World Wildlife Fund Canada Endangered Species Recovery Fund.

Category	Amphibians
Source	

436. Green, D.M. and C. Parent (2003) Variable and asymmetric introgression in a hybrid zone in the toads, Bufo americanus and Bufo fowleri. Copeia 2003 (1) : 34-43 February 26, 2003

Study Date	1978-1981 (majority of original sample collection)
Location	• Niagara Peninsula, Long Point
Findings/Purpose	• Examine the existence of hybrid populations at geographically close locations where both species are present • Hybrids occur at Long Point naturally, but do not in the Niagara Peninsula although species are sympatric at both locations • Hybrid zones are suggested as not being conforming to 'tension zones' but rather occur related to a 'localized sympatric' hybrid zone – such that occurrence of both species does not necessitate hybridization
Category	Amphibians
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

437. Gregor, D.J. and W. Rast (1979) Trophic characterization of the U.S. and Canadian nearshore zones of the Great Lakes. PLUARG, International Joint Commission

Category	Water Quality/Limnology
Source	McMaster Libraries

438. Griffiths, R.W. (1986) Impact of Industrial Development on the Nearshore Benthic Fauna of Lake Erie Near Nanticoke: Part 1: Texaco Canada. Aquatic Ecostudies Limited: Ecological Research Specialists report to the Ontario Ministry of the Environment.

Study Date	1977-1983
Location	• Nanticoke
Findings/Purpose	• Evaluate the effect of Texaco Canada's oil refinery effluent on the nearshore environmental quality • 1977-1978, pre-operation conditions • 1982-1983, operational conditions • Various quality indicators show that nearshore environmental quality is impaired by the effluent discharged from the refinery • No indication that the effluent was toxic to aquatic life or that it caused anoxic conditions in the discharge area • Effluent did cause an organic enrichment problem • Organics were part of the effluent or a result of the anit-emulsifiers in the effluent coagulating the organic matter in the water column in the water produced from the Nanticoke TGS • Effluent may have helped increase standing stock of fish in the Nanticoke vicinity available to the sport fishery
Category	Human Impacts, Fish
Source	MNR Library – Peterborough

439. Grove. E. (1974) A lakeshore study of Haldimand and Norfolk Counties. 2nd Ed. Haldimand-Norfolk Joint Study Committee. 51 pp

Category	Land Use and Management, Water Quality/Limnology
Source	McMaster Libraries CWS London

440. Guire, K.E. and E.G. Voss (1963) Distributions of distinctive shoreline plants in the Great Lakes Region. *The Michigan Botanist* 2:99-114.

Category	Terrestrial Vegetation, Aquatic Vegetation
Source	

441. Guglielmo. C. G, D. J. Cerasale, and C. Eldermire (2005) A Field Validation of Plasma Metabolite Profiling to Assess Refueling Performance of Migratory Birds. *Physiological and Biochemical Zoology*, 78 (2005), pages 116–12

Study Date	April – June, 2002
Location	• Long Point Bird Observatory
Findings/Purpose	• Two sites based on site quality (spit BASE sites – high quality, spit TIP sites – low quality) were used to assess refuelling performance of six passerine bird species using plasma metabolite profiling (blood-sampling) • Site quality was previously determined independently by other studies • An indicator of fat deposition was higher at the BASE sites in 3 early-season species • An indicator of lipid utilization and fasting was lower at BASE sites for the same 3 species • No metabolite suggested better conditions at the TIP sites • Results suggest use of plasma metabolites for assessing stopover habitat quality and individual performance in re-fuelling migrants
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

442. Haggeman, J.G. (1981) Some characteristics of a population of Spotted Turtles and a population of Blandings Turtles. Unpublished report, Department of Zoology, University of Guelph. 15 pp.

Category	Reptiles
Source	CWS London

443. Haggeman, J.G., B. Parker, J. Dawson, A. Gracie, H. Maxwell and J. Strybosch (1987) Wetland Data Record and Evaluation – Long Point Wetland Complex. Fieldwork, 1984, Update 1987. Ontario Ministry of Natural Resources, Simcoe & Long Point Foundation for Conservation. 12pp + 6 maps + 20 pp supplement.

Category	General Wetlands
Source	

444. Haig, S. (1985) The status of the Piping Plover in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 23 pp.

Category	Birds
Source	

445. Halyk, L. (1983) The fish community of a portion of the Big Creek Marsh – preliminary results. Unpublished Ontario Ministry of Natural Resources Report. 2 pp.

Category	Fish
Source	CWS London

446. Halyk, L. (1984) Summer Creel census on the Long Point Crown Marsh, 1984. Unpublished Technical Report, Ontario Ministry of Natural Resources, Simcoe, Ontario. 21 pp.

Category	Fish
Source	CWS London

447. Hamilton, D.J. (1992) The relationship between two predator groups, diving ducks and fish and a novel prey item, the Zebra mussel (*Dreissena polymorpha*) in Lake Erie at Point Pelee, Ontario. Masters Thesis. The University of Western Ontario, London, Ontario.

Study Date	1991-1992
Location	• Point Pelee
Findings/Purpose	• Examine the relationship between potential predators (ducks & fish) and zebra mussels • Predator exclusion cages were used to monitor the impact of predators on mussel populations (combined with gut and gizzard analysis, behavioural analysis, and duck population changes) • Do these predators have an impact on zebra mussle control? Have they become an important food source? • Fish were not found to consume the mussels, ducks however reduced mussel biomass by 46% • Selective in prey size, changing mussel population structure • Ducks were found to have altered their migration patterns since the arrival of the zebra mussel • Study suggests that ducks area mitigating impact of zebra mussels in the area as they have in Europe
Category	Invasive Species, Macro-invertebrates
Source	MNR Library – Peterborough

448. Hamilton, D.J., C.D. Ankney, and R.C. Bailey (1994) Predation of zebra mussels by diving ducks: An exclosure study. Ecology 75(2): 521-531.

Study Date	1990-1991
Location	• Point Pelee
Findings/Purpose	• Not LP specific – LP used as a secondary example from other work completed, not a study site • Zebra mussels are an abundant potential food source for diving ducks in Lake Erie • Study examines the predator-prey relationship between them • ~ decrease in zebra mussel biomass by 57% during heavy feeding period • No measurable impact on zebra mussel numbers • Size-selective predation of mussels – medium to large mussels preferred • After period of low feeding, caged areas and open areas showed little difference in abundance or biomass • Overall little lasting impact was made on the mussels by duck predation
Category	Invasive Species, Waterfowl
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

449. Hamilton, J.P., G.S. Whitelaw, and A. Fenech (2001) Mean annual temperature and total annual precipitation trends at Canadian Biosphere Reserves. Environmental Monitoring and Assessment 67(1-2): 239-275.

Study Date	Historical data-sets
Location	• Waterton Lakes, Riding Mountain, Niagara Escarpment, **Long Point**, Kejimkujik • Climate observations for Long Point Biosphere Reserve are from: Delhi CDA Ont. 42°52'N 80°33'W (1934–1998) London A (adj) Ont. 43°02'N 81°09'W (1895–1998) Port Dover Ont. 42°47'N 80°13'W (1895–1983) Simcoe Ont. 42°52'N 80°20'W (1895–1961) St.Williams Ont. 42°42'N 80°27'W (1954–1990) St.Williams Auto Ont. 42°42'N 80°27'W (1989–1997) Woodstock (adj) Ont. 43°08'N 80°46'W (1895–1998)
Findings/Purpose	• Examine climate variations within 5 Canadian Biosphere Reserves • World climate observations indicated temperature increase of ~0.6°C over the last century • In the northern hemisphere this effect has been more acute

	• North American precipitation has increased ~4-5% over last century • Long Point data indicates a general warming trend of ~0.5-0.6°C over last century • Variations in precipitation are not consistent – with statistically insignificant increases at some stations and 8-22% increases in annual precipitation at others
Category	Weather and Air Quality, Climate Change
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

450. Hamley, J.M. and N.G. MacLean (1979) (different years from different sources). Impacts of Nanticoke industrial development. Contact 11(1): 81-115.

Study Date	April – October, 1971-1978 (excluding 1973)
Location	• 10 areas within LPB (sample map in text)
Findings/Purpose	• Rock bass, yellow perch and freshwater drum most commonly collected • Seasonal and temporal differences in fish catches • Net mesh size influence fish size and species caught (small species dominantly missed) • Species variation in catch influenced by sample location • Accurate fish abundance estimates cannot be gained with this method • Standardization will reduce bias
Category	Human Impacts
Source	McMaster University, Thode library periodicals

451. Hamley, J.M. (1981) Summary of Nanticoke Fish Studies in 1979-1978. Unpublished report, Ontario Ministry of Natural Resources, Port Dover, Ontario. 182 pp.

Category	Fish
Source	CWS London

452. Hamley J.M., T.P. Howley, and A, Punhani (1983) Estimating larval fish abundances from plankton net catches in Long Point Bay, Lake Erie: 1971-78 *Journal of Great Lakes Research* 9 (4): 452-467 1983

Study Date	Summers, 1971-1978
Location	• Long Point Bay
Findings/Purpose	• Small larvae (4-10mm) were relatively scarce in surface waters during the day and catches decreased throughout the season • Larger larvae (>10mm) were rarely caught indicating they were avoiding the nets • No evidence was found that the Nanticoke development was impacting larval populations however it is noted that given inter-annual variations would preclude evidence of all but very large disturbances to populations • Multi-year studies are suggested to observe impact
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

453. Hamley, J.M., J.C. Lockhart and D.J. Reid. (1981) Sport fishing in Long Point Bay. Unpublished report, Ontario Ministry of Natural Resources, 21 pp.

Category	Fish
Source	CWS London

454. Hamley, J.M. and T.P Howley (1985) Factors affecting variability of trapnet catches. *Canadian Journal of Fish. Aquat. Sci. 42:1079-1087*

Study Date	Review paper
Location	• Long Point Bay Lake Erie
Findings/Purpose	• Standard deviations of catch were high for all species, including those

	most commonly caught (stdev greater than the mean in most cases) • 50-65% of differences can be attributed to soak time, sampling location, season, and year • Precision of estimating catch also a contributing factor – to estimate to within 20-25%, 100+ lifts would be required • A longer term study is suggested to compensate for these variations
Category	Fish
Source	MNR Library – Peterborough McMaster University Library – Thode periodicals CWS London

455. Hardy, P.A. (1979) Coastal Marsh Management: The Case of Big Creek, Long Point, Lake Erie. M.A. thesis, Department of Geography, University of Waterloo, Waterloo, Ontario.

Category	General Wetlands
Source	CWS London

456. Hardy, P.A. and J.G. Nelson (1979) Managing marsh use and effects on the north Lake Erie shore: The case of Big Creek Marsh, Long Point. Paper presentation at 22nd Conference Great Lakes Res., Rochester, New York.

Category	Land Use and Management
Source	CWS London

457. Hardy, P.A. (1979) Past cultural activities in the Big Creek Marsh, Long Point, Lake Erie. Unpublished report to Canadian Wildlife Service. 12 pp.

Category	Land Use and Management, Human Impacts
Source	CWS London

458. Hardy, P.A. (1980) Land use history and management of Big Creek Marsh. Contact 12(3): 1-12.

Category	Land Use and Management
Source	McMaster University Libraries

459. Harland, R. (1979) Sand dune rehabilitation program: Long Point Provincial Park. Unpublished report, Ontario Ministry of Natural Resources, Simcoe, Ontario.

Category	Terrestrial Geography, Hydrology and Sediments
Source	CWS London

460. Harper, N.S. (1982) Palynology of samples from three boreholes at Long Point. NWRI report of Study H-4309. 4 pp.

Category	Terrestrial Geography
Source	

461. Harris, G.P. and R.A. Vollenweider (1982) Paleolimnological evidence of early eutrophication in Lake Erie. *Canadian Journal of Fisheries and Aquatic Sciences* 39: 618-626.

Study Date	June, 1971
Location	• Sample Collected: 42°00.1' N 81°36.2', central basin Lake Erie
Findings/Purpose	• Diatom remains are used to investigate eutrophication processes within Lake Erie • Supported by evidence from a literature review of other nutrient studies in Lake Erie • Evidence of eutrophication from 1850 (mesotrophic to eutrophic conditions) • Long-term fluctuations in nutrient regime
Category	Water Quality/Limnology
Source	McMaster University, Thode library periodicals

462.Hartley, R.P. (1968) Bottom currents in Lake Erie. Proceedings from the Conference of Great Lakes Research. 11: 398-405.

Category	Hydrology and Sediments
Source	CWS London

463.Haylock, B., J. Cebrowski and G.L. Holroyd (1970) A Study of Sand Dune Succession at Long Point. Long Point Bird Observatory Newsletter 2: 5-10.

Category	Hydrology and Sediments
Source	CWS London

464.Haymes, G.T. and T.G. Dunstall (1989) The Influence of Industrialization on the Aquatic Environment of Long Point Bay, Lake Erie, in the Vicinity of Nanticoke, 1968 to 1983. Ontario Hydro Research Division, Toronto, Ontario.

Category	Human Impacts, Water Quality/Limnology
Source	McMaster Libraries

465.Haynes (Haymes?), G.T. (1977) Preliminary survey of present and historical nesting sites of piscivorous birds in Canadian waters from Lake Superior to the Niagara River. Unpublished report to Canadian Wildlife Service.

Category	Birds
Source	CWS London

466.Haynes, J.M., N.A. Tisch, C.M. Mayer and R.S. Rhyne (2005) Benthic macroinvertebrate communities in southwestern Lake Ontario following invasion of *Dreissena* and *Echinogammarus*: 1983 to 2000. *Journal of the North American Benthological Society* 24(1): 148-167.

Study Date	1983-2000
Location	• Lake Ontario
Findings/Purpose	• Reference is made to studies of duck predation of zebra mussels in Lake Erie, however LP is not a specific study area • Natural and artificial reef sites are examined for changes in the Benthic macroinvertebrate communities • Several periods of increase in populations of macro-invertebrates were noted through 1983, 1999, 2000 • Some sharp drops in population are also noted – comparison is made between these decreases and possible causes. Waterfowl predation at LP is examined as a possible explanation, but is ruled out for the study site in question • Oligotrophication is cited as the most probable cause for density reductions in *Dreissena* populations observed and changes to the benthic communities
Category	Macro-Invertebrates, Invasive Species
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

467.Heathcote, I. (1981) Major physical features of Long Point Bay and its watershed. Journal of Great Lakes Research 7(2): 81-95

Study Date	Review
Location	• Long Point Bay & Surrounding areas
Findings/Purpose	• Provide background information regarding physical development and underlying sediments of Long Point, Long Point Bay and surrounding areas for use in future long terms studies as development of Nanticoke occurs and further industrial development becomes likely • Implications for development are considered
Category	Terrestrial Geography
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

468. Heathcote, I.W., R.R. Weiler and J.W. Tanner (1981) Lake Erie nearshore water chemistry at Nanticoke, Ontario 1969-1978. Journal of Great Lakes Research 7: 89-95

Study Date	1969-1978
Location	• Long Point Bay – Nanticoke • Bathymetric map with sampling stations in text
Findings/Purpose	• Long-term monitoring of water quality parameters prior to the development of the Nanticoke Thermal Generation Station • WQ parameters were similar between stations but could be classified into two groups – nearshore and offshore based dominantly on Secchi disk transparency and Kjeldhal nitrogen • Seasonal variations existed for most parameters – most parameters decreased or remained the same in decade of study • Phytoplankton increased over study period
Category	Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

469. Hebb, Andrea (2003) Implementation of a GIS to Assess the Effects of Water Level Fluctuations on the Wetland Complex at Long Point, Ontario [electronic resource] -- Waterloo : University of Waterloo. Faculty of Environmental Studies, Geography.

Study Date	Data from 1945-1999
Location	• Long Point Bay Wetland Complex
Findings/Purpose	• Water-level fluctuations are used as a surrogate for climate change • Spatio-temporal trend analysis examining changes in the structure and composition of the wetland • Drier periods (lower water level) = increased drier emergent plants & meadow vegetation; pronounced in the inner bay and N-portion of the outer bay spit; lower fragmentation and complexity • Wetter periods = increased open water, increased cover of species adapted to saturation/near-saturation; increased complexity • 3 models were applied to estimate predictive capabilities of GIS for wetland response to environmental variables (water-table change)
Category	Water Levels, General Wetlands
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

470. Hebert, C.E. and H.A. Morrison (2003) Consumption of fish and other prey items by Lake Erie waterbirds. *J. Great Lakes Res. 29(2)*: 213-227

Study Date	Data from other studies applied to a model Original field data late 1989-2000 (varies by study)
Location	• Lake Erie (all 3 basins)
Findings/Purpose	• Fish consumption by nesting/resident birds and migratory birds is estimated by fish species using a tailored version of the Madenjain and Gabrey (1995) bioenergetics model • Total model-estimated consumption on Lake Erie: 18,776 metric tons • Eastern basin consumption was between consumption levels in the Eastern (highest) and Central (lowest) with 2,078 metric tons consumed • Consumption is broken down by selected bird species and fish species, with the majority of fish eaten not being of significant economic importance
Category	Birds, Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

471. Hebert, C.E., V. Glooschenko, G.D. Haffner and R. Lazar (1993) Organic Contaminants in Snapping Turtle (Chelydra serpentina) Populations from Southern Ontario, Canada Arch. Environ. Contam. Toxicol. 24, 35-43

Study Date	1988-1989

Location	• Long Point amongst 16 other sites in S-Ontario • Site map in text
Findings/Purpose	• Significant differences in organochlorine contamination level was found between sites in 78 adult snapping turtles examined • Mean levels in muscle were below fish consumption guidelines for PCB's, DDT and mirex; levels in some older turtles exceeded guidelines • A very significant relationship was found between adult females and their eggs • Differences in levels was correlated to previous findings (other studies) showing patterns of reproductive success
Category	Reptiles
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

472. Hecner S.J. (2004) Great Lakes wetlands as amphibian habitats: A Review. *Aquatic Ecosystem Health and Management 7(2):* 289-303.

Study Date	Review Paper
Location	• Great Lakes wetlands – bulk review, not very site specific
Findings/Purpose	• Generally, size and contiguity of wetland areas determine the diversity of amphibians in the system • Loss of habitat appears to be the most significant cause of population decline for many amphibians, however water quality issues and water supply issues are also important • ~ 2/3 of amphibian species are considered of concern in the Great Lakes area with many local extirpations occurring • Wetland characteristics, amphibian habitat requirements and research and conservation efforts and programs are considered
Category	Amphibians
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

473. Heffernan, S.E. (1978) Long Point Ontario: Land Use, Landscape Change and Planning. M.A. thesis, Department of Geography, University of Waterloo. 165 pp.

Category	Land Use and Management
Source	CWS London

474. Heffernan, S.E. and B.D. Ralph (1978) Vegetation of Long Point, Ontario (from Courtright Ridge to the tip). Unpublished report to the Canadian Wildlife Service. 53 pp.

Category	Terrestrial Vegetation, Aquatic Vegetation
Source	CWS London

475. Heffernan, S. and J.G. Nelson (1979) Land use history, vegetation and planning for Long Point, Rondeau and Point Pelee peninsulas, Lake Erie. Contact 11(1): 53-80.

Category	Land Use and Management, Terrestrial Vegetation
Source	McMaster Libraries

476. Heffernan, S.E. (1980) Planning and management for National Wildlife Areas in the Long Point region: Commentary. Contact 12(3): 27-30.

Category	Land Use and Management
Source	McMaster Libraries

477. Herdenorf, C.E. (2004) Morphometric factors in the formation of Great Lakes coastal wetlands. *Aquatic Ecosystem Health & Management, 7(2)*: 179–197

Study Date	Review Paper
Location	• Great Lakes Region
Findings/Purpose	• A review of the geological and geomorphological formation of the Great Lakes Basin and the subsequent development of prime wetland forming features

	• Great Lakes are considered separately with short backgrounds • Hydrological function of wetlands is discussed as well as the morphological conditions behind the creation of differing coastal wetland forms: coastal lagoons, estuarine, deltaic, kettle lake, solution-based, and diked wetlands • A list of significant wetlands is included in the text
Category	General Wetlands, Terrestrial Geography
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

478. Henshaw, B. and H. Kerr (1994) Ontario Round-up: December 1993 and January 1994. Birders Journal 3:1-6.

Category	Birds
Source	

479. Henshaw, B. and H. Kerr (1994) Ontario Round-up: April and May 1994. Birders Journal 3: 113-124.

Category	Birds
Source	

480. Henshaw, B. and H. Kerr (1994) Ontario Round-up: February and March 1994. Birders Journal 3: 65-71.

Category	Birds
Source	

481. Hewitt, N. and M. Kellman (2004) Factors influencing tree colonization in fragmented forests: an experimental study of introduced seeds and seedlings. *Forest Ecology and Management* 191(1-3): 39-59

Study Date	1995-1997
Location	• Backus Woods • Haldiman-Norfolk forest fragments
Findings/Purpose	• Investigate tree colonization in forest fragments of southern Ontario where the species is not present • Seed and seedlings were used to test colonization potential • Probability of colonization was calculated for three locations in woodlots – uncolonized, colonized and sunny forest edges • Seed dispersal and introduction into areas sustained over several years is required to establish colonization • Management practices must therefore reflect this and potentially require seedling introduction to maintain eastern deciduous species in fragmented woodlots
Category	Forests
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

482. Hewitt, N. and M. Kellman (2002) Tree seed dispersal among forest fragments: II. Dispersal abilities and biogeographical controls. *Journal of Biogeography* 29 (3): 351-363

Study Date	1997
Location	• Forest fragments near Long Point • 42°40'N, 80°29'W
Findings/Purpose	• Investigate seed dispersal abilities of temperate hardwood tree species, ecological controls of dispersal – distance to and connectivity of seed sources, seed source strength, and dispersal mechanisms and seed size • Distance to seed source deemed important in determination of patch colonization • Infrequent dispersal above distances greater than ~100-150m • Raises issues surrounding the colonization and maintenance of diversity in forest fragments

	• Distances of ~50m appear to have an isolating effect for seed dispersal and colonization
Category	Forests
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

483. Higgins et al (2005) The wall of green: The Status of *Cladophora glomerata* on the northern shores of Lake Erie's eastern basin. *Journal of Great Lakes Research 31(4)*: 547-563.

Study Date	1995-2002
Location	• North Shore Lake Erie – Eastern Basin • Study-site map in text
Findings/Purpose	• *Cladophora* began accumulating at most sites by early may, maximum values ~ mid July • Areal coverage of 4-100% (median of 96%) • Mid-summer die-off occurred soon after biomass peak when water temperatures neared 22.5°C • Following die-off, areal cover decreased to <10% • *Cladophora* biomass is sensitive to phosphorous and light availability; due to increased phosphorous availability and light penetration (water clarity) through the establishment of *Dreissenids*, biomass may increase where previously it was controlled by these factors
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

484. Hinch, S.G., R.C. Bailey and R.H. Green (1985) Habitat effects on growth of the freshwater clam *Lampsilis radiate* (Bivalva: Unionidae): A reciprocal transplant experiment. *Canadian Journal of Fisheries and Aquatic Sciences*

Category	Macro-Invertebrates
Source	McMaster Libraries

485. Holcombe, T.L., L.A. Taylor, P.A. Vincent, J.S. Warren, and D.F. Reid (1999) International Association for Great Lakes Research: Great Lakes, Great Science, Great Cities. Programs and Abstracts. p. A-47.

Category	General
Source	

486. Holcombe, T.L., L.A. Taylor, D.F. Reid, J.S. Warren, P.A. Vincent, and Charles E. Herdendorf (2003) Revised Lake Erie Postglacial Lake Level History Based on New Detailed Bathymetry. *Journal of Great Lakes Research* 29(4): 681–704. International Association of Great Lakes Research

Study Date	n.d.
Location	• Lake Erie • Long Point a major feature component
Findings/Purpose	• Describes major bathymetric features within Lake Erie • Long Point is featured prominently throughout the study • Several features impact the development and location of Long Point spit and bay, and influcence water levels as well as lake basin and inter-basin hydrology • Long Point Spit is discussed as a unique feature • Geologic and geomorphologic explanations for the formation of the described bathymetric features is also provided • Variations in water level fluctuations are discussed in terms of bathymetric variation, basin size and shape
Category	Water Levels
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

487. Holder, M. and H. Kerr (1994) Ontario Round-up: October and November 1994. Birders Journal 3: 245-255.

Category	Birds
Source	

488. Holroyd, G.L. and A. Wasserfall (1969) The Status of the Bald Eagle at Long Point. Long Point Bird Observatory Newsletter 1(3): 1-3.

Category	Birds
Source	CWS London

489. Holroyd, G.L. (1972) Resource use by four avian species of aerial insect feeders. M.Sc. thesis, University of Toronto, Toronto, Ontario. 100 pp.

Category	Birds
Source	

490. Holroyd, G.L. (1975) Nest site availability as a factor limiting population size of swallows. Canadian Field-Naturalist 89:60-64.

Category	Birds
Source	McMaster Libraries BSC Library

491. Holroyd, G.J. and J.G. Woods (1975) Migration of the Saw-whet Owl in Eastern North America. Bird Banding 46: 101-105.

Category	Birds
Source	

492. Holroyd, G.L. and M.S. Bradstreet (1982) A One-year Study of Waterfowl Feeding Habits at Long Point Bay, Ontario. Unpublished funding proposal to Ducks Unlimited.

Category	Waterfowl, Aquatic Vegetation
Source	

493. Holroyd, G.L. (1983) Foraging strategies and food of a swallow guild. Ph.D. Thesis, University of Toronto, Toronto, Ontario. 190 pp.

Category	Birds
Source	

494. Hopkins, G.J. and C. Lea (1982) A ten year study of phytoplankton biomass and composition in the Nanticoke region of Long Point Bay, Lake Erie. Journal of Great Lakes Research 8: 428-438.

Study Date	1969-1978
Location	• East Long Point Bay - Nanticoke Thermal Generating Station
Findings/Purpose	• Evaluation of the changes in abundance, taxonomic composition and seasonal succession of phytoplankton near Nanticoke • Phytoplankton quantity was lowest in 1969 and highest in 1978 • Seasonal patterns were unimodal, bimodal, and even trimodal between stations and years • 1969, 1974 showed low phytoplankton • 1970, 1974 showed high phytoplankton • Study provides a good comparison for future studies of phytoplankton of near-shore Lake Erie
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

495. Hopkins, G.J. and C. Lea (1985) A fifteen year study of phytoplankton biomass and composition in the Nanticoke region of Long Point Bay, Lake Erie. Ontario Ministry of the Environment, Water Resources Branch, Toronto, Ontario. 36 pp.

Category	Water Quality/Limnology
Source	

496. Hough, J. (1991) Black-capped Vireo: new to Canada. Ontario Birds 9:64-66.

Category	Birds
Source	

497. Hough, J.R. (1992) Breeding bird census #58, white pine-white cedar savannah. Journal of Field Ornithology 63 (Supplement):69-70

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

498. Hough, J.R. and M.J. Palmer (1992) Breeding bird census #77, dry cottonwood-juniper savannah. Journal of Field Ornithology 63 (Supplement):81

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

499. Howell, E. T.; and A. Todd (2003) Impacts of tributaries on the nearshore of eastern Lake Erie. 46th Conference on Great Lakes Research held in conjunction with the 10th World Lake Conference on Global Threats to Large Lakes: Managing in an Environment of Instability and Unpredictability, June 22-26, 2003, Chicago, IL, USA

Study Date	2001
Location	• Nearshore waters, 3 tributaries of Lake Erie: Lower Grand, Sandusk Creek and Nanticoke Creek
Findings/Purpose	• Only abstract from oral presentation available • Mixing of tributary and lake water were monitored – spatial patterns of conductivity and UV fluorescence • Areas of mixing were generally oriented along the shoreline and/or in contact with the shoreline • Tributary water quality and quantity varied temporally
Category	Hydrology and Sediments, Water Quality/Limnology
Source	McMaster University, Thode library periodicals

500. Howlett, D. (1992) Breeding bird census #39, red oak-sugar maple forest. Journal of Field Ornithology 63 (Supplement):57-58

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

501. Howlett, D. (1992) Breeding bird census #40, red oak-sugar maple savannah. Journal of Field Ornithology 63 (Supplement):58-59

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

502. Howlett, D. and P. Derbyshire (1992) Breeding bird census #57, tamarack slough. Journal of Field Ornithology 63 (Supplement):68-69

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

503. Hubbs, C.L. and D.E.S. Brown (1929) Materials for a distributional study of Ontario fishes. *Transactions Roy. Can. Inst. 17(1?):1-56*

Category	Fish
Source	McMaster Libraries

504. Hubbs, F.T. (1979) Endemic herpetofaunal species and their distribution in the Big Creek Marsh, Port Rowan, Ontario. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Amphibians, Reptiles
Source	CWS London

505. Humphreys, G.B. and F.F. Mallory (1977) Colour preferences of the Pond Slider, *Chrysemys scripta elegans* (Schoepff), and the Spotted Turtle, *Clemmys guttata* (Schneider). Ontario Field Biologist 31(2): 41-44

Category	Reptiles
Source	CWS London

506. Hunt, I.A. (1958) Winds, wind set-up and seiches on Lake Eerie, *Second National Conference on Applied Meteorology. Ann Arbor, Michigan.* 37pp.

Category	Weather and Air Quality
Source	CWS London

507. Hurst, R., J. Jalava and J. Tasker (1979) Forty-second breeding bird census. Dune-grass-cottonwood beach. American Birds 33:76.

Findings/Purpose	See: Van Velzen, W.T. (1979)
Category	Birds
Source	McMaster University

508. Hurst, R., L. Gibb, J. Jalava, J. McCracken, J. Tasker and G. Wagner (1979) Forty-second breeding bird census. Birch-oak savannah and wetland. American Birds 33:75-76.

Findings/Purpose	See: Van Velzen, W.T. (1979)
Category	Birds
Source	McMaster University

509. Hurst, R., M. Delafield, J. Jalava, C. Risley and J. Tasker (1979) Forty-second breeding bird census. Sedge-tamarack dune pond. American Birds 33:103-104.

Findings/Purpose	See: Van Velzen, W.T. (1979)
Category	Birds
Source	McMaster University

510. Hussell, D.J.T. (1960) The Long Point Banding Station: 1956-1959. OBBA Contributions 1(1): 7-12.

Category	Birds
Source	

511. Hussell, D.J.T. and J. Woodford (1961) The use of a heligoland trap and mist-nets at Long Point, Ontario. Bird Banding 32:115-125.

Category	Birds
Source	CWS London

512. Hussell, D.J.T. and R.W. Stamp (1965) Movements of Black-capped Chickadees at Long Point, Ontario during the spring of 1962. Bird Banding 36:71-86.

Category	Birds
Source	CWS London

513. Hussell, D.J.T. and J. Woodford (1965) Piping Plover's nest containing eight eggs. Wilson Bulletin 77: 294.

Category	Birds
Source	McMaster Libraries

514. Hussell, D.J.T. and R.D. Montgomerie (1966) The status of Piping Plover at Long Point, Ontario: 1960-1965. Ontario Field Biol. 20: 14-16.

Category	Birds
Source	CWS London

515. Hussell, D.J.T. (1967) Recovery rates for small band sizes used at the Long Point Bird Observatory, 1960-1964. *Ontario Bird Banding* 3:5-10.

Study Date	1960-1964
Location	• LPBO
Findings/Purpose	• A very low recovery rate was observed for small band sizes, with an average of 0.12% • Numbers are too low to calculate species' recovery rates • Band size recovery rates increase with increasing band size • Part of the recovery rate may be attributed to the location of contact and identification information – small bands have information printed on the inside, whereas with increasing size, the information is printed on the outward side – thie affects recoveries noted by the general public (a large proportion of the reports provided) • Suggestion is to carry out an investigation into the impact of readability on reporting
Category	Birds
Source	BSC Library

516. Hussell, D.J.T. (1967) Differential fall migration of adult and immature Least Flycatchers. Bird Banding 38(1): 61-66.

Category	Birds
Source	CWS London

517. Hussell, D.J.T. (1969) Weight loss of birds during nocturnal migration. Auk 86:75-83

Study Date	May 1965, September 1966
Location	• LP Light House (at/within the lighthouse itself)
Findings/Purpose	• Energy metabolism during migratory flight • Weight loss varied between species examined (~0.2-0.4 g/hr lost) • Adults an immatures do not have significantly different weight loss characteristics • Flight metabolism was estimated at 0.12-0.10 kcal/(gxhr) for the sampled Veeries and Ovenbirds respectively
Category	Birds
Source	McMaster University, Thode library periodicals

518. Hussell, D.J., R.W. Stamp, P.S. Woodford, J. Bradshaw, M. Bradstreet & W.A. Martin (1969) Long Point Bird Observatory: 1967 Report. *Ontario Bird Banding*. 5(1): 7-47

Study Date	1967
Location	• LPBO
Findings/Purpose	• Provides an account of activities, projects, banding counts, expenditures, etc. that occurred within the operational year of 1967 • Highlights from the 1967 migration periods • Species list of banded birds, and counts of each species • Recoveries & returns • Annotated list of species (observation dates) • Some photos of the operations, etc. are in text
Category	Birds
Source	BSC Library

519. Hussell, D.J.T. and L.D. Caldwell (1972) Flight metabolism of the Myrtle Warbler (*Dendroica coronata*) during nocturnal migration. Proc. XVth Int. Ornith. Cong. 1972: 653-654.

Category	Birds
Source	McMaster Libraries

520. Hussell, D.J.T. (1974) Tree swallow studies (1971) Long Point Bird Observatory 1971 Annual Report pp. 5-7

Category	Birds
Source	

521. Hussell, D.J.T. (1974) Studies of breeding Tree Swallows (1972) Long Point Bird Observatory 1972 Annual Report. Pp. 15-16

Category	Birds
Source	

522. Hussell, D.J.T. (1975) Piping Plovers, Bald Eagles and giant Canada Geese - Mixed News. Long Point Bird Observatory Newsletter 7(2): 5-6.

Category	Birds, Waterfowl
Source	CWS London

523. Hussell, D.J.T. and M.J. Porter (1976) Blue Grosbeak at Long Point. Ontario Field Biologist 30(2): 46-47.

Category	Birds
Source	CWS London

524. Hussell, D.J.T. and N.J. Porter (1977) fieldfare in Ontario. *Canadian Field Naturalist 91:91-92*

Category	Birds
Source	McMaster Libraries

525. Hussell, D.J.T. and C.J. Risley (1978) Monitoring bird populations by migration sampling. Unpublished report to Canadian Wildlife Service. 143 pp.

Category	Birds
Source	CWS London

526. Hussell, D.J.T. (1980) The timing of fall migration and molt in Least Flycatchers. *Journal of Field Ornithology* 51(1):65-71.

Study Date	Uses existing samples – no years identified
Location	• North and Central America
Findings/Purpose	• Difference in migration timing of up to 1 month has been observed between young-of-the-year and adult Least Flycatchers in S-Ontario (Long Point) and Kansas, however similar differences are not evident elsewhere • Study uses museum samples to examine this relationship • Study findings agree with those indicating later migration of immature birds and indicates a more westerly route taken by adults
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

527. Hussell, D.J.T. (1981) Migrations of the Least Flycatcher in southern Ontario. *Journal of Field Ornithology* 52(2):97-111.

Study Date	1966-1968
Location	• Long Point Bird Observatory • 42°33'N, 80°03'W
Findings/Purpose	• Investigate the difference in migration timing between immature and adult Least Flycatchers during spring and fall migration periods • Males preceded females by ~6d in the spring, however no sex difference was evident in the fall • Fall migration in adults was mid-July to early-August • Immature fall migration peak was generally the last few days of August with peaks separated by 38 days for all years of the study • No molt in spring migration, molt by both adults and immatures during fall migration
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

528. Hussell, D.J.T. and A.B. Lambert (1980) New estimates of weight loss during nocturnal migration. Auk 97: 547-558.

Category	Birds
Source	McMaster Libraries

529. Hussell, D.J.T. (1981) The use of migration counts for monitoring bird populations levels. Studies in Avian Biology 6:92-102.

Category	Birds
Source	CWS London

530. Hussell, D.J.T. (1982) Longevity and fecundity records in the Tree Swallow. North American Bird Bander 7(4):154.

Study Date	1970-1982
Location	• LPBO – easter end (42°33'N, 80°04'W)
Findings/Purpose	• Reports and 11 year-old female Tree Swallow – two years older than another other reported • Originally banded in 1970 as a yearling • Re-trapped 1971-1980 (except 1974) • Not found in 1981-1982 • She was 11 in 1980 • Information is given about the clutches she produced during her breeding years at LP
Category	Birds
Source	BSC Library

531. Hussell, D.J.T. (1982) Migration of the Yellow-bellied Flycatcher in southern Ontario. Journal of Field Ornithology 53(3): 223-234.

Study Date	1966-1968
Location	• Long Point Bird Observatory • 42°33'N, 80°03'W
Findings/Purpose	• Migrations of the Yellow-bellied Flycatcher closely follow those of the Least Flycatcher • Spring migration times are different by ~17d, however fall migrations are almost simultaneous and show the delayed migration of immatures in both species
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

532. Hussell, D.J.T. (1982) The timing of fall migrations in Yellow-bellied Flycatchers. Journal of Field Ornithology 53(1): 1-6

Study Date	Uses existing samples – no years identified
Location	• Various (North and Central America)
Findings/Purpose	• Adults peak migration is mid-August • Immatures peak ~24 days later • Immatures follow a more westerly route similar to that of the Least Flycatchers (and have almost simultaneous migration timing)
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

533. Hussell, D.J.T. (1983) Age and plumage color in female Tree Swallows. Journal of Field Ornithology 54(3):312-318.

Study Date	1970-1982
Location	• Long Point Bird Observatory • 42°33'N, 80°03'W
Findings/Purpose	• Study investigates the use of plumage colour to accurately assess age in female Tree Swallows • Most females can be aged as being second-year or after-second-year

	based on plumage colouring with ~95% accuracy
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

534. Hussell, D.J.T. (1983) Tree Swallows pairs raise two broods in a season. Wilson Bulletin 95:470-471.

Category	Birds
Source	McMaster Libraries

535. Hussell, D.J.T. (1984) Direct Canada-Mexico recovery of a banded Least Flycatcher. *Journal of Field Ornithology* 55:116-117.

Study Date	Fall Migration, 1982
Location	• Long Point Bird Observatory, Ontario; Las Rosas Chiapas, Mexico
Findings/Purpose	• For both hatch-year and after-hatch-year birds, migration time between Long Point and Mexico is ~25d • Minimum average daily flight of 98km
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

536. Hussell, D.J.T. (1986) Supply and demand in Tree Swallow broods. XIX Congressus Internationalis Ornithologicus Abstracts No. 520.

Category	Birds
Source	McMaster Libraries

537. Hussell, D.J.T. and T.E. Quinney (1987) Food abundance and clutch size of Tree Swallows (Tachycineta bicolor). Ibis 129:243-258.

Category	Birds
Source	McMaster Libraries

538. Hussell, D.J.T. (1988) Supply and demand in Tree Swallow broods: a model of parent-offspring food-provisioning interactions in birds. *American Naturalist* 131:175-202.

Study Date	1982-1984
Location	• Port Rowan, Ontario • 42°37’N, 80°27’W
Findings/Purpose	• The supply and demand theory of economics is applied to brood-feeding birds • Tree-swallow nest boxes were studied • A supply-demand model was developed for nidicolous birds with supply being represented by the feeding response of parents to hunger signals from the brood, and demand being the hunger-signaling response of the brood to the feeding-rate • Supply function changes in response to food availability and environmental condition • Demand changes in response to nutritional condition of the young • Model presented only deals with single parent-offspring relationship, further development is required for more complicated relationship representation • Implications for clutch-size theory and studies of sibling competition
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

539. Hussell D.J.T (1990) Implications of age-dependent bill length variation in *Empidonax* for identification of immature alder and willow flycatchers. *Journal of field ornithology 61(1):* 54-63.

Study Date	1966-1968
Location	• Long Point Bird Observatory

Findings/Purpose	• Bills of immatures were found to be shorter than adult bills • Raises potential issues with using Stein's (1963) formula for separating Willow from Alder flycatchers • A modification is proposed for using Stein's formula on immatures • Methods for identifying Alder and Willow flycatchers should be used with caution when used for identifying individuals
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

540. Hussell, D. (1991) Ups and Downs: Population Fluctuations in Migrant Birds. Long Point Bird Observatory Newsletter 23(1): 21-22.

Category	Birds
Source	

541. Hussell, D.J.T. (1991) Additional comments on Black-capped Chickadee recoveries during spring migration. North American Bird Bander 16(2):40-41.

Study Date	Review – 1962 research overview
Location	• Point Pelee • Long Point
Findings/Purpose	• Discussion of recovery of banded black-capped chickadees during the same migration period • During a single spring migration, several studies found that chickadees were re-captured at different locations • Time between capture and distance travelled were variable • Chickadees moved generally in a northward direction, however over shorter distances sometimes were found moving in a southerly direction • Some evidence of individuals travelling together was found based on banding records (location and time of banding) • Generally, the rate of travel is slow and reported as 'relatively aimless'
Category	Birds
Source	BSC Library

542. Hussell, D.J.T. (1991) Fall migrations of Alder and Willow Flycatchers in southern Ontario. Journal of Field Ornithology 62(2): 260-270.

Study Date	1966-1968
Location	• Long Point Bird Observatory
Findings/Purpose	• Adults of both species migrated earlier in fall than immatures • Willow flycatchers as a species however migrated earlier in both age classes than Alder flycatchers • Similarities in migration and molting patterning exist for these species and those of the Least Flycatcher
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

543. Hussell, D.J.T. (1991) Regulation of food provisioning in broods of altricial birds. Acta XX Congressus Internationalis Ornithologici: 946-960.

Category	Birds
Source	McMaster Libraries

544. Hussell, D.J.T. (1991) Spring migrations of Alder and Willow Flycatchers in southern Ontario. Journal of Field Ornithology 62(1):69-77.

Study Date	1966-1968
Location	• Long Point Bird Observatory
Findings/Purpose	• Migration peaked early June for both species • Willow flycatcher had a slightly earlier migration start and longer over-

	all migration period • Males migrated earlier than females for Willow and likely the Alder flycatchers
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

545. Hussell, J.D., M.H. Mather and P.H. Sinclair (1992) Trends in numbers of tropical and temperate - wintering migrant landbirds in migration at Long Point, Ontario 1961-1988 IN: Ecology and Conservation of Neotropical Migrant Landbirds (Ed. Hagan III, J.M. and D.W. Johnston). Smithsonian Insititute Press, Washington, D.C. p. 101-114.

Category	Birds
Source	

546. Hussell D.J.T. (1996) The influx of Black-capped Chickadees at Long Point, Ontario in the spring of 1962: A 35-year perspective on an unusual event. *Journal of Field Ornithology 67(4):* 614-622

Study Date	1960-1994
Location	• Long Point
Findings/Purpose	• Large spring migrations of black-capped chickadees are relatively infrequent at LP • No direct correlations were found to exist between exceptionally large spring migrations and irruptions or temperature • The 1962 migration event is viewed as an unusual event
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

547. Hussell, D.J.T. (1997) Monitoring migrants to detect changes in populations of birds breeding in Canada: present status and future prospects. Pages 43-48 IN: E.H. Dunn, M.D. Cadman and J.B Falls (Eds.) Monitoring bird populations: the Canadian experience. Occasional Paper 95, Canadian Wildlife Service, Ottawa.

Category	Birds
Source	McMaster Libraries

548. Hussell, D.J.T. and S.J. Anderson (1999) Longevity record for the Tree Swallow. *North American Bird Bander* 24: 6-8.

Category	Birds
Source	

549. Hussell, D.J.T. (2003) Two more double-brooded Tree Swallows. *North American Bird Bander* 28(2):49-51.

Study Date	2001
Location	• LPBO (42°37'N, 80°27'W) – Tip, Sewage Lagoons (SL), Backus Field (BF), Mud Creek (MC)
Findings/Purpose	• Author reported first account of double-brooded Tree Swallows, article reports two more occurrences of double-brooding • When nesting was established with a brood – adults were identified, sexed and aged • Both additional cases of double-brooding were noted at the SL site • Double brooding requires an early first brood • On average SL clutch initiations were 5 days earlier than those at the Tip – temperature differences due to proximity to the Lakes cooling effects • All detected double-brooded nests occurred with after-second-year females
Category	Birds
Source	BSC Library

550. Hussell, D.J.T. (2003) Climate change, spring temperatures, and timing of breeding of tree swallows (tachycineta bicolor) in Southern Ontario. *Auk* 120:607-618.

Study Date	1969-2001 (with various coverage over period at different sites)
Location	• Long Point & surrounding area
Findings/Purpose	• Some studies have indicated increasingly early breeding dates which are attributed to climate change including a reported 5-9 day change for Tree-Swallows • Study found no warming trend at Long Point for local air temperature • No significant difference in average timing of laying for the 1970-1980, 1980-1990, and 1990-2000 periods • However, a significant trend for earlier laying was found in 1990-2000 attributed to a particularly warm May between 1998-2000 • Findings indicate that clutch laying is significantly correlated to spring temperatures, but no evidence of increasing temperature was found at Long Point
Category	Climate Change, Trees
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

551. Hussell, D.J.T. (2004) Determining productivity indices from age composition of migrants captured for banding: problems and possible solutions. *Studies in Avian Biology* 29: 82-91.

Category	Birds
Source	

552. Hussell, D.J.T. (2004) Tactics for coping with a variable environment: laying interruptions and extended incubation in Tree Swallows. Association of Field Ornithologists and Wilson Ornithological Society, Ithaca, NY, April 2004.

Category	Birds, Climate Change
Source	

553. Independent Test-lab Ltd. (1982) Report on the geotechnical aspects of the Big Creek Marsh proposed Old Channel Dyke. Unpublished report for Ducks Unlimited (Canada). 7pp + borehole logs.

Category	Terrestrial Geography
Source	CWS London

554. International Joint Commission (1973) Regulation of the Great Lakes water levels – Report by the International Great Lakes Levels Board (Under reference of October 7,1964). 100pp +

Category	Water Levels
Source	McMaster Libraries

555. International Joint Commission (1974) Regulation of the Great Lakes water levels – a summary report, 1974 (International Great Lakes Levels Board). Pamphlet.

Category	Water Levels
Source	McMaster Libraries

556. International Joint Commission (1980-1984) Lake Erie water level study newsletter – International Lake Erie regulation study.

Category	Water Levels
Source	McMaster Libraries

557. International Joint Commission (1981) Lake Erie water level study, main report. Windsor, Ontario. 231 pp. Appendix F: Environmental effects. 166pp + annexes

Category	Water Levels
Source	CWS London

558. International Joint Commission (1989) Living with the Lakes: Progress Report of the Level Reference Study. Levels Reference Board, Windsor, Ontario.

Category	Water Levels
Source	McMaster Libraries

559. International Join Commission (1993) Methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes – St. Lawrence River Basin: A report to the Government of Canada and the United States. 53pp

Category	Water Levels, Land Use and Management
Source	McMaster Libraries

560. Irish, S.M. and G.W. Platzman (1962) An investigation of the meteorological conditions associated with extreme wind tides on Lake Erie. Mon. Wes. Rev. 90: 39-47.

Category	Weather and Air Quality
Source	CWS London

561. Ives, J.L. (1972) Pt. Petre to Long Point Waterfowl Harvest Survey. Tweed District.

Study Date	1972
Location	• Pt. Petre to Long Point
Findings/Purpose	• Includes hunting accessible and non-accessible areas • Information regarding hunder success, hunting and retrieving methods, redidence of hunters, familiarity with the area, time of day, weather and species composition of the water fowl • Tables of collected data are provided in appendices • Hunter density and kill rate per species are given
Category	Waterfowl
Source	MNR Library

562. Jackson, F.G. (1958) Big Creek Region conservation report: Forest. Ontario Department of Planning and Development, Conservation Branch. 47 pp. – CWS LONDON

Category	Land Use and Management, Forests
Source	McMaster Libraries

563. Jackson, M.B. and Hamdy, Y.S. (1982) Projected *Cladophora* growth in Southern Georgian Bay in response to proposed municipal sewage plant discharges to the Mary Ward Shoals. J. Great Lakes Res. 8(1): 153-163.

Study Date	1979-1980
Location	• Mary Ward Shoals – Southern Georgian Bay
Findings/Purpose	• Not Long Point Specific • Implications of increased nutrient loading and eutrophication related to potential increases in algal growth has applications to increased nutrient loading in Lake Erie – agricultural intensification and expansion,as well as sewage release
Category	Human Impacts, Water Quality/Limnology
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

564. James, R.D., P.L. McLaren and J.C. Barlow (1976) Annotated checklist of the birds of Ontario. Life Science Miscellaneous Publications. Royal Ontario Museum. 75pp.

Category	Birds
Source	CWS London

565. Jarvis P, Dow J, Dermott R and Bonnell R (2000) Zebra (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*) distribution and density in Lake Erie, 1992–1998. Canadian Technical Report of Fisheries and Aquatic Sciences No. 2304, Burlington, Ontario, Canada, 46 pp

Category	Invasive Species, Macro-Invertebrates
Source	McMaster Libraries

566. Jaworski, E., C.N. Raphael, P.J. Mansfield and B.B. Williamson (1979) Impact of Great Lakes water level fluctuations on coastal wetlands. Report to U.S. Department of the Interior, Office of Water Resources, East Lansing, Michigan. 351 pp.

Category	Water Levels, General Wetlands
Source	CWS London

567. Jeffs, D.N. (1981) Introduction: Long Point Bay Study. *Journal of Great Lakes Research 7(2):77-80*

Study Date	Non-study – review & introduction
Location	• Long Point Bay and Nanticoke • Area of interest map in text
Findings/Purpose	• Special issue journal coordinated by the Nanticoke Environmental Committee (NEC) (Introduction) • History of the NEC and previous work of the Nanticoke area are reviewed • Broad descriptions of the intended use and industrial groups in close proximity to the site are introduced and discussed • Future activities for the site are also presented • Articles from this special issue are presented separately in this bibliography
Category	Land Use and Management
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

568. Jermyn-Gee, K. (2005) An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1998-2001). Volumes I, II. Canadian Wildlife Service.

Category	Birds
Source	McMaster Libraries

569. Jessen, S., J.C. Day and J.G. Nelson (1983) Assessing land-use regulations in coastal wetlands: The case of the Long Point area, Lake Erie, Ontario. *Coastal Zone Management Journal* 11(1-2): 91-115.

Category	Land Use and Management
Source	CWS London

570. Johnston, R. and B. Fearis (1973) Thirty-seventh breeding bird census. Red oak-sugar maple forest. American Birds 27:967-968.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

571. Jones J., Francis C.M., Drew M., Fuller S., and Ng M.W.S. (2002) Age-related differences in body mass and rates of mass gain of passerines during autumn migratory stopover. *CONDOR* 104 (1): 49-58

Study Date	1966-2000
Location	• LPBO
Findings/Purpose	• Body mass, fat scores and rates of mass gain are compared for adults and immatures of 52 species at LPBO during fall migration stopover to better understand age-related differences in stopover ecology • Mean body mass was greater in adults, but across species the difference was only ~1% • Fat scores were also higher in adults • Rate of mass gain did not vary significantly between age classifications (power to detect differences was relatively low) – averaged across species mass gain in adults was 10% greater (confidence interval: 12% - 32%) • Differences possibly due to differences in foraging skills, however at early stages of migration not likely detrimental to immatures at LP

Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

572. Jones, J. and C.M. Francis (2003) The effects of light characteristics on avian mortality at lighthouses. *Journal of Avian Biology* 34: 328–333.

Study Date	1960-2002 (1969-1980 – pre) (1990-2002 – post)
Location	• LPBO
Findings/Purpose	• Artificial light sources create significantly increase avian mortality for night-migrating birds • Study investigates mortality at LPBO pre- and post-instalment of a new narrower & dimmer light on the lighthouse at LPBO • Mean annual kills prior to new light installation: Spring – 200, Fall – 393 with single-night mortality up to 2000 • New light was installed in 1989 • 1990-2002 saw a drastic reduction in avian mortality at the lighthouse with seasonal means of 18.5 birds in spring and 9.6 in fall • Results indicate that small changes in light signature can significantly reduce avian mortality for night-migrating birds
Category	Birds, Human Impacts
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

573. Jones, S.R. and P.T. Woo (1992) Vector specificity of Tripanosoma catostomi and its infectivity to freshwater fishes. *The Journal of Parasitology 78(1):* 87-92

Study Date	n.d
Location	• Fish and leech (from the collected fish) samples collected from various locations from Ontario including Long Point
Findings/Purpose	• To investigate the nature of transfer of the *Tripanosoma catostomi* from leeches to fish and the susceptibility of different leech and fish species investigated in carrying and transferring the disease
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

574. Jones, S.R. and P.T. Woo (1989) Use of kidney impressions for the detection of trypanosomes of anura. *Journal of Wildlife Diseases* 25(3): 413-415.

Study Date	n.d
Location	• LP (42°35'N, 80°27'W), Guelph and Orangeville
Findings/Purpose	• Investigates the use of kidney impressions technique (KIT) for disease detection compared to other published methods (stained blood films, hematocrit centrifugation technique (HCT)) • Success was dependent on infection, however overall the technique is more sensitive and more efficient than other commonly used methods
Category	Amphibians
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

575. Kane, D.D., J.E. Gannon, D.A. Culver (2004) The status of *Limnocolanus macrurus (Copepoda: Calaoida: Centropagidae)* in Lake Erie. *Journal of Great Lakes Research 30(1): 22-30*

Study Date	1995-2000
Location	• Lake Erie
Findings/Purpose	• Cultural causes of eutrophication in Lake Erie caused declines in *Limnocolanus macrurus* populations in the mid-20th century • Study finds that since 1995, *Limnocolanus macrurus* has repopulated in the western basin to 1930 levels, however populations have not increased in the central or eastern basin

	• Increased population likely related to phosphorous abatement and subsequent increase in dissolved oxygen however similar improvements in the central and western basins do not have the same effect • High densities of rainbow smelt and associated predation may be the dominant cause in the central and eastern basins
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

576.Karstad, L. (1962) Report on arbovirus research, Ontario Veterinary College, Guelph, Ontario. Arthropod-Borne Virus Exchange.

Category	Insects
Source	

577.Karstad, L. (1965) Surveillance for arbovirus infections in migrating birds at Long Point, Ontario, 1961-62. *Ontario Bird Banding* 1:1-9.

Study Date	1961-1962
Location	• LP
Findings/Purpose	• Birds have been considered as transport hosts for arboviruses during their migratory flights • Examines the possibility of transport and occurrence of the eastern encephalitis virus (EEV), western encephalitis virus (WEV) and the St. Louis envephalitis virus (SLE) • Long Point was used as a good station for monitoring the northern movement of these viruses in migrating birds from tropical and near-tropical environments • Blood samples were taken from banded birds • The cellular portionso f the blood samples were used for virus isolation by inoculating checken embryos, newly hatched chickens, or infant mice • Death in the test subjects were taken as indicative of possible presence of viral agents – these were then tested • 1875 birds were sampled • Antibodies to all three viruses were found • Generally, it does not appear that viral infections are carried to the northern summer habitats, although local infections may occur
Category	Insects, Birds
Source	BSC Library

578.Keddy, P.A. and A.A. Reznicek (1985) Vegetational dynamics, buried seeds and water level fluctuations on the shorelines of the Great Lakes IN: Coastal Wetlands (Ed. Prince, H.H. and F.M. D'Itre). Lewis Publishers, Chelsea, MI. p. 33-59.

Study Date	Review paper
Location	• Great lakes (shoreline areas)
Findings/Purpose	• Provide a consolidated source of information on the impact of water level fluctuations on shoreline vegetation • Examination of the occurrence of fluctuating water levels is provided based on existing literature • Vegetation communities (by wetland type/location in coastline spectra) • Existing shoreline vegetation is dependent on regular fluctuations in water levels – increasing diversity and species count • Priorities for future research are proposed
Category	Water Level, Aquatic Vegetation
Source	MNR Library – Peterborough

579.Kehoe, F.P. and C.D. Ankney (1985) Variation in digestive organ size among five species of diving duck (*Aythya* spp.). *Canadian Journal of Zoology* 63(10): 2339-2343

Study Date	1982-1983
Location	• Long Point Bay • Mitchell's Bay • Lake St. Clair
Findings/Purpose	• 5 species of diving ducks were examined to compare measurements of ceca length, small intestine length, and gizzard weight • Species: Lesser Scaup, Righ-necked Duck, Greater Scaup, Redhead, Canvasback • Dietary preferences and habits between these species are reported as distinct in terms of their diversity, fibre intake and • Interspecific differences in gut morphology not explained by differences in body weight, were explained by differences in diet • Less fibre showed shortened ceca and intestinal lengths and lighter gizzards
Category	Waterfowl
Source	BSC Library McMaster University Library – Thode periodicals

580.Keith, E.W. (1974) Banding of Monarch Butterflies at Long Point: 1963-1972. p. 17-20. IN: Long Point Bird Observatory 1972 Annual Report (G. Fairfield ed.)

Category	Insects
Source	CWS London

581.Kellner, A. and D.M. Green (1995) Age structure and age at maturity in Fowlers' toads, *Bufo woodhousii fowleri* at their northern range limit. *Journal of Herpetology* 29:417-421.

Study Date	1992
Location	• LP
Findings/Purpose	• Rings of bone deposition may act like tree-rings indicating year-to-year environmental conditions as they impact growth and development (hibernation generates lines of significantly slower growth separating high growth periods) • Correlation between age, growth and environmental conditions suggests that use of bone growth rings can be applied (although findings are preliminary) • Use of amphibian growth rings may be useful for examining decline in toad populations caused by climatic and anthropogenic impacts that influence their environment
Category	Amphibians
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

582.Kellogg, W.A. (1997) Metropolitan growth and the local role in surface water resource protection in the Lake Erie basin. *Journal of Great Lakes Research* 23(3): 270-285.

Study Date	1970s-1990s - Review
Location	• Cuhyahoga, Ohio
Findings/Purpose	• Although not Long Point Specific, implications for water quality protection and stewardship have applications in the Long Point area as well • Investigates the changing and evolving roles of government, non-government, and citizens groups in studying, and protecting surface water qualities • Some programs operate bi-nationally with Canada
Category	Water Quality and Sediments, Land Use and Management
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

583.Kelly, J.F. and R.L. Hutto (2005) An east-west comparison of migration in North American wood warblers. *The Condor* 107: 197-211.

Study Date	n.d. – Review

Location	• Various, including Long Point as a key migration stopover area
Findings/Purpose	• Study seeks to quantitatively show differences in migration of eastern and western migrant groups of wood warblers using existing data • Evidence suggests that western warblers are geographically isolated from eastern warblers throughout the annual cycle • Eastern and western wood warbler taxa are distinct evolutionary warblers • Fat-stores and age proportions are different between eastern and western groups • Frugivory is unknown to northwest and southwest populations • Riparian habitat is more heavily used by western warblers in spring • Suggests that a better understanding of western migration is a key research question for avian science
Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

*584.*Kelso, J.R.M. (1971) The structure of the Long point Bay fisheries. Pre-operational report, Nanticoke, Ontario. Ontario Ministry of Natural Resources, Sport Fisheries Branch *5:1-77*

Category	Fish
Source	CWS London

585.Kelso, J.R.M. (1973) The structure of the Long Point Bay fishery, 1972, in relation to 1971 investigations. Ontario Ministry of Natural Resources, Port Dover, Ontario. 96 pp.

Category	Fish
Source	

586.Kelso, J.R.M. (1973) Movement of Yellow Perch (*Perca flavescens*), Small-mouth Bass (*Micropterus dolomieui*) and White Bass (*Morone chrysops*) released in Long Point Bay, Lake Erie, during 1971 and 1972. Fish. Res. Board Can. Tech. Rep. 386: 1-27.

Study Date	1971-1972
Location	• Nanticoke area of LPB
Findings/Purpose	• 4478 yellow perch, 1322 smallmouth bass, 1048 white bass were marked prior to the operation of the Nanticoke station to gain an understanding of the natural population dispersion • Recaptures in 1971 and 1972 showed no local sub-groups • Yellow perch showed onshore eastward movement • Smallmouth showed seasonal movement – westward in spring, eastward in fall • White bass were far ranging – generally westward, also showed the most rapid rate of movement • Exploitation based on recapture was highest for yellow perch and lowest for white bass • Commercial fisheries selected of length
Category	Fish
Source	MNR Library – Peterborough McMaster University Library

587.Kelso, J.R.M. and R. Frank (1974) Organochlorine residues, mercury copper and cadmium in Yellow Perch, White Bass and Small-mouth Bass, Long Point Bay, Lake Erie. *Transactions of the American Fisheries Society* 103(3): 577-581

Study Date	May-October, 1972
Location	• Nanticoke, LPB
Findings/Purpose	• Total DDT concentrations were low for all species with no evident seasonal changes, and little inter-species difference despite different fat contents • Within species – concentrations increased with fat content, and age • PCB's up to 6.5 times greater than DDT; lowest in yellow perch,

	highest in white bass, and increased with increasing fat content • Dieldrin concentrations were low and showed no apparent trends with season or fat content • Mercury residues were found in only two specimens
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

588.Kemp. A.L.W. (1975) Sources, sinks and dispersion of fine-grained sediment in Lake Erie. p. 369-377. IN: Proc. Of the 2nd Federal Conf. on the Great Lakes. Great Lakes Basin Commission. Argonne Nat. Laboratory.

Category	Hydrology and sediments
Source	McMaster Libraries

589.Kemp, A.L.W., R.L. Thomas, C.I. Dell and J.M. Jaquet (1976) Cultural impact on the geochemistry of sediments in Lake Erie. J. Fish. Res. Board Can. 33: 440-462.

Category	Human Impacts, Hydrology and Sediments
Source	McMaster Libraries

590.Kemp, A.L.W., G.A. MacInnis. And N,S. Harper (1977) Sedimentation Rates and a Revised Sediment Budget for Lake Erie. Journal of Great Lakes Research Vol. 3, No. 3-4, p 221-233, December 1977. 4 fig, 4 tab, 31 ref.

Study Date	1971-1975 (active field work), study covers much larger period
Location	• Lake Erie • No sedimentation sample locations in Long Point Bay, however many located in the eastern basin • Sample map and locations in text
Findings/Purpose	• Estimates current sedimentation rates and review past sedimentation records using pollen dating techniques • Sedimentation rates were highest in the western basin, near the mouths of the Detroit and Maumee Rivers and in the deepest parts of the eastern basin east of Long Point • Mean sedimentation rates are given for areas and for the lake • ~14.3 million tons of fine-grained sediments is annually deposited in the lake • Erosion of shoreline bluffs a major source (~40% of total materials) • Rivers provide ~28% of the external sediment load
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

591.Kerman, B. R., R. E. Mickle, R. V. Portelli and N. B. Trivett (1982) The Naticoke Canada shoreline diffusion experiment. JUNE 1978 2. Internal Boundary Layer Structure. *Atmospheric Environment* 16 (3) : 423-438 1982

Category	Weather and Air Quality
Source	McMaster Libraries

592.Kiely, P. and H. Sahota (1984) Nanticoke Environmental Management Program analysis of SO2 exceedance events in the Haldimand-Norfolk region for 1975-1983 Ontario Ministry of the Environment, 163 p

Category	Land Use and Management
Source	

593.Kilborn Limited (1978) Preliminary engineering study, Big Creek Marsh, Long Point. Unpublished Report. Ducks Unlimited Canada.

Category	Land Use and Management
Source	CWS London

594. King, R.B., A. Queral-Regil and K.M. Stanford (2006) Population size and recovery criteria of the threatened Lake Erie Watersnake: Integrating multiple methods of population estimation. *Herpetological Monographs* 20: 83-104.

Study Date	1980-1985, 1988-1992, 1996-1998, 2000-2004
Location	• Lake Erie Islands – Western Lake Erie
Findings/Purpose	• Each research block had an independent primary research objective • 1980-1985: role of natural selection on color and patterning • 1988-1992: tissue sampling for examining gene transfer between islands • 1996-1998: watersnake distribution and abundance (US islands) • 2000-2004: population estimation, watersnake movement and hibernation site usage
Category	Reptiles
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

595. Kirby, M. K., and W. E. Dunform (1981) Attached algae of the Lake Erie shoreline near Nanticoke generating station Canada. Journal of Great Lakes Research 7 (3) : 249-257 1981

Study Date	1971-1978
Location	• Nanticoke – nearshore
Findings/Purpose	• Distribution, species composition, and standing crop was examined to determine the impact of the Nanticoke development • Station operation has no apparent influence on the spatial distribution of attached algae • Cooling water release generates accelerated growth rates in immediately surrounding areas • Species composition was also different in these areas
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

596. Kirk, D.A., M. Csizy, R.C. Weeber, C.M. Francis and J.D. McCracken (2001) Habitat associations of marsh-nesting birds in the Great Lakes basin: Implications for local conservation and management. Unpublished final report to Wildlife Habitat Canada.

Category	Birds
Source	

597. Kirk, D.A. (1985) Draft Checklist of Vascular Plants for the Big Creek Floodplain ANSI. Ontario Ministry of Natural Resource, Simcoe District.

Category	Terrestrial Vegetation, Aquatic Vegetation
Source	

598. Kirmse, P. (1966) New Wild Bird Hosts For Pox Viruses. Bull. Wildlife Disease Assoc. Vol. 2, April, 1966. pp. 30-33.

Category	Birds
Source	

599. Kirmse, P. (1966) Cnemidocoptic Mite Infestations in Wild Birds. Bull. Wildlife Disease Assoc. Vol 2, Oct., 1966. pp. 86-99.

Category	Insects, Birds
Source	

600. Kirmse, P. (1967) Host specificity and long persistence of pox infection in the Flicker (*Colaptes auratus*). Bull. Wildl. Disease Assoc. 3: 14-20.

Category	Birds
Source	

601.Kissner, K.J., P. J. Weatherhead and C.M. Francis (2003) Sexual size dimorphism and timing of spring migration in birds. *Journal of Evolutionary Biology* 16: 154–162

Study Date	1960-1996 (data sets from these years)
Location	• LPBO (42°33'N, 80°10'W)
Findings/Purpose	• Sexual selection favours larger males, larger males also have lower mortality rates than smaller males • Larger males being stronger should be able to migrate earlier when harsh weather favours larger males for energetic reasons • Early male migrants are in timing with female migrants and given the above should be larger proportional to females • Sexual size dimorphism and difference in arrival time of males and females was found to be significantly positively correlated • Findings support theory that selection and survival ability favours sexual size dimorphism
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

602.Klinkenberg, R. (1979) Environmental impact assessment of the conceptual plans for the entrance road redesign for Long Point Provincial Park. Unpublished report to the Ontario Ministry of Natural Resources. Simcoe, 21pp.

Category	Human Impacts
Source	CWS London

603.Klinkenberg, R. and J. Rhodes (1981) Long Point Provincial Park Life Science Inventory: 1980. Unpublished Ontario Ministry of Natural Resources report, Simcoe District. 144 pp.

Category	General
Source	CWS London

604.Knapton, R.W. (1982) The Henslow's Sparrow (*Ammodramus henslowii*) in Canada: A status report. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 77 pp.

Category	Birds
Source	CWS London

605.Knapton, R. W. (1993) Population status and reproductive biology of the Mute Swan, Cygnus olor, at Long Point, Lake Erie, Ontario. Canadian Field Naturalist. 107:354-356.

Study Date	May – August, 1991-1992
Location	• Long Point: 42°35'N, 80°24' W, at road accessible locations for viewing marshes and wetlands around the Inner Bay • SE corner of LP Provincial Park around the perimeter of the bay to Turkey Point (NE edge of the bay)
Findings/Purpose	• Breeding pair census and non-breeding adults • Degree of reproductive success • Examining evidence of a rapidly increasing and expanding population • 31 pairs with broods found, 9 – 1991, 22 – 1992 • Average brood size 4.9 • Population increase 1991-1992 = 14%, similar to 12 year (1969-1981) average of 12%
Category	Waterfowl
Source	McMaster University, Thode library periodicals

606.Knapton, R. W., and K. Pauls (1994) Fall food habits of American Wigeon at Long Point, Ontario. *Journal of Great Lakes Research* 20:271-276.

Study Date	September-November, 1991
Location	• South Shore – Inner LPB
Findings/Purpose	• 92% dry aggregate of the diet was plant material, 7.8% seeds, 0.6% animal matter • A wide variety of plant species were identified, however Wigeons

	showed selectivity in their diet (preference) • Muskgrass, elodea and bushy pondweed were dominant • Some sex, age and seasonal differences in diet preference were noted
Category	Waterfowl
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

607. Knapton, R. W., and S. A. Petrie (1999) Changes in distribution and abundance of submerged macrophytes in Long Point's Inner Bay, Lake Erie: implications for foraging waterfowl. *Journal of Great Lakes Research*. 25:783-798.

Study Date	1992-1994 – bird diet monitoring 1991, 1992, 1995 – submerged macrophyte monitoring
Location	• LPB
Findings/Purpose	• 29 plant species were monitored for consumption • *Vallisneria americana* was the most commonly consumed • *Chara vulgaris, Potamogeton spp., Polygonum spp.* and *Najas flexilis/quadalupensis* were also important dietery items • Submerged macrophyte distribution and percent abundance were monitored at 322 locations in Inner Long Point Bay • Results from macrophyte monitoring are compared against older studies and discussed in terms of influence on waterfowl • Changes in lake water quality and introduction of Quagga mussels has changed the dynamics of species available with some positive and some negative results
Category	Aquatic Vegetation
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

608. Knapton, R. W., S. A. Petrie, and G. Herring (2000) Human disturbance of waterfowl on Long Point Bay, Lake Erie. Wildlife Society Bulletin. 28: 923-930.

Study Date	Spring, Fall - 1993
Location	• Inner LPB
Findings/Purpose	• Mixed species of flocks of diving ducks most commonly disturbed waterfowl group • Disturbance rates greater in spring than fall, however number of birds disturbed was greater in the fall – due to flock congregation in relatively few locations with disturbances eliciting responses from the entire flock • Two responses were noted: a) flight followed by resumption of feeding, b) flight and discontinued feeding • Disturbance was primarily caused by boat traffic (commercial or recreational) • Creating non-traffic refuges in portions of the inner bay would increase suitability of ILPB as a staging area for diving ducks
Category	Human Impacts, Waterfowl
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

609. Knight, K.D. (1983) Conceptual ecological modelling and interaction matrices as environmental assessment tools with reference to the Long Point ecosystem. M.A. thesis, Department of Geography, University of Waterloo, Waterloo, Ontario.

Category	Land Use and Management
Source	CWS London

610. Knight, K.D. (1984) Conceptual ecological modelling and interaction matrices as environmental assessment tools in coastal planning. *Water, Science and Technology 16:559-567*

Category	Land Use and Management

Source	McMaster Libraries

611.Knight, D. (1983) An ecosystem approach to shore zone planning in the Long Point area p. 1-11. IN: Coastal Studies in Canadian Geography, Number 2 (P.J. Ricketts ed.). St. Mary's University, Halifax, Nova Scotia.

Category	Land Use and Management
Source	CWS London

*612.*Knister, R. (1973) Long Point, Lake Erie. *Canadian Geographic Journal 2:72-82*

Category	Unkown
Source	CWS London

613.Knowles, W.L. and B.L. Wheeler (1976) Report on erosion at the Long Point light station for the Ministry of Transport. Unpublished report for Federal Ministry of Transport. 37 pp.

Category	Hydrology and Sediments, Terrestrial Geography
Source	CWS London

614.Kostuk, K. A. and Chow-Fraser, P. (2006) Comparing gear types and sampling procedures to survey fish communities in the great lakes coastal wetlands. IAGLR Conference Program and Abstracts 49: 101 2006

Category	Fish
Source	McMaster Libraries

615.Kreutzwiser, R.D. (1979) Flood and erosion adjustment policies on the Lake Erie north shore. Contact 11(1): 137-152.

Category	Water Levels, Hydrology and Sediments
Source	McMaster Libraries

616.Kreutzwiser, R. D. (1980) Recreational significance of Long Point Marsh, Lake Erie. Research Report. Dept. of Geography. Univ. Guelph 28 pp.

Category	Land Use and Management
Source	CWS London

617.Kreutzwiser, R.D. (1981) The economic significance of the Long Point Marsh, Lake Erie, as a recreational resource. Journal of Great Lakes Research 7(2): 105-110

Study Date	1978
Location	• Long Point Marsh • Point Pelee Marsh
Findings/Purpose	• Recreation often not considered economically in land use decision-making for marshes • Users identified nature viewing, fishing, and waterfowl hunting as major uses at LP with over 17,000 users • Over $400,000 of potential direct and indirect dollars could be gained by exploring marsh LP recreational potential
Category	Land Use and Management
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

618.Kreutzwiser, R. D. and A.O. Gabriel (1993) Managing for sustainable development and use of the long point sandy barrier: a report to the Laidlaw Foundation. University of Guelph, 69 p

Category	Land Use and Management
Source	

619.Kreutzwiser, R. D. and A.O. Gabriel (2000) Managing environmental stress: An evaluation of environmental management of the Long Point sandy barrier, Lake Erie, Canada. Environmental Management 25 (1): 71-85

Study Date	Review Paper – various dates and studies
Location	• LP

Findings/Purpose	• Differences in land ownership and stewardship influence the effective management of the transitional feature of long point • Human construction (cottages, dykes, roads, etc.) influences the transfer of sediments for the maintenance of the point • Non-jurisdiction of sediment sources also impacts ability to manage point maintenance • Evolution of the point is the greatest difficulty for environmental mangers of the long point system
Category	Land Use and Management
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

620. Kroetsch, D.J. and P. Lepson (1980) Mapping of emergent vegetation of Boucks Pond in Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Aquatic Vegetation
Source	CWS London

621. Kroetsch, D.J. (1980) Deer exclosure sites, Long Point National Wildlife Area: Vegetation sampling. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Mammals, Terrestrial Vegetation
Source	CWS London

622. Kroetsch, D.J. (1980) A preliminary study of selected plant communities: Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Terrestrial Vegetation
Source	CWS London

623. Kullik, S.A., M.K. Sears, D.G.R. McLeod, L.L. Gualtieri and A.W. Schaafsma (2005) Phenology and field biology of Black Cutworm (Lepidoptera: Noctuidae) in Ontario no-till corn. *Journal of Economic Entomology* 98(5): 1594-1602.

Study Date	2000-2002
Location	• Long Point (42°36.25''N, 80°34.28''W) • Dunnville, Woodstock
Findings/Purpose	• First captures were later than reported in the US, and consisted of both males and females (where males were caught earlier than females in the US) • Indicates perhaps a more mature source for Ontario invaders • Cutworm age and leaf age corresponded rather than moth timing – indicating that phenology was dominantly related to food quality and availability
Category	Terrestrial Vegetation
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

624. Kurczewski, F.E. (2000) History of White Pine (*Pinus strobus*)/oak (*Quercus* spp.) savanna in southern Ontario, with particular reference to the biogeography and status of the Antenna-weaving Wasp, *Tachysphex pechumani* (Hymenoptera: Sphecidae). *Canadian Field Naturalist* 114(1): 1-20.

Category	Forests, Terrestrial Vegetation, Insects
Source	McMaster Libraries

625. Kurczewski, F.E. and H.F. Boyle (2005) Nesting behaviour, ecology, seasonal and geographic distribution of the sand wasp, *Stictiella emarginata (Hymenoptera: Sphecidae). Canadian Field Naturalist 119(1)*: 6-15

Category	Insects
Source	McMaster Libraries

626. Kwan, K.K., and B.J. Dutka (1995) Comparative Assessment of Two Solid-Phase Toxicity Bioassays: The Direct Sediment Toxicity Testing Procedure (DSTTP) and the Microtox Solid-Phase Test (SPT) *Bulletin of Environmental Contamination and Toxicology* 55:338-346.

Study Date	n.d.
Location	• Big Creek (sample collection only)
Findings/Purpose	• Negative control samples (non-toxic samples) were taken from Big Creek • Examines the effectiveness and application of two toxicity testing methods • Chemical analyses often only test for 'priority pollutants' neglecting other potential hazards • Biological testing relies on exposure tests of organisms to bioavailable chemicals in a sample and noting changes in biological activity • Pore-water tests may miss toxicants that are in low concentrations, poorly soluble or insoluble • Two solid-phase tests are examined as an alternate method for toxic screening • Both were found to be sensitive tests for bioavailable toxicants in solid phase samples
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

627. Kwan, K.K. and B.J. Dutka (1996) Development of reference sediment samples for solid phase toxicity screening tests. *Bulletin of Environmental Contamination and Toxicology* 56(5): 696-702.

Study Date	n.d.
Location	• Inner Long Point Bay – sample collection
Findings/Purpose	• Study seeks to provide standardized testing procedures for solid-phase toxicity screening, which has to date been a limiting factor
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

628. Laidler, G. (1944) Long Point, Lake Erie: Some physical and historical aspects. Ont. Hist. Soc. Pap. And Rec. 36: 48-69

Category	Land Use and Management, Terrestrial Geography, Human Impacts
Source	McMaster Libraries

629. Laidly, W.T. (1962) Regimen of the Great Lakes and fluctuations of lake levels IN: Great Lakes Basin. Am. Assoc. Advancement Sci. Publ. 71: 91-105.

Category	Water Levels, Hydrology and Sediments
Source	McMaster Libraries

630. Laing, D. (2006) Southern Ontario Bald Eagle Monitoring Program 2005 Final Report. Unpublished Bird Studies Canada report. 24p.

Category	Birds
Source	

631. Lambert, A. and E. Nol (1978) Status of the Piping Plover at Long Point, 1978. Long Point Bird Observatory Newsletter. 40 pp.

Category	Birds
Source	CWS London

632. Lambert, A.B. (1980) Assessment of effects of winter navigation on bird populations on the Great Lakes. Unpublished report. U.S. Fish and Wildlife Service. 105 pp.

Category	Birds

Source	CWS London

633. Lambert, A.B. and R.B.H. Smith (1984) The status of the Prairie Warbler (*Dendroica discolour*). Unpublished report to Ontario Ministry of Natural Resources. 318 pp.

Category	Birds
Source	

634. Lambert, A.B. and R.B.H. Smith (1984) The status of the Piping Plover in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 110 pp.

Category	Birds
Source	CWS London

635. Landon, M. (1931) Elk remains in Norfolk County. *Canadian Field Naturalist* 45:50.

Category	Mammals
Source	McMaster Libraries

636. Landon, M. (1960) Vascular plants of Norfolk County, Ontario. Big Creek Region Conservation Authority, Simcoe, Ontario. 66 pp.

Category	Terrestrial Vegetation
Source	CWS London

637. Laucht, S. (2006) Differences in age and sex ratios of migrating landbirds at Long Point, Lake Erie, Canada in relation to location and light sources. M.Sc. thesis, University of Ulm, Germany. 116 pp.

Category	Birds
Source	

638. Laurin, G. and D.M. Green (1989) Spring emergence and male breeding behaviour of Fowler's Toads, *Bufo woodhousii fowleri*, at Long Point, Ontario. Report to Ontario Ministry of Natural Resources and Canadian Wildlife Service.

Category	Amphibians
Source	

639. Laurin, G. and D.M. Green (1990) Spring emergence and male breeding behaviour of Fowler's Toads (*Bufo woodhousii fowleri*) at Long Point, Ontario. *Canadian Field-Naturalist* 104:429-434.

Study Date	May-June 1988
Location	• Long Point – site map in text
Findings/Purpose	• 9 breeding sites observed, individual toads observed for 10 min, specimen measurements: temperature, snout-vent length • Site characteristics and toad behaviour including: calling rate, movement, breeding activity, distance to neighbour, water depth, surface temp, air temp, vegetation, etc. • Fowler’s toads observed at LP May 15, ~2 weeks after American toads
Category	Amphibians
Source	McMaster University, Thode library periodicals

640. Law, M. (1986) Sediment size variations across a nearshore bar, Long Point, Ontario. Honours BSc thesis, Department of Geography, University of Guelph, Guelph, Ontario. 172 pp.

Category	Hydrology and Sediments
Source	

641. Lawrence, P.L. and K. Beazley (1994) Analysis of Land Cover and Land Use Change in the Long Point Area from 1955 to 1990 Using Aerial Photography. Long Point Environmental Folio Publication Series - Technical Note 2. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 29 pp.

Study Date	1955-1990

Location	• Long Point
Findings/Purpose	• Examines changes in land cover change (not land USE change) through the use of Air photo interpretation from 1955-1990 for LP • Land Use change maps show areas of altered land cover throughout several time periods • The land cover classification scheme is listed in text • Maps of land cover change are presented in text • Photos from ground-truthing visits are presented in text • Areas of significant land use change are hightlighted
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

642. Lawrence, P. L. and J. G. Nelson (1994) Shoreline flooding and erosion hazards in the Long Point area. Long Point Environmental Folio Publication Series – Working Paper 7. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 32 pp.

Category	Water Levels, Hydrology and Sediments
Source	Heritage Resources Centre, University of Waterloo http://www.kwic.com/~longpointbio/Reserve/Publications/FOLIO/content/content.htm

643. Lawrence, P.L., K. Beazley and C.L. Yeung (1996) Analysis of Land Cover Change in the Long Point Area. Chapter 12: Long Point Environmental Folio Publication Series. Heritage Resource Centre, University of Waterloo, Waterloo, ON. 9pp.

Study Date	1974-1984 1955-1990
Location	• Long Point
Findings/Purpose	• Examines changes in land cover change (not land USE change) through the use of Landsat Multispectral Scanner (MSS) images and change detection within desired classes (1974-1984) • Air photo interpretation of land cover change from 1955-1990 was also undertaken for a small area closer to LP • Land Use change maps show areas of altered land cover throughout several time periods
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

644. Lawrence, P.L. and J.G. Nelson (1996) Shoreline Flooding and Erosion Hazards in the Long Point Area. Chapter 14: Long Point Bay Environmental Folio Publication Series. Heritage Resource Centre, University of Waterloo, Waterloo, Ontario. 15pp.

Study Date	Historical and current data
Location	• Long Point
Findings/Purpose	• Brief history of occurrences of flooding and erosional hazards • Natural spit forming and modification processes are reviewed • Brief examination of development along the shore of Lake Erie in Norfolk-Haldimand and along Long Point • Shore protection activities and human response to hazards • Shoreline feature dominance is provided for Haldimand-Norfolk and for Long Point specifically (dunes, bluffs, major material type, etc.)
Category	Water Levels, Hydrology and Sediments
Source	BSC Library Waterloo Heritage Resource Centre

645. Leach, J.H. and S.J. Nepszy (1976) The fish community in Lake Erie. *Journal of the Fisheries Research Board of Canada*, 33(3): 622-638.

Study Date	Review using existing research – data from 1914 to ~1975
Location	• Lake Erie
Findings/Purpose	• Examines changes in dominant fish species from 1914 (some earlier data) with bias towards commercially viable species.

	• Changing community composition is linked to cultural stresses including: intensive commercialization, nutrient loading, non-native species introduction, tributary & shoreline restructuring, erosion and siltation, pollution
Category	Fish
Source	McMaster University, Thode library periodicals

646. Leach, J.H. (1981) Comparative limnology of Inner Long Point Bay, Lake Erie, and adjacent waters of the outer bay. Journal of Great Lakes Research 7(2): 123-129.

Study Date	April-November, 1978-1979
Location	• Inner and Outer Long Point Bay
Findings/Purpose	• Inner bay receives diffuse-source nutrient loading, supports dense stands of aquatic vegetation • Of 14 parameters studied, all by dissolved O_2, nitrate, and total alkalinity were different between the inner and outer bay • Seasonality of some parameters was noted • Shallow waters of the inner bay generate a higher temperature fluctuation • Inner bay is considered eutrophic, outer bay mesotrophic • Changing agricultural practices have changed nitrogen loading • Findings suggest continued enrichment of the inner bay
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

647. Leahy, M.G., M.Y. Jollineau, P.J. Howarth and A.R. Gillespie (2005) The use of Landsat data for investigating the long-term trends in wetland change at Long Point, Ontario. *Canadian Journal of Remote Sensing* 31(3): 240-254.

Study Date	1976-1999 (image periods)
Location	• Long Point
Findings/Purpose	• Water-level fluctuations are natural processes and necessary for productivity, however their magnitude and rate can significantly influence wetland systems • By overlapping landsat derived NDVI images over the period of interest, changes in wetland cover are monitored using two change-detection methods - post-classification comparison and multitemporal data clustering • Resulting patterns were compared against lake level records and drought indices • Decreases in lake water levels corresponded with increases in emergent vegetation coverage • The multitemporal data clustering allowed change detection across the entire period
Category	Water Levels
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

648. LeDrew, E.F. and S.E. Franklin (1987) Mapping potential effluent pathways in the Long Point region of Lake Erie from LANDSAT imagery. *Journal of Coastal Research* 3(2): 219-232.

Category	Water Quality/Limnology
Source	McMaster Libraries

649. Lemieux, C. (1982) Forty-fifth breeding bird census. Red oak-american basswood savannah. *American Birds* 36:76-77.

Findings/Purpose	See: Van Velzen, W.T. (1982)
Category	Birds
Source	McMaster University

650. Lepage, D. (2002) Preliminary Breeding Bird Inventories of Long Point Region Conservation Authority Forest Tracts in 2002. Unpublished Bird Studies Canada report for the Long Point Region Conservation Authority. 22p.

Category	Birds
Source	

651. Lepson, P. (1980) pH monitoring of precipitation and of dune ponds: A preliminary study. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Water Quality/Limnology
Source	CWS London

652. Leslie, J. K. and C. A. Timmins (1997) Early life history of fishes in Long Point inner bay, Lake Erie. / by J.K. Leslie and C.A. Timmins Canada. Dept. of Fisheries and Oceans, Great Lakes Laboratory for Fisheries and Aquatic Sciences Burlington, Ont.: Fisheries and Oceans Canada, 18p.

Category	Fish
Source	McMaster Libraries

653. Leslie, J.K. and C.A. Timmins (1998) Seasonality of fish in surf zone and tributary of Lake Erie: a comparison. Great Lakes Laboratory for Fisheries and Aquatic Sciences. 15pp.

Category	Fish
Source	McMaster Libraries

654. Lewis, C.F.M. (1967) Sedimentation studies of unconsolidated deposits in the Lake Erie basin. Ph.D. thesis, University of Toronto, Toronto, Ontario. 134 pp.

Category	Hydrology and Sediments
Source	

655. Lewis, C.F.M. (1969) Late Quaternary history of lake levels in the Huron and Erie basins. Proceedings from the 12th Conference on Great Lakes Research: 250-270.

Category	Terrestrial Geography
Source	McMaster Libraries

656. Lewis, C.F.M., T.W. Anderson, S.M. Blasco, G.D.M. Cameron, and J.P. Coakley (1999) Did early Holocene Lake Erie experience closed-basin conditions? International Association for Great Lakes Research: Great Lakes, Great Science, Great Cities. Programs and Abstracts. p. A-70.

Category	Terrestrial Geography, Water Levels
Source	

657. Library of Canada. Various Maps of the Long Point Area (various years) Library and Archives of Canada. Searchable Database: http://amicus.collectionscanada.gc.ca/aaweb-bin/aamain/rqst_sb?sessionKey=999999999_142&r=2&i=SU&l=0&v=0&lvl=1&t=Long+Point+Region+Conservation+Authority--Maps

Study Date	--
Location	• Long Point
Findings/Purpose	• Library of Canada Map Holdings for the Long Point Area • Topics Include: Conservation Areas, Climate, Municipal Maps, Economic Conditions, Remote Sensing Maps
Category	General
Source	(see link in reference)

658. Liard, A.C. (1973) A Study of the Energy-Transport Relationship and a Computer Simulation of Long Point, Lake Erie. M.Sc. thesis, Department of Earth Sciences, University of Waterloo, Waterloo, Ontario.

Category	Hydrology and Sediments
Source	

659. Liard, A.C. (n.d.) Long Point Ontario: A National Proposal. National Parks Service-Planning. Unpublished Report to the Department of Indian Affairs and Northern Development. 18pp.

Category	Land Use and Management
Source	CWS London

660. Licinsky, S. (1968) Report on the deer of Long Point in Lake Erie. Unpublished report to the Long Point Company

Category	Mammals
Source	CWS London

661. Lindsay, K.M. (1979) Long Point Provincial Park - Life Science Inventory Check Sheet. OMNR, Southwestern Region, London. 9pp.

Category	Terrestrial Geography
Source	

662. Lindsay, K.M. (1984) Life science areas of natural and scientific interest in Site District 7-2: A review and assessment of significant natural areas in Site District 7-2 west of the Haldimand Clay Plain. Parks and Recreation Areas Section, Ontario Ministry of Natural Resources, Central Region. 131 pp

Category	General
Source	McMaster Libraries

663. Lindsay, L.R., I.K Barker, G.A. Surgeoner, S.A. McEwen, L.A. Elliott, and J. Kolar (1991) Apparent incompetence of *Dermacentor variabilis* (Acari: Ixodidae) and fleas (Insecta: Siphonaptera) as vectors of *Borrelia burgdorferi* in an *Ixodes dammini* endemic area of Ontario, Canada. Journal of Medical Entomology 28(5): 750-753.

Category	Insects
Source	McMaster Libraries

664. Lindsay, L.R., I.K. Barker, A.G. Surgeoner, S.A. McEwen, T.J. Gillespie and J.T, Robinson (1995) Survival and Development of Ixodes scapularis (Acari: Ixodidae) Under Various Climatic Conditions in Ontario, Canada. Journal of Medical Entomology 32 (2) : 143-152 1995

Study Date	December 1991-May 1993
Location	• Long Point (42°36'N, 80°05'W) • Ottawa • Hearst • Kenora
Findings/Purpose	• Investigates the potential constraints on spread of Blacklegged tick populations due to colder climatic conditions • An endemic population is known to exist at Long Point • Specimens (some fed, some unfed, adult and juvenile) were held in containers in natural environments at the stated locations above • Both fed and unfed females overwintered with higher survival rates at the northern sites, survival was similar at all sites for nymphs • Hearst showed delayed egg laying, and no hatching • Decreased hatching, fewer large mammal hosts and difficulty in finding a mate are cited as the most likely causes for limited spread of this species when introduced in very small numbers
Category	Insects
Source	McMaster University, Health Science Stacks

665. Lindsay, L.R., I.K. Barker, G.A. Surgeoner, S.A. McEwen, and G.D. Campbell (1997) Duration of *Borrelia burgdorferi* in white-footed mice for the tick vector *Ixodes scapularis* under laboratory and field conditions in Ontario. Journal of Wildlife Diseases 33(4): 766-775.

Study Date	1993
Location	• LP – infected tick collection, field study

Findings/Purpose	• Investigates the duration of infectivity within white footed mice within a laboratory setting using lab-raised mice and wild mice infected with *Borrelia burgodoferi* from ticks collected at Long Point or located at Long Point • As time progressed (21, 35 and 49 days post inoculation), the number of infective mice decreased • Overall findings indicate that infected tick nymphs are the likely over-wintering 'reservoir' for the infection rather than infected mammalian hosts
Category	Insects, Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

666. Lindsay, L.R., I.K. Barker, G.A. Surgeoner, S.A. McEwen, T.J. Gillespie, and E.M. Addison (1998) Survival and development of the different life stages of *Ixodes scapularis* (Acari: Ixodidae) held within four habitats on Long Point, Ontario, Canada. Journal of Medical Entomology 35(3): 189-199

Category	Insects, Terrestrial Geography
Source	McMaster Libraries

667. Lindsay, L.R.; S.Mathison, I.K. Barker, S.A. Mcewen, T. J. Gillespie, and G.A. Surgeoner (1999) Microclimate and habitat in relation to Ixodes scapularis (Acari: Ixodidae) populations on Long Point, Ontario, Canada. Journal of Medical Entomology 36 (3) : 255-262 May, 1999

Study Date	1989-1992
Location	• Long Point
Findings/Purpose	• Investigate the impact of microclimate and density of hosts for adult ticks at 4 sites on LP – oak savannah (OS), cottonwood dune (CD), maple forest (MF), and white pine (WP) habitats • Vapour pressure deficits were higher in OS and CD which likely impacted tick egg and juvenile survival • Adult ticks did not differ significantly between the examined habitats • Mean number of adults within each habitat also did not vary • Significantly more adults were harvested from MF than WP • Adult ticks per white-tailed deer increased from 1989-1991 and decreased in 1992 • While microclimate affected tick abundance, habitat use by deer also appears to have a significant influence on the population
Category	Insects, Terrestrial Geography
Source	Available at cost from publisher

668. Lindsay, L.R., S.W. Mathison, I.K. Barker, S. A. Mcewen, and G. A. Surgeoner (1999) Abundance of Ixodes scapularis (Acari: Ixodidae) larvae and nymphs in relation to host density and habitat on Long Point, Ontario. Journal of Medical Entomology 36 (3) : 243-254 May, 1999

Study Date	1990-1992
Location	• Long Point
Findings/Purpose	• Investigat the relationship between the density of mouse populations and density of immature tick population • Significantly more tick larvae were found in the maple forest than in the oak savannah or white pine habitats for 1989-1991 • In 1992, no significant difference between the habitats was found • Significantly more tick nymphs were found in the maple forest for all years • The number of mice captured was not significantly correlated with the number of ticks • Findings indicate that other factors outside of size of the mouse population were responsible for the differences between the habitats examined

Category	Insects, Mammals
Source	Available at cost from publisher

669. Lineham, J.T. (1968) Thirty-second Breeding Bird Census. *Audubon Field Notes* 22: 655-690

Study Date	1968
Location	• Various. Those of interest listed below. • 1 mi from tip of LP, 42°33' N, 80°04' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Sand dunes with cottonwoods • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

670. Lipsit, J.H. (1977) Diet, age and growth, and management of Northern Pike, *Esox lucius* L., in Inner Long Point Bay, Lake Erie. Unpublished report; Department of Zoology, University of Western Ontario, London, Ontario. 26 pp.

Category	Fish
Source	CWS London

671. Liu, P.C. (1970) Statistics of Great Lakes levels. Proc. 13th Conf. Great Lakes Res., Internat. Assoc. Great Lakes Res. p. 360-368.

Category	Water Levels
Source	McMaster Libraries

672. Loftus K.K., R.C. Smardon and B.A. Potter (2004) Strategies for the stewardship and conservation of Great Lakes coastal wetlands. *Aquatic Ecosystems Health and Management 7(2):* 305-330.

Study Date	Review Paper
Location	• Great Lakes Coastal Wetlands – General • Long Point Mentioned as a RAMSAR site
Findings/Purpose	• Review of coastal wetland conservation measures and regulations in both the United States and Canada • Tax incentives, stewardship initiatives, special program/partnerships • Examines international, national, provincial, state and local programs and efforts and their effectiveness • Recent initiatives focus on water quality from federal/state and waterfowl from government/non-government
Category	Land Use and Management, General Wetlands
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

673. Long Poing Waterfowl and Wetlands Research Fund. Long-term monitoring of spring and autumn waterfowl populations at Long Point Bay, Lake Erie: 1971 – present. Unpublished data. Long Point Waterfowl and Wetlands Research Fund / Bird Studies Canada & Environment Canada – Canadian Wildlife Service.

Category	Waterfowl
Source	

674. Long Point Waterfowl and Wetlands Research Fund (2003) Tri-annual Mid-summer Mute Swan surveys on the Canadian Lower Great Lakes: 2002 – present. Unpublished data. Long Point Waterfowl and Wetlands Research Fund / Bird Studies Canada & Environment Canada - Canadian Wildlife Service.

Category	Waterfowl
Source	

675. Lougheed, V. (2000) A study of water quality, zooplankton and macrophytes in wetlands of the Canadian Great Lakes Basin: implications for the restoration of Cootes Paradise Marsh. PhD Thesis, McMaster University.

Study Date	1993-1999
Location	• Cootes Paradise (primary location) • Various, including Long Point as comparative sites
Findings/Purpose	• Examines how macrophytes and lower trophic levels are affected by water and sediment quality • Wetland quality is examined in term of anthropogenic stressors and carp • Various wetlands throughout the Great Lakes basin are assessed • Focus is on placing Cootes paradise within the context of other wetlands in the Great Lakes basin • Implications for management and restoration are considered in Cootes Paradise, a relatively disturbed and highly impacted S-Ontario wetland
Category	Water Quality/Limnology, Aquatic Vegetation, Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

676. Loery, G. (1967) Thirty-first Breeding Bird Census. *Audubon Field Notes* 21: 611- 640

Study Date	1967
Location	• Various. Those of interest listed below. • 1 mi from tip of LP, 42°33’ N, 80°04’ W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Sand dunes with cottonwoods • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

677. Loery, G. (1969) Thirty-third Breeding Bird Census. *Audubon Field Notes* 23: 700-732

Resource #	
Study Date	1969
Location	• Various. Those of interest listed below. • 1 mi from tip of LP, 42°33’ N, 80°04’ W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Sand dunes with cottonwoods, • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

678. Logier, E.B.S. (1929) Melanism in the Garter Snake, Thamnophis s. sirtalis, in Ontario. Copeia, No. 172 (Jul. - Sep., 1929), pp. 83-84

Category	Reptiles
Source	McMaster Libraries

679. Logier, E.B.S. (1930) Some Additional Notes on Melanism in Thamnophis s. sirtalis in Ontario. *Copeia*, Vol. 1930, No. 1 (Apr. 30, 1930), p. 20

Category	Reptiles
Source	McMaster Libraries

680. Logier, E.B.S. (1931) The amphibians and reptiles of Long Point. pp. 229-236. IN: A Faunal Investigation of Long Point and Vicinity, Norfolk County, Ontario (L.L. Snyder and E.B.S. Logier eds.). Trans. Roy. Can. Inst. 18: 117-236

Category	Amphibians, Reptiles
Source	McMaster Libraries

681.Logier, E.B.S and G.C. Toner (1961) Checklist of amphibians and reptiles of Canada and Alaska. 2nd ed. Royal Ontario Museum, Toronto, Ontario. 93pp.

Category	Amphibians, Reptiles
Source	CWS London

682.Long Point Bird Observatory (1960+) Annual reports (some years combined). Long Point Bird Observatory, Port Rowan, ON.

Category	Birds
Source	

683.Long Point Bird Observatory (1969+) Quarterly newsletters. Long Point Bird Observatory, Port Rowan, ON.

Category	Birds
Source	

684.Long Point Bird Observatory (1978+) Great Lakes beached bird survey. Annual Reports. Long Point Bird Observatory, Port Rowan, ON.

Category	Birds
Source	

685.Long Point Bird Observatory (1978) Breeding bird censuses on Long Point. Unpublished Report. Canadian Wildlife Service, Ontario Region. 10pp

Category	Birds
Source	

686.Long Point World Biosphere Reserve Foundation (1994) Long Point country community action plan. Long Point World Biosphere Reserve Foundation Port Rowan, Ontario. 61p.

Category	Land Use and Management
Source	

687.Long Point World Biosphere Reserve Foundation (1995) Lake Erie and Long Point Bay fisheries symposium: problems and prospects. -- Port Rowan, Ont. Long Point World Biosphere Reserve Foundation, 1995.

Category	Fish, Land Use and Management
Source	

688.Long Point Biosphere Reserve (2000) Long Point Biosphere Rerserve, Periodic Review Report, 2000. Unpublished report 77 pp.

Category	Land Use and Management
Source	

689.Lovisek, J. (1983) Spotted Turtle research at the Thoroughfare Point Unit of Long Point National Wildlife Area in 1982. Unpublished progress report to Canadian Wildlife Service, London, Ontario. 10 pp.

Category	Reptiles
Source	CWS London

690.Lovvorn, J.R. (1989) Food dependability and anti-predator tactics: Implications for dominance and pairing in Canvasbacks. The Condor 91(4): 826-836.

Study Date	March-April, 1984 (LPB dates)
Location	• Inner LPB • Other locations at different times based on migration locations
Findings/Purpose	• Time spent in aggression, rate of aggressive encounters were monitored for each location • Aggression increased in locations where size of food items were larger relative to food densities

	• Foraging aggression was rare in estuarine bays (wintering locations) • During pairing in spring, paired females were the most aggressive of all age and sex classes • Wintering habitat: food is not scarce and not economically defendable • Anti-preditor tactics conflict with pair-bonding and feeding-site defence in winter in open-water
Category	Waterfowl
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

691. Lovvorn, J.R. (1990) Courtship and aggression in Canvasbacks: Influence of sex and pair-bonding. The Condor 92(2): 369-378.

Study Date	March-April, 1984
Location	• LPB
Findings/Purpose	• 25-28% of Canvasbacks present were female • 17-27% of females were paired • Paired individuals spent more time in foraging-aggression and initiated and won more encounters than non-paired • During courtship behaviours, females were the dominant aggressors, however roles reversed just before or upon arrival at nesting sites, including the repelling of other males
Category	Waterfowl
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

692. Lovvorn, J.R. (1994) Nutrient reserves, probability of cold spells and the question of reserve regulation in wintering Canvasbacks. *The Journal of Animal Ecology* 63(1): 11-23.

Study Date	March-April, 1984 (LPB dates)
Location	• LPB • Lake Mattamuskeet, North Carolina* - primary site considered
Findings/Purpose	• Endogenic responses to cold spells and reliance on nutrient reserves is considered • Predictability of cold periods is difficult – cold snaps are more frequent at higher latitudes, however their timing and duration is not predictable • As such, question is raised as to the ability of Canvasbacks and other species to have endogenic controls during these periods
Category	Waterfowl
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

693. Lusis, M. (1980) Air quality research and management in the Long Point, Haldimand-Norfolk area. *Contact* 12(3): 65-79.

Category	Weather and Air Quality
Source	McMaster Libraries

694. MacCallum, W. (1969) The distribution of Smelt in Lake Erie in the early 1960's. M.Sc. thesis, University of Toronto, Toronto, Ontario.

Category	Fish
Source	CWS London

695. MacCulloch, R (1983) Proposal for research in the Long Point National Wildlife Area. Royal Ontario Museum. 4pp.

Category	General
Source	CWS London

696. MacCrimmon, H.R., and D.J. Gordon (1981) Salmonid spawning runs and estimated ova production in Normandale Creek of Lake Erie. *Journal of Great Lakes Research 7(2):* 155-161

Category	Fish
Source	

697. MacDonald, J.D.A. (1986) The Varden site: A multi-component fishing station of Long Point, Lake Erie. Unpublished report for Ontario Heritage Foundation and Ontario Ministry of Citizenship and Culture. 119 pp.

Category	Fish
Source	CWS London

698. MacGregor, RB. (1987) Preliminary Estimates of Incidental Smallmouth Bass Mortality in Gill Nets in Long Point Bay (1983-1984). Ontario Ministry of Natural Resources. 43pp

Study Date	July-August 1983, 1984
Location	• Long Point Bay
Findings/Purpose	• 1983 estimates were between 6,238 – 9,954 depending on estimation method • Confidence in estimated kill rates are low based on current methods • Studies sugges that smallmouth mortality could be siginificantly reduced is commercial fishermen routinely removed live entangled fish from their nets for immediate return to the water • Information in this report is not sufficient to evaluate the impact of incidental kills – further work is required (suggestions are provided in text)
Category	Fish
Source	MNR Library

699. MacGregor, R.B. and L.D. Witzel (1987) A twelve year study of the fish community in the Nanticoke Region of Long Point Bay, Lake Erie: 1971-1983 Summary Report. Ontario Ministry of Natural Resources. 616pp.

Study Date	1971-1983 (review)
Location	• Long Point Bay – Nanticoke
Findings/Purpose	• Major discussion sections cover: Fish Abundance and Distribution (larval and adult fish), and Fish Biology (Good and Feeding, Reproduction, Age and Growth) • Development of the areas around LPB raised concerns about fish populations and community changes – this study has attemped to examine what changes have been caused • Few changes to the fish community were found by this study that can be directly attributed to industrialization • Changes detected are quite localized in extent • Rainbow smelt most common larval fish caught • Year-to-year differences were significant but not correlated to industrial development • ~63 different species of adult fish were captured • Few long term trends were detected • Significant differences in the abundance of adult fish among sampling sites were detected in both trapnet and gillnet catches • Sport fishing in vicinity of the Nanticoke PGS has increased due to fish attraction to warmer waters • Fish are more vulnerable in the discharge areas of the power plant • Rock bass travel further than previously anticipated • Displaced yellow perch returned to spawn in the Inner Long Point Bay • No major dietary differences were noted in species examined (except perch) • Spawning was seen in discharge channels • Inner Bay and nearshore waters of LP were shown to be most important for spawning

Category	Fish
Source	MNR Library

700.MacGregor, R.B. (1988) Estimated Incidental Catches of smallmouth bass in commercial gill nets, Long Point Bay, Lake Erie, 1987. Lake Erie Fisheries Assessment Unit Report

Study Date	April-October, 1987
Location	• Long Point Bay
Findings/Purpose	• Investigate the occurrence of incidental catches of smallmouth bass in commercial gill nets • Simulated commercial fishing estimates of incidental smallmouth bass catches • On board observations • LPB was divided into three areas – with varying catch averages between them • Estimates of survival of smallmouth immediately upon being pulled up in nets ~25% • Anglers harvest approximately 37% of the catchable segment of the smallmouth bass population annually • Results indicate that with some modifications to commercial fishing methods could reduce incidental kill rates • Suggestions include: restricted gill netting in certain areas and times, emphasize benefits of releasing bass carefully back to the water where possible • Further research areas are suggested
Category	Fish
Source	MNR Library – Peterborough

701.MacGregor, R.B. and D.C. Howe (1989) Estimated Incidental Catches of smallmouth bass in commercial gill nets, Long Point Bay, Lake Erie, 1988. Lake Erie Fisheries Assessment Unit Report

Study Date	April-October 1988
Location	• Long Point Bay (emphasis on waters east of Port Dover)
Findings/Purpose	• Investigate the occurrence of incidental catches of smallmouth bass in commercial gill nets • Examination of seasonal and temporal trends in incidental smallmouth bass catches – simulated commercial fishing • On-board observations of commercial fishing catches in LPB • Critical vulnerability period: July 1- September 30 (some possible issues with changes to test protocols may influence data) • ~ Incidental catch of smallmouth was 7,594 (+-3,025) in 1988 of which, 74% were taken in waters east of Port Dover • Bass concentrate in rocky areas near to and west of Peacock Point, Nanticoke Shoal • Bass move into the bay for spawning • Suggested reduction or restriction on gill netting in sensitive areas during key times • Further research is suggested
Category	Fish
Source	MNR Library – Peterborough

702.MacInnes, C.D. and D.D. Dow. (1965) An aerial transect method for estimating duck populations on Long Point Bay. Unpublished report; University of Western Ontario, London, Ontario.

Category	Waterfowl
Source	Environment Canada Libraries – Gatineau, QC

703.MacIntyre, K.A. (1999) Ectoparasitism and growth of nestling Tree Swallows, *Tachycineta bicolor*. Honours B.Sc. Thesis, Lakehead University.

Study Date	1998

Location	• Long Point Bird Observatory – Sewage Lagoon, Mud Creek
Findings/Purpose	• Investigate the impact of ecoparasite infestation (investigation focused on fleas) on nestling tree swallow growth • Infestation rates were much higher at the Sewage Lagoon site than Mud Creek however no significant difference was found between pre-fledging weight and primary feather lengths of birds at the two sites • Spraying reduced infestation, however nestling growth was slightly slower at sprayed sites • Natural (even heavy natural) infestation does not appear to affect nestling growth
Category	Birds
Source	McMaster University, Thode library periodicals

704. MacKenzie, S.A. (2006) Long Point Bird Observatory: 2006 Field Operations Report. Bird Studies Canada.

Study Date	2006
Location	• LPBO
Findings/Purpose	• Review of programs • Reports success and status of programs • Species of note, and highlights from the year are reported
Category	Birds
Source	BSC

705. MacLean, J.K. (1979) A Preliminary Assessment of the Fish Populations of the Big Creek Marsh Conducted in the Summer of 1979. Canadian Wildlife Service unpublished report.

Category	Fish
Source	CWS London

706. MacLean, J.K. (1979) The impact of a one-meter reduction in water level on the fish population of Big Creek Marsh. Unpublished report to Canadian Wildlife Service, London, Ontario. 18 pp.

Category	Water Levels
Source	CWS London

707. MacLean, N.G. (1977) Summary of Creel census results, Long Point Bay, Lake Erie, from various sources. Unpublished Ontario Ministry of Natural Resources report.

Category	Fish
Source	

708. MacLean, N.G. and G.C. Teleki (1977) Homing behaviour of Rock Bass (*Ambloplites rupestris*) in Long Point, Lake Erie. Journal of Great Lakes Research 3: 211-214.

Study Date	April-November, 1974-1976
Location	• North Shore LPB
Findings/Purpose	• Rock Bass commonly believed sedentary, with restrictive areas of travel • Study results indicate that this is true during non-reproductive periods • During spawning season, migration of 35-40 km into Inner LPB was noted • Trajectories and catch locations are noted on maps in text
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

709. MacLean, N. G., G. C. Teleki and J. Polak (1982) Ultrasonic telemetry studies of fish activity near the Nanticoke thermal generation station Lake Erie Canada. Journal of Great Lakes Research 8 (3) : 495-504

Study Date	1973-1977
Location	• Nanticoke, LPB
Findings/Purpose	• Investigate the influence of warmwater discharge on smallmouth

	bass, rock bass, and yellow perch movement patterns • Continuous measurement of position, distance between turns, swim speed, angle of course alteration, and environmental parameters • Activity was lower inside the plume for all species • Water depth was most important determinant of fish movement • Wave height, current speed and temperature were also important and are directly influenced by the discharge plume
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

710.MacPherson, A.R. (1981) Long Point Provincial Park Waterfowl Management Unit. Annual Report, 1980. Long Point Provincial Park.

Study Date	1980
Location	• Long Point Provincial Park • Site map in text
Findings/Purpose	• The waterfowl management unit was designed to control access to and hunting on provincially owned marshland in the Long Point Provincial Park • Management was deemed necessary due to deteriorating hunting conditions • 3 sections: 1) operational procedures; 2) details of the 1980 waterfowl hunting season and weekly trends of hunter activity, performance, and species composition of kills; 3) 20 year trends in waterfowl hunting • Species information and trends in both activity and bird populations are given in graphical format and discussed in text
Category	Waterfowl, Land Use and Management
Source	MNR Library

711.Macoun, W.T. (1898) Bird notes for June. *Ottawa Naturalist* 12:88.

Category	Birds
Source	

712.Madore, P. (1981) A preliminary report on the age structures of five different forest covers of Long Point National Wildlife Area. Unpublished Report. Canadian Wildlife Service. 26pp.

Category	Forests
Source	CWS London

713.Madore, P. (1981) Management report: Big Creek National Wildlife Area – Hahn Unit. Wood duck nest boxes survey, 1980. Unpublished Canadian Wildlife Service report, London Ontario.

Category	Waterfowl
Source	CWS London

714.Mahon, R. (1976) Ecological fish production of a lakeshore lagoon, with notes on fish distribution in lagoons of Long Point, Lake Erie. M.Sc. thesis, University of Guelph, Guelph, Ontario. 123 pp.

Category	Fish
Source	CWS London

715.Mahon, R. (1976) Effect of the cestode *Ligula intestinalis* on Spottail Shiners, *Notropis hudsonius*. *Canadian Journal of Zoology* 54: 2227-2229

Study Date	June 1975
Location	• Temporary pool, LP – S-shore (42°32' N, 80°07' W)
Findings/Purpose	• All fish were collected from the temporary pool and preserved • Infection incidence increased with age • Host fish condition deteriorates with increased occurrence of infection

	• Infection appears to result in sterilization of the host
Category	Fish
Source	McMaster University, Thode library periodicals

716.Mahon, R. (1977) Age and fecundity of the tadpole madtom, *Noturus gyrinus*, on Long Point, Lake Erie. *Canadian Field Naturalist* 91: 292-294.

Study Date	May, August 1975
Location	• Lagoons, eastern end of LP (42°32' N, 80°07' W)
Findings/Purpose	• Electofish sampling • 2 sampling locations – shallow inshore of large lagoon (<1m depth), several small isolated lagoons (<600m^2) peripheral to large lagoon • Fish were preserved, identified, sexed, weighed, measured, ripe eggs were weighed and counted from ovaries • Relationship between weight and length is examined • Ripe females found in both May and August
Category	Fish
Source	McMaster University, Thode library periodicals

717.Mahon, R. and E.K. Balon (1977) Ecological fish production in Long Pond, a lakeshore region on Long Point, Lake Erie. Env. Biol. Fish. 2(3): 261-284.

Study Date	1974
Location	• Long Pond, LP
Findings/Purpose	• All fish from Long Pond were killed and collected; 47,768 fish, 22 species • Age, growth and production were calculated giving a total fish production estimate of 87.5 kg ha^{-1} y^{-1} • Fish were dominantly young • 9 fish species dominated the overall population
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

718.Mahon, R. and E.K. Balon (1977) Fish community structure in lakeshore lagoons on Long Point, Lake Erie. *Canadian Env. Biol. Fish. 2(1):71-82*

Study Date	1974-1975
Location	• LP
Findings/Purpose	• Fluctuating water levels may influence the species composition of ponds on LP • 12 ponds were samples, with 33 species in evidence • A lognormal relationship was found between number of fish species and lagoon size • Reproductive guilds varied with site characteristics – beach lagoon vs lagoon interior • This pattern was not evident in small ponds where adaptations for survival were more important than reproductive strategy
Category	Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

719.Mahon, R. (1979) The structure of fish communities in lakeshore lagoons on Long Point, Lake Erie, and their significance. *Contact* 11(1): 19-36.

Category	Fish
Source	McMaster Libraries

720.Marshall, R.J. (1974) Long Point Waterfowl Unit Annual Report 1974. Ministry of Natural Resources, Simcoe District.

Study Date	1974
Location	• Long Point Provincial Park
Findings/Purpose	• Provide an overview of waterfowl hunting activities within the Long

	Point Provincial Park • Blue winged teal, Mallard and Baldpate – primary species on opening day • Mallard followed by Black, Canvasback and Green Wing Teal for the remainder of the season as prime hunting species • LP flooded on November 14th (no damage) • Two hunting zones were used for hunting with a total of 2043 hunters in zone A and 319 in zone B – hunt success was ~1.8 ducks per hunter for zone A and 0.98 ducks per hunter for zone B • ~48% of kills occurred between sunrise and 10am with the next highest proportion caught between noon and closing time
Category	Waterfowl, Land Use and Management
Source	MNR Library – Peterborough

721. Martel, A.L., B.S. Baldwin, R.M. Dermott, and R.A. Lutz (2001) Species and epilimnion/ hypolimnion-related differences in size at larval settlement and metamorphosis in Dreissena (Bivalvia). *Limnology and Oceanography* 46(3): 707-713.

Study Date	1992-1995
Location	• Outer LPB; North Shore, Lake Erie
Findings/Purpose	• Shell growth in newsly settled quagga mussels and zebra mussels • Settling quagga mussels were significantly larger than zebra mussels • Settling quagga mussels were larger in the hypolimnion off-shore environment than near-shore epilimnion habitat
Category	Water Quality/Limnology, Macro-Invertebrates
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

722. Martin, P.A., T.V. McDaniel, and B. Hunter (2006) Temporal and spatial trends in chlorinated hydrocarbon concentrations of mink in Canadian Lakes Erie and St. Clair. *Environmental Monitoring and Assessment* 113 (1-3): 245-263.

Study Date	1998-2003
Location	• 5km radius around Lakes Erie and St. Clair and related tributaries & marshes
Findings/Purpose	• Mink carcasses were collected from local commercial trappers and tested for chlorinated hydrocarbon concentrations in their livers and compared between sites • Similar tests from the last 25 years were used for comparison against new findings • Western Lake Erie samples had significantly higher concentrations than of sum PCBs, with the remainder of Lake Erie being intermediate • Chlorinated hydrocarbons in mink have shown a general decrease in last two decades – however this trend is not true in certain areas (W-Lake Erie) • Mink levels are high - associated with reproductive impairement – in 11.7% overall, and ~40% in western Lake Erie populations
Category	Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

723. Maycock, P.F. (1963) The phytosociology of the deciduous forests of extreme southern Ontario. *Canadian Journal of Botany* 41: 379-438.

Category	Forests
Source	McMaster Libraries

724. Marra, P.P., C.M. Francis, R.S. Mulvihill and F.R. Moore (2005) The influence of the timing and rate of spring bird migration. Oecologia 142(2):307-315

Category	Birds
Source	

725. Marvin, C., L. Grapentine and S. Painter (2004) Application of a sediment quality index to the lower Laurentian Great Lakes. Environmental Monitoring and Assessment 91: 1–16, 2004.

Study Date	1997-1998
Location	• Lower Laurential Great Lakes
Findings/Purpose	• Using a modified version of the Canadian Water Quality Index, a soil quality index (SQI) was developed and applied to sediment samples taken from Lakes Erie and Ontario • SQI indices were based on scope, area frequency and amplitude on failure of various quality indicators • 34 compounds were considered • Lake Erie: SQI numbers decreased (poorer quality) from the east to the west basins, and from north to south, with quality ranging from excellent to fair • Lake Ontario: 3 depositional basins had the poorest quality – all with fair quality • Overall, Lake Ontario had poor sediment quality when compared to Lake Erie
Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

726. Mayall, K.M. (1958) Big Creek Region conservation report: Wildlife. Ontario Department of Planning and Development, Conservation Branch. 29 pp

Category	Mammals, Land Use and Management
Source	McMaster Libraries

727. McCann, S.B. (1980) Coastline of Canada – littoral processes and shore morphology. Geological Survey of Canada. Book: 100pp.

Category	Hydrology and Sediments, Water Level
Source	McMaster Libraries

728. McCarthy, D., Graham Whitelaw, Paula Jongerden, and Brian Craig. (In Press). Contributions of Four Long Point Sustainability Workshops to Community Social Learning and the Logistics Function of the Biosphere Reserve. Environments: A Journal of Interdisciplinary Studies.

Category	Land Use and Management
Source	

729. McCarthy, D.D.P. (2006) A Critical Systems Approach to Socio-Ecological Systems: Implications for social learning and governance, Phd Thesis University of Waterloo. 237pp.

Study Date	1988-2005
Location	• Oak Ridges Morraine • Long Point World Biosphere Reserve
Findings/Purpose	• Investigates environmental movements and their impacts on socio-economic development • Critical-systems approach to land use and planning – framework development for assisted planning and policy-making • Develop practical research contributions and recommendations for future planning, policy making and governance for the areas studied and other areas • Long Point and Oak Ridges Morraine are used as case studies for determining the influence of environmental movements on policy and management and to test the framework of the critical systems approach developed within the thesis
Category	Land Use and Management
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

730. McCracken, J.D. (1975) Thirty-ninth breeding bird census. Tamarack-white cedar slough. *American Birds* 29:1104.

Findings/Purpose	See: Van Velzen, W.T. (1975)
Category	Birds
Source	McMaster University

731. McCracken, J.D. (1975) Thirty-ninth breeding bird census. White pine-white cedar forest. *American Birds* 29:1104.

Findings/Purpose	See: Van Velzen, W.T. (1975)
Category	Birds
Source	McMaster University

732. McCracken, J.D. (1977) A comparative analysis of the body weights of spring and fall White-throated Sparrows. Unpublished report; Department of Zoology, University of Western Ontario, London, Ontario. 52 pp.

Category	Birds
Source	CWS London

733. McCracken, J.D. (1978) The Breeding Birds of the Big Creek National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario. 79 pp.

Category	Birds
Source	CWS London

734. McCracken, J.D. (1979) The Breeding Birds of the Big Creek National Wildlife Area: 1978-1979 Studies. Unpublished report to Canadian Wildlife Service, London, Ontario. 70 pp.

Category	Birds
Source	CWS London

735. McCracken, J.D. (1980) Avifaunal Surveys at the Big Creek National Wildlife Area in 1980. Unpublished report to Canadian Wildlife Service, London, Ontario. 26 pp.

Category	Birds
Source	CWS London

736. McCracken, J.D. (1981) Avifaunal Surveys in Cattail Marshes at Long Point. Unpublished report to Canadian Wildlife Service, London, Ontario. 59 pp.

Category	Birds
Source	CWS London

737. McCracken, J.D. (1981) Status report on the Prothonotary Warbler (*Prothonotaria citrea*, Boddaert) in Canada. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Ontario. 27 pp.

Category	Birds
Source	CWS London

738. McCracken, J.D. (1981) Status report on the Prothonotary Warbler (*Prothonotaria citrea*) in Canada. Unpublished report to the Canadian Wildlife Service. London, Ontario, 24pp.

Category	Birds
Source	CWS London

739. McCracken, J.D. (1982) Forty-fifth breeding bird census: Cat-tail marsh. *American Birds 36:98-99*

Findings/Purpose	See: Van Velzen, W.T. (1982)
Category	Birds
Source	McMaster University

740. McCracken, J.D. (1982) Bird Studies of Certain Wetlands at Long Point. Unpublished report to Canadian Wildlife Service, London, Ontario. 63 pp.

Category	Birds
Source	CWS London

741.McCracken, J.D., G.B. McCullough and J.I. Robinson (1988) Overbrowsing of Vegetation by White-tailed Deer on the Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario. 59 pp.

Category	Mammals, Terrestrial Vegetation
Source	

742.McCracken, J.D. (1989) Post-dyking Assessment of the Breeding Birds of Big Creek National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario. 50 pp.

Study Date	1978-1979, 1989
Location	• Big Creek National Wildlife Area
Findings/Purpose	• Two 10ha plots were surveyed in 1978-1979 and 1989 • Site 1: dyking prior to the 1989 survey, Site 2: natural habitat modification • Examines the impact of dyking on habitat, and breeding bird communities • Control plot: much drier with a smaller open water component causing advanced community succession and habitat homogeneity – parallel changes in the birds community were observed with increased passerines and decreased waterbirds • Dyked Site: Water levels were artificially maintained aimed at maintaining a 50:50 ratio of water to vegetation. Species diversity decreased, abundance increased (dominantly through increased passerines), little to no change in waterbirds • Although relatively little negative change occurred, study suggests a 50:50 water-vegetation ratio is not the ideal management scenario with an open water component of ~30% suggested as a more ideal management target
Category	Birds, Waterfowl, Aquatic Vegetation
Source	BSC Library

743.McCracken, J.D, M.S.W. Bradstreet and G.L. Holroyd (1991) The breeding birds of Long Point, Lake Erie. Canadian Wildlife Service. Report Series No.44 74pp.

Category	Birds
Source	CWS London

744.McCracken, J.D. (1991) Daily Counts of Migrant Landbirds at Long Point, Ontario 1989-91. Unpublished report for the Canadian Wildlife Service. 11 pp.

Study Date	1989-1991
Location	• Long Point
Findings/Purpose	• Reports raw numbers of birds migrating through the LPBO • Information at time of writing was not corrected for weather effects, and as such, not data interpretation is completed • Continuation of the 1961-1988 study published by Hussel *et al* (1991), with goal of reporting annual bird counts for increased understanding of migratory bird trends and population changes
Category	Birds
Source	BSC Library

745.McCracken, J.D. (1991) Monitoring Bird Migration at Field Stations: An Operations Manual. Unpublished report to the Ontario Ministry of Natural Resources.

Category	Birds
Source	

746.McCracken, J.D. (1993) Wetland Bird Surveys in Great Lakes Marshes. Interim Report to Long Point Bird Observatory.

Category	Birds
Source	

747.McCracken, J.D. (2004) A Natural Heritage Assessment of Forests Owned by the County of Norfolk Based Upon Breeding Bird Inventories. Unpublished Bird Studies Canada report for the County of Norfolk. 27p

Category	Forests
Source	

748.McCuaig, J.M. and R.H. Green (1983) Unionid growth curves derived from annual rings: A baseline model for Long Point Bay, Lake Erie. *Canadian Journal of Fisheries and Aquatic Sciences* 40(4): 436-442

Study Date	July 1981
Location	• Inner LPB – 4 stations near southeastern shore of inner bay, and one in center of inner bay mouth • Sample location map in text
Findings/Purpose	• Annual growth rings were used to age living clams • Variation in growth rings were used to examine deterioration of environmental conditions – change in temperature, nutrient quality, pollution, etc.
Category	Macro-Invertebrates
Source	McMaster University, Thode library periodicals

749.McCullough, G.B. (1981) Migrant waterfowl utilization of the Lake Erie shore, Ontario, near the Nanticoke industrial development. Journal of Great Lakes Research 7(2): 117-122.

Study Date	1977-1978
Location	• Nanticoke
Findings/Purpose	• Study designed for baseline information collection • Aerial and grounds surveys • Major staging area for Greater and Lesser Scaup • Gastropods identified as a major diet component
Category	Waterfowl
Source	McMaster University, Thode library Available digitally from publisher at cost

750.McCullough, G.B. and J.T. Robinson (1988) Overbrowsing of vegetation by white-tailed deer on the Long Point National Wildlife Area. Unpublished Report. Canadian Wildlife Service, London, ON. 59pp.

Study Date	1978-1987
Location	• Long Point
Findings/Purpose	• Vegetation communities show little regeneration with very little woody vegetation growth within 2m of the ground • Majority of existing trees are >60 yrs old with few to no saplings in evidence – primarily attributed to deer browsing • Very high deer densities (summer habitat = ~22.7 deer/km^2, winter habitat = ~62.5 deer/km^2) • 1980 – deer exclosures were established • Results indicate that the removal of deer browsing allows plant regeneration • Various methods for deer control were investigated, and a controlled culling of the deer population is suggested
Category	Mammals, Terrestrial Vegetation
Source	BSC Library

751.McKeane, L. and D.V. Weseloh (1993) Bringing the Bald Eagle back to Lake Erie: A State of the Environment Fact Sheet. Environment Canada, Toronto, Ontario.

Category	Birds
Source	McMaster Libraries

752. McKeating, G.B. and Bowman (1977) The Ontario endangered and threatened species program. Ontario Fish and Wildlife Review 16(4): 1-25.

Category	Land Use and Management
Source	CWS London

753. McKeating, G.B. (1980) Interim management guidelines for Long Point National Wildlife Area. Canadian Wildlife Service, London, Ontario. 31 pp.

Category	Land Use and Management
Source	CWS London

754. McKeating, G.B. (1980) Planning and management for National Wildlife Areas in the Long Point region. *Contact* 12(3): 17-26.

Category	Land Use and Management
Source	McMaster Libraries

755. McKeating, G.B. (1983) Management Plan: Long Point National Wildlife Area. Environment Canada, Canadian Wildlife Service, London, ON.

Study Date	n.d.
Location	• Long Point
Findings/Purpose	• First full management plan for the area since being donated by the Long Point Company • Includes guidelines and objectives for the management of the LP area including information on how the LP management plan fits into the official plan of the Regional Municipalitiy of Haldimand-Norfolk, public activity allowances and restrictions (rules governing), historical and cultural management, biological management, how to implement the plan and develop public awareness • A second section delves into historical information about the area and provides a biological inventory of the lands covered by the management plan
Category	Land Use and Management
Source	MNR Library - Peterborough

756. McKeating, G.B. and J. Robinson (1982) Proposed designation of the Long Point wetlands for recognition in the list of wetlands of international importance. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	General Wetlands, Land Use and Management
Source	CWS London

757. McKeating, G. and K. Dewey (1983) Preliminary Management Plan: Big Creek National Wildlife Area. Canadian Wildlife Service unpublished report.

Category	Land Use and Management
Source	CWS London

758. McKeating, G. and P. Prevett (1983) Proposed Introduction of Eaglets to the Lake Erie Bald Eagle Population. Unpublished report to Canadian Wildlife Service, Ontario Ministry of Natural Resources proposal to Elsa Wild Animal Appeal of Canada. 11 pp.

Category	Birds
Source	CWS London

759. McKeating G.B. and K. Dewey (1984) Management plan: Big Creek National Wildlife Area. Canadian Wildlife Service, London, Ontario. 80 pp.

Category	Land Use and Management
Source	CWS London

760. McKeeman, K.L. (1981) Pedology and slope morphology of the Gravelly Bay area, Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario. 25 pp.

Category	Terrestrial Geography
Source	CWS London

761.McKeeman, K.L. (1981) Pedology of Bluff Point, Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario. 25 pp.

Category	Terrestrial Geography
Source	CWS London

762.McKeeman, K.L. (1982) Soil study of Squire's Ridge and the deer exclosures at Long Point National Wildlife Area, Lake Erie. Unpublished report to Canadian Wildlife Service. 20 pp.

Category	Terrestrial Geography
Source	CWS London

763.McKenzie, D.I., B. Russell and R.A. Lall (1983) Assessment of earth science features and processes for land use planning of Long Point Peninsula Provincial Park Reserve. Ontario Ministry of Natural Resources.

Category	Terrestrial Geography, Land Use and Management
Source	

764.McKinney, R.G. (2004) Skull Pneumatization in Passerines: A Table of Last Dates Many Passerines in the Northeast Can be Aged Safely by Skulling. *North American Bird Bander* 29(4) 164-170.

Category	Birds
Source	

765.McLarty, A.W. and H.D. Craig (1976) Benthic fauna studies of Long Point Bay in the vicinity of Nanticoke, 1969-1974. Unpublished report to Ontario Ministry of the Environment, West-Central Region, Stoney Creek, Ontario.

Category	Zooplankton and Phytoplankton, Macro-Invertebrates, Fish
Source	

766.McNair, S.A. (2006) The use of primary producers for assessing and monitoring aquatic habitat quality in Great Lakes coastal wetlands. PhD Thesis. McMaster University.

Study Date	1995 (data) - 2005
Location	• Long Point • Big Creek • Cootes Paradise
Findings/Purpose	• Provide a scientific basis for the use of primary producers, algae and aquatic and vascular plants in the evaluation of the Great Lakes coastal wetlands • Protocol is developed and tested to benthic algal biomass • Found algal biomass can be used as an indicator for environmental degradation • Diversity and abundance of submergent macrophytes declines as algal biomass increased • Occurrences of fish and submergent plant taxa were highly correlated in 60 coastal wetlands – suggests that submergent plants can be used as a tool for assessment of fish habitat in these ecosystems
Category	Water Quality/Limnology, Aqautic Vegetation, Zooplankton and Phytoplankton, Fish
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

767.McNair, S.A. and P. Chow-Fraser (2003) Change in biomass of benthic and planktonic algae along a disturbance gradient for 24 Great Lakes coastal wetlands. *Canadian Journal of Fisheries and Aquatic Sciences* 60: 676–689

Study Date	May-August, 2000-2001
Location	• Coastal wetlands – Laurentian Great Lakes, including Long Point

Findings/Purpose	• Quantification of chlorophyll Ψ content in benthic and planktonic algae in 24 coastal wetlands in all 5 Laurential Great Lakes • Examines a wide variety of habitat types – nutrient-poor clear-water marshes to nutrient-enriched, turbid marshes • Total phosphorous, turbidity and suspended solids are associated closely with human disturbance • Periphytic & epiphytic biomass were negatively correlated with % cover and species richness of submergent macrophytes, but phytoplankton was not • Study indicates that periphytic and epiphytic biomass and planktonic chlorophyll Ψ are are good indicators of water quality degradation • Monitoring levels of these indicators would be an effective component of wetland management programs
Category	Zooplankton and Phytoplankton, General Wetlands
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

768.Melfi D.A., S.M. Yaksich, D.B. Baker and J.W. Kramer (1985) Lake Erie Nutrient Loads: 1970-1980. *Journal of Great Lakes Research 11(2):* 117-131

Study Date	1974-1980
Location	• US tributaries to Lake Erie
Findings/Purpose	• Investigation of nutrient loading due to increased stream flow • Soluble orthophosphate loads, chloride loads and silica loads decreased • Nitrogen species were highly variable & increased over the study period • Phosphorous removal at wastewater treatment plants has reduced lake concentrations
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

769.Melski, T. (1972) An economic evaluation of the sport fishery on Long Point Bay, Lake Erie. Unpublished report to Ontario Ministry of Natural Resources, 45 pp.

Category	Fish, Land Use and Management
Source	CWS London

770.Merriman, J.C., J. Struger and R.S. Szawiola (1991) Distribution of 1,3-Dichlorpopropene and 1,2-Dichlopopropene in Big Creek watershed. *Bulletin of Environmental Contamination and Toxicology* 47: 572-579.

Study Date	April – July, 1989
Location	• Big Creek watershed • 2 sampling locations near output, others further upstream in watershed • Sample location map in text
Findings/Purpose	• The substances in question are ingredients in common nematocides (1,3-Dichlorpopropene) or is a byproduct of its production (1,2-Dichlorpopropene) • Both substances are considered moderately toxic to aquatic life • 1,2-Dichlorpopropene was not found above detection limit at any locations • 1,3-Dichlorpopropene was found at least once at all locations above detection limit • 1,3-Dichlorpopropene is unlikely to be persistent in aquatic environment at monitored levels, and not expected to bioaccumulate • Detectible concentrations occurred surrounding application period, and thus not likely to cause adverse effects at concentrations found
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications

	Available digitally from publisher at cost

771.Meyer, S. W. (2003) Comparative use of *Phragmites australis* and other habitats by birds, amphibians, and small mammals at Long Point, Ontario. M.Sc. Thesis. University of Western Ontario. London, Ontario.

Category	Aquatic Vegetation, Birds, Amphibians, Mammals
Source	

772.Miller, D. (1983) Summer creel census on Long Point Bay, Lake Erie. Unpublished technical report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 40 pp.

Category	Fish
Source	

773.Miller, G.W. (1974) Thirty-eighth breeding bird census. Tamarack-white cedar slough. *American Birds* 28: 1017-1018.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

774.Miller, G.W. (1977) The Current Status and Breeding Performance of the Long Point Piping Plovers: A Survey of an Endangered Species Population. Unpublished report to Long Point Bird Observatory 28 pp.

Category	Birds
Source	CWS London

775.Miller, G.W. (1978) The Status of the Piping Plover on Long Point: 1976. LPBO 1976 Annual Report. p. 12-14.

Category	Birds
Source	CWS London

776.Mills, A. M. (2005) Protogyny in autumn migration: do male birds 'play chicken'? *The Auk* 122(1): 71-81.

Study Date	1977-2000 banding data
Location	• LPBO data
Findings/Purpose	• To investigate the occurrence of protogyny in males and females (examined for 4 species) • Males arrive earlier than females in spring – possibly related to terretorial competition or intersexual relationships requiring males to be present prior to female arrival • Females arrive earlier than males during fall migration • Males may ‘play chicken’, attempting to protect breeding locations for future years, risking exposure to harsher weather in northern areas
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

777.Mills, A.M. (2005) Changes in the timing of spring and autumn migration in North American migrant passerines during a period of global warming. Ibis 147:259-269.

Study Date	1975-2000 banding data
Location	• LPBO
Findings/Purpose	• Previous studies based on first arrival dates (FAD’s) have indicated that both long distance migrators (LDM’s) and short distance migrators (SDM’s) are migrating earlier – in correspondance to climate change predictions • Paper study looks at 14 passerines for indication of this occurrence at LP • Only 2 of 13 species showed earlier spring migrations • 6 of 13 species displayed delayed fall migration • FAD data agrees with previous findings, however when examined

	over the whole migration period, changes are much less evident
Category	Birds, Climate Change
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

778. Ministry of the Environment (1993) Bringing the Bald Eagle back to Lake Erie. State of the Environment Reporting. Pamplet.

Category	Birds
Source	McMaster Libraries

779. Minns, C.K., J.R.M. Kelso, and W. Hyatt (1978) Spatial distribution of nearshore fish in the vicinity of two thermal generating stations, Nanticoke and Douglas Point on the Great Lakes. *Journal of the Fisheries Research Board of Canada* 35: 885-892.

Study Date	1974
Location	• Nanticoke, Douglas Point
Findings/Purpose	• Fish density at Nanticoke varied between 162 and 14204/10000m^3 • Fish density increasd at shallower depths (3-5m) • Low relief at Nanticoke created no distinct communities • No obvious change in distribution relative to temperature was seen at Nanticoke (low operational period) • No vertical thermal stratification was noted at Nanticoke during study • Fish appear to dominantly be responding to currents and perhaps topography rather than the currently small impact of the generating station
Category	Fish, Human Impacts
Source	MNR Library – Peterborough

780. Minns, C.K., Doka, S.E., Bakelaar, C.N., Brunette, P.C.E., and Schertzer, W.M. (1999) Identifying habitats essential for pike, Esox lucius L., in the Long Point region of Lake Erie: a suitable supply approach. Pages 363-382. In L. Benaka, editor. American Fisheries Society Symposium 22: Fish Habitat: Essential Fish Habitat and Rehabilitation. Bethesda, Maryland. 459p.

Category	Fish
Source	

781. Mitchell, M.H. (1935) The Passenger Pigeon in Ontario. Contributions of the Royal Ontario Museum of Zoology No. 7. 181pp.

Category	Birds
Source	McMaster Libraries

782. Mitchell, J. S., R. W. Knapton, and R. C. Bailey, Robert C. (1994) Impact of waterfowl and fish predation on zebra and quagga mussel populations at Nanticoke, Lake Erie. 79th Annual Meeting of the Ecological Society of America, August 7-11, 1994, Knoxville, Tennessee, USA *Bulletin of the Ecological Society of America* 75 (2 PART 2) : 156

Category	Waterfowl, Fish, Macro-Invertebrates, Invasive Species
Source	

783. Mitchell, Jeremy S., R. C. Bailey and R. W. Knapton, Richard W. (1996) Abundance of Dreissena polymorpha and Dreissena bugensis in a warmwater plume: Effects of depth and temperature. *Canadian Journal of Fisheries and Aquatic Sciences* 53 (8) : 1705-1712

Study Date	1993
Location	• Nanticoke
Findings/Purpose	• Dressenid densities were estimated in areas affected by warmwater discharge • Quagga mussels were more abundant in warmwater areas than those not affected by the discharge • Zebra mussels were unaffected by the plume at a broad scale, but were absent at the mouth of the discharge canal

	• Inconsistent with other studies indicating higher heat tolerance of zebra mussels
Category	Macro-Invertebrates, Invasive Species, Human Impacts
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

784.Mitchell, J.S., R.C. Bailey and R. W. Knapton (2000) Effects of predation by fish and wintering ducks on dreissenid mussels at Nanticoke, Lake Erie. *Ecoscience* 7 (4): 398-409

Study Date	Winter 1993-1994
Location	• Outer LPB – Nanticoke • Two locations: 42°47.442’ N 80°03.882’ W; 42°47.895’ N 80°02.189’ W
Findings/Purpose	• Based on European findings and other works, predation by ducks that over-winter in the ice-free zones near Nanticoke would reduce mussel populations • An ice-covered and ice-free site were compared using exclosure cages to investigate fish and duck predation of mussels • Findings indicate predation by over-wintering ducks at the ice-free site with selective behaviour of both mussel species and size • The ice-covered site seems to indicate predation of mussels by fish • Rock size also seemed to be an influence on predation because of effects on mussel abundance
Category	Waterfowl, Fish, Macro-Invertebrates, Invasive Species
Source	McMaster University, Thode library periodicals

785.Mohr, P. J.T. Planck and J. Dean (1982) Vegetation inventory and assessment of the proposed Gravelly Bay Walking Trail, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service. 41 pp.

Category	Terrestrial Vegetation
Source	CWS London

786.Mohr, P., J.T. Planck and J. Dean. (1982) Vegetation inventory of Bluff Point, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service.

Category	Terrestrial Vegetation
Source	CWS London

787.Mohr, P. and L. Maltby (1985) A summary of background information on National Wildlife Areas in the Ontario Region. Canadian Wildlife Service and Environment Canada, 82pp.

Category	General
Source	CWS London

788.Moore, F.R. (ed.) (2000) Stopover ecology of Nearctic-Neotropical landbird migrants: habitat relations and conservation implications. BOOK 133pp

Category	Birds
Source	McMaster Libraries

789.Morshed, M.G., J.D. Scott, K. Fernando, G. Geddes, A. McNabb, S. Mak and L.A. Durden (2006) Distribution and characterization of *Borrelia burgdorferi* isolates from *Ixodes scapularis* and presence in mammalian hosts in Ontario, Canada. *Journal of Medical Entomology* 43(4): 762-773.

Study Date	1993-2002
Location	• Ontario • Long Point indicated as a site of tick collection and *Borrelia burgdoferi* incidence amongst others
Findings/Purpose	• Investigate the frequency and distribution of *Borrelia burgdoferi* in ticks taken from mammalian hosts throughout Ontario (including humans, domestic and wild mammals) • Relatively high genetic heterogeneity in strains of *Borrelia burgodferi*

	in Ontario • Connections were made to the endemic populations in the northeastern United States populations
Category	Insects, Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

790. Mortsch, L., J. Ingram, A. Hebb and S. Doka (eds.) (2006) Great Lakes Coastal Wetland Communities: Vulnerability to Climate Change and Response to Adaptation Strategies. Final report submitted to the Climate Change Impacts and Adaptation Program, Natural Resources Canada. Environment Canada and the Department of Fisheries and Oceans, Toronto, Ontario. 251 pp.

Category	General Wetlands, Climate Change
Source	

791. Moses, G., R, Harris, M. Schugar, N. Bernstein, K. McGowan and G. Miller (1974) Thirty-eighth breeding bird census. Sedge-rush swale. *American Birds* 28:1051-1052.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

792. Moses, G., R. Harris, M. Schugar, N. Bernstein, G. Miller and K. McGowan (1974) Thirty-eighth breeding bird census. Dry cottonwood sand dune. *American Birds* 28: 1022-1023.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

793. Moses, G., R. Harris, N. Bernstein, G. Miller and K. McGowan (1974) Thirty-eighth breeding bird census. Dry juniper-cottonwood savannah. American Birds 28:1023.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University

794. Mudroch, A. (1980) Biogeochemical investigation of Big Creek Marsh, Lake Erie, Ontario. *Journal of Great Lakes Research* 6(4): 338-347.

Study Date	May-November, 1978
Location	• Big Creek Marsh • Sampling location map in text
Findings/Purpose	• Maximum concentrations of Pb, Ni, Cu, Cr, Zn were lower in Big Creek Marsh than in surficial sediments of Lake Erie • Maximum concentrations of As & Hg were higher in Big Creek Marsh sediments than surficial Lake Erie sediments • DDT metabolites found in marsh due to agricultural use prior to 1970 • Submergent macrophytes had higher concentrations of Pb, Cu, Ni, Cd & Cr than emergent species
Category	Water Quality/Limnology
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

795. Mudroch, A. (1981) A Study of Selected Great Lakes Coastal Marshes. Scientific Series No. 122, National Water Research Institute.

Study Date	April-November 1976-1978 (1978 for Big Creek location)
Location	• Big Creek Marsh
Findings/Purpose	• Coastal wetlands were evaluated to assess their impact on lake water quality • Parameters measured include: nutrient and trace element concentrations, sediment geochemistry, marsh plant nutrient and trace element uptake. • Study Sites: Cootes Paradise, Big Creek, Dover, St. Lukes, Balmoral

	and St. Clair River • Anaerobicity of sediment environment and changes to chemicals are discussed, water quality parameters including pH, dissolved nutrients (nitrogen, phosphorus) are considered • General Finding: coastal wetlands provide negligible inputs of N & P to lake waters compared to loading from other sources, however localized effects near shore may be more significant
Category	General Wetlands
Source	McMaster University, Thode library periodicals

796.Mudroch, A. (1979) Big Creek Marsh, Lake Erie, ON. Unpublished Report. Canadian Wildlife Service, London, ON.

Category	General Wetlands
Source	CWS London

797.Muir, T. (1981) Economics and Entropy: Phosphorus Management in Lake Erie. Planning Division, Water Planning and Management Branch, Inland Waters Directorate, Ontario Region, Toronto, Ontario.

Category	Human Impacts, Water Quality/Limnology, Land Use and Management
Source	

798.Munawar, M. and N.M. Burns (1976) Relationships of phytoplankton biomass with soluble nutrients, primary production, and chlorophyll a in Lake Erie, 1970. *Journal of the Fisheries Research Board of Canada*. 33: 601-611

Study Date	April-December, 1970
Location	• Various in Lake Erie, 1 location in outer LPB
Findings/Purpose	• Distributions between elements of interest (phytoplankton biomass, primary production, chlorophyll Ψ, and soluble nutrients) were similar in Lake Erie in 1970 • Upon examination few relationships existed between them and that these were seasonally dependent
Category	Zooplankton and Phytoplankton, Water Quality/Limnology
Source	McMaster University, Thode library periodicals

799.Munawar, M. and I.F. Munawar (1976) A lakewide study of phytoplankton biomass and its species composition in Lake Erie, April-December 1970. *Journal of the Fisheries Research Board of Canada*. 33: 581-600.

Study Date	April-December, 1970
Location	• Various in Lake Erie, 1 location in outer LPB
Findings/Purpose	• Samples collected at 4-wk intervals at 25 stations • 125-150 species identified in each basin • Some perennial species were identified across all basins • Some species were more location specific and found in specific basins with varying concentrations • Species concentrations varied across seasons and throughout basins in part due to nutrient and limnological differences
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals

800.Munawar, M., T. Edsall, I.F. Munawar (1999) State of Lake Erie: Past, Present and Future.Backhuys Publishers, Leiden, The Netherlands.

Study Date	Review (text book)
Location	• Lake Erie (some LP Specific Data)
Findings/Purpose	• LP specific information: Bottom Trawl Surveys, Gillnet Surveys • Text covers topics including: The changing ecosystem (physical, flora and fauna, water quality, anthropogenic), Invasion of exotics (dreissenid mussels, white and yellow perch), Contaminants (organic contaminants, bioaccumulation), Emerging approaches and techniques (management, linking causes and indicators, fish habitat,

	etc.)
Category	Fish, General
Source	MNR Library – Peterborough

801.Munroe, P.L. and A. de Vos (1962) A study of waterfowl productivity at Long Point Company Marsh. Unpublished progress report. 6 pp.

Study Date	1962
Location	• Long Point Company Marsh
Findings/Purpose	• Investigate key chemical and physical properties of the marsh • Investigation of an important nesting area for waterfowl on Long POInt to asses their ecology, population and activities • Possible management techniques for waterfowl development in the area are provided by the author
Category	Waterfowl
Source	MNR Library

802.Munroe, P.L. (1964) Territory Selection by Ducks in Long Point Marsh. Seminar Paper at University of Guelph, Guelph, Ontario. 10 pp.

Category	Waterfowl
Source	CWS London

803.Munroe, P.L. (1965) An ecological survey of Long Point marsh with special reference to duck production. M.Sc. thesis, University of Guelph, Guelph, Ontario. 188 pp.

Category	Waterfowl, General Wetlands
Source	CWS London

804.Murdoch, D. (1994) The dangers of ticks - birders & Lyme Disease. *Birding World* 7:208-211.

Category	Insects
Source	

805.Myers, J.E. (1974) Pt. Petre – Long Point Waterfowl Harvest Survey.

Study Date	1974
Location	• Pt. Petre to Pt. Traverse
Findings/Purpose	• Reports number of kills, species, and number of hunters and location of hunting
Category	Waterfowl
Source	MNR Library

806.Nagy, E., P. Murdoch, A. Murdoch and R.L. Thomas (1984) Hydrocarbons in the surficial sediments of Lakes St. Clair, Erie and Ontario. *Environmental Geology and Water Sciences* 6(1): 31-37.

Category	Hydrology and Sediments
Source	McMaster Libraries

807.Nakashima, D.J. (1973) Thirty-seventh breeding bird census. Sedge-rush swale. *American Birds* 27:1012.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

808.Nakashima, D.J. (1973) Thirty-seventh breeding bird census. Tamarack-white cedar slough. *American Birds* 27:980.

Findings/Purpose	See: Van Velzen, W.T. (1973)
Category	Birds
Source	McMaster University

809. Nanticoke Environmental Committee (1987) Nanticoke Environmental Committee 1986 Air Quality Data Summary, December 1987. Ontario Ministry of the Environment, Nanticoke Environmental Management Program.

Category	Weather and Air Quality
Source	McMaster Libraries

810. Nanticoke Environmental Committee (1973) The aquatic ecosystem of Long Point Bay in the vicinity of Nanticoke, 1967-1971: a summary report, May 1973. prepared by the Nanticoke Environmental Committee Nanticoke, a pre-operational report. 19pp.

Category	Water Quality/Limnology, Fish, Zooplankton and Phytoplankton, Human Impacts
Source	

811. Needham, R. D. and J. G. Nelson (1977) Newspaper response to flood and erosion hazards on the North Lake Erie shore. *Journal Environmental Management* . 1(6): 521-540

Category	Water Levels, Land Use and Management
Source	

812. Needham, R. D., and J. G. Nelson (1979) Newspaper response to flood and erosion hazard adjustments along the north Lake Erie shore. *Contact* 11:154-175.

Category	Water Levels, Land Use and Management
Source	

813. Neilson, A.L., J.S. Pollock (2001) Bald eagle populations in the Great Lakes region: back from the brink. Environment Canada. 11pp

Category	Birds
Source	

814. Nelson, J.G. (1974) The three Erie peninsulas, land use history and landscape change. Progress report for Canada Council, University of Western Ontario, London, Ontario.

Category	Land Use and Management
Source	

815. Nelson, J.G. and R.D. Needham (1979) The Lake Erie peninsulas: Management issues and directions. *Contact* 11(1): Spring

Category	Land Use and Mangement
Source	McMaster Libraries

816. Nelson, J.G. and S. Jessen (1980) Coastal resources and environment management: The case of the Long Point area, Lake Erie, Ontario. *Contact* 12(3): Fall

Category	Land Use and Management
Source	McMaster Libraries

817. Nelson, J.G., S. Jessen and R.D. Needham (1980) Coastal resources and environmental management: the Case of the Long Point area, Lake Erie, Ontario. Introduction. *Contact 12(3)*: viii-xiv – CWS LONDON

Category	Land Use and Management
Source	McMaster Libraries

818. Nelson, J.G. and J.C. Day (1985) Wildlands management of Point Pelee, Rondeau and Long Point peninsulas. *Environments* 17(3): 65-80.

Category	Land Use and Management
Source	Wilfred Laurier University Library University of Waterloo Libary

819. Nelson, J. G., P.L. Lawrence, K. Beazley, R. Stenson, A. Skibicki, C. L. Yeung, and K. Pauls (1993) Preparing an Environmental Folio for the Long Point Biosphere Reserve

and Region. Long Point Environmental Folio Publication Series - Working Note 1. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 13 pp.

Study Date	n.d.
Location	• Long Point
Findings/Purpose	• Same information as is found in Nelson, J.G. *et al*. (1996) (see next reference)
Category	Land Use and Management, Human Impacts
Source	BSC Library

820.Nelson, J.G., P.L Lawrence, K. Beazley, R. Stenson, A. Skibicki, C.L. Yeung and K. Pauls (1996) An Environmental Folio for the Long Point World Biosphere Reserve and Area: Chapter 1. Long Point Environmental Folio. Heritage Resource Centre, University of Waterloo, Waterloo, ON.

Study Date	n.d.
Location	• Long Point
Findings/Purpose	• Brief background about the geographical setting within Southern Ontario • Figure illustrating the goals and subdivisions of the study chapters including methods for determining significance and constraints in terms of study goals
Category	Land Use and Management, Human Impacts
Source	BSC Library Waterloo Heritage Resource Centre

821.Nelson, J.G. (1996) Long Point Environmental Folio: Providing Environmental, Land Use and Planning Information for People Interested in the Long Point Area. Long Point Environmental Folio. Heritage Resources Centre, University of Waterloo, Waterloo, ON.

Study Date	n.d
Location	• Long Point
Findings/Purpose	• This is an opening booklet describing the purpose of the publication series with a list of background papers available through the Heritage Resource Centre at cost and a list of chapters found within the publication series
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

822.Nepszy, S.J. (1977) Changes in percid populations and species interactions in Lake Erie. *Journal of the Fisheries Research Board of Canada* 34: 1861-1868.

Study Date	Literature review – no field work
Location	• Lake Erie – general
Findings/Purpose	• Examines changes in major percid population in Lake Erie for past 150 yrs – dominantly those of current of past commercial importance • Includes: Sauger, Blue pike, Walleye, Yellow perch
Category	Fish
Source	McMaster University, Thode library periodicals

823.Newdick, J. (1982) Vegetation surveys, Long Point National Wildlife Area deer exclosures. Unpublished report to Canadian Wildlife Service. 21 pp.

Category	Terrestrial Vegetation, Mammals
Source	CWS London

824.Niewojt, L. (2007) From waste land to Canada's tobacco production heartland: Landscape change in Norfolk County, Ontario. Landscape Research 32(3): 355-377.

Study Date	Historical, 1900s – present
Location	• Norfolk County, Long Point Area
Findings/Purpose	• Investigates the change in production and economic capacity of Norfolk County • Early 19^{th} C forestry – decrease in farming with soil erosion – re-

	forestation – tobacco establishment • Socio-economic conditions, storm events, government interventions and other impacts anticipated and unexpected are considered as part of the historical development of Norfolk county as a major tabacco producing area in Canada
Category	Land Use and Management
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

825. Nol, E., C. Risley, A. Rivers, J.M. Speirs, P. Taylor and S. Traquair (1979) Forty-first breeding bird census. Mixed forest. *American Birds* 32:64-65.

Category	Birds
Source	McMaster Libraries

826. Nol, E. (1980) Factors Affecting the Nesting Success of the Killdeer (*Charadrius vociferous*) on Long Point, Lake Erie. M.Sc. thesis, University of Guelph, Guelph, Ontario.

Study Date	
Location	• Long Point
Findings/Purpose	• Expanded information on the article: Nol, E. and R.J. Brooks (1982) Effects of Predator Exclosures on Nesting Effects of Killdeer. *Journal of Field Ornithology*, 53(3): 263-268 • Thesis includes moderately poor quality photos of the exclosures, predators approaching nesting sites, and more detailed explanations of the methods and results than is found in the article.
Category	Birds
Source	BSC Library

827. Nol, E. and R.J. Brooks (1982) Effects of Predator Exclosures on Nesting Effects of Killdeer. *Journal of Field Ornithology*, 53(3):263-268

Study Date	1978
Location	• Western third of LP
Findings/Purpose	• Exclosures were used to test their application for reducing predation • Killdeers adapted well to use of exclosures • Efficacy of exclosure at preventing predation depended on predator present • Avian predation was reduced by exclosure use • Mammals destroyed 64% of exclosed nests and 43% of unexclosed nests – this may have been precipitated by the study and the scent of the researchers leading to the observed nests
Category	Birds
Source	McMaster University, Thode library – government publications Available digitally from publisher at cost

828. Nol, E. and A. Lambert (1984) Comparison of Killdeers *Charadrius-vociferus* breeding in mainland and peninsular site in southern Ontario Canada. *Canadian Field-Naturalist* 98 (1) : 7-11 1984

Study Date	Spring-Summer: 1977 (Port Rowan), 1978 (LP, Port Rowan), 1979 (LP)
Location	• Wide pebbled beaches & base of wooded ridges, bordered on S by Lk Erie, N by *Typha* sp. Marshes, on western 3rd of LP (42°34' N, 80°17' W) • Fields, old building foundations, cemeteries, parking lots and lawns around and up to 6km from Port Rowan (42°37' N, 80°27' W) • Study area map in text
Findings/Purpose	• Measured: distance to nearest marsh, distance to lake, height about Lk Erie, size of nest clearing, other atmospheric information • Timing of clutch production, incubation length, clutch completion and number of nests are compared • Smaller clutch volumes, lighter eggs, longer incubation times on LP

Category	Birds
Source	McMaster University, Thode library periodicals

829. Norris, T.A. (1992) A Life Science Inventory of Amherst to Long Point Bay Area of Natural and Scientific Interest. Draft. Ontario Ministry of Natural Resources, Tweed District, Tweed, Ontario. v + 40 pp.

Category	General
Source	

830. Noseworthy, S.M. and W. Threlfall (1978) Some Metazoan Parasites of Ring-Necked Ducks, Aythya collaris (Donovan), from Canada. *The Journal of Parasitology*, 64(2): 365-367

Study Date	June-December, 1974
Location	• LP (42°40'N, 80°10'W)
Findings/Purpose	• A list of parasites found in viscera of hunter-kills is provided with the organ/area in which it was discovered including the % of birds infected • Parasite distribution was relatively similar for age and sex, except in the case of cotylurids which occurred significantly more frequently in males
Category	Waterfowl
Source	McMaster University, Health library Available digitally from publisher at cost

831. Nsembukya-Katuramu, S., E.K. Balon and R. Mahon (1981) A comparison of spawning, harvested, and die-off Rainbow Smelt, *Osmerus mordax*, in eastern Lake Erie. *Journal of Great Lakes Research* 7(2): 144-154

Study Date	1976-1977
Location	• Long Point
Findings/Purpose	• The parasite Glugea hertwigi had no significant influence on the proportion of die-offs in either commercial or spawning areas, however caused the fish to grow more slowly • Population structure observations cannot be necessarily linked to fishery exploitation as no data exists prior to its development
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London office

832. Ogden. N.H., L.R. Lindsay, G. Beauchamp, D. Charron, A. Maarouf, C.J. O'Callaghan, D. Waltner-Toews and I.K. Barker (2004) Investigation of relationships between temperature and developmental rates of tick *Ixodes scapularis* (Acari: Ixodidae) in the laboratory and field. *Journal of Medical Entomology* 41(4): 622-633.

Study Date	1989-1992
Location	• Long Point (42°36'N, 80°5'W)
Findings/Purpose	• Preoviposition, preeclosion, and premolt developmental period were investigated in relation to temperature • Developmental period lengths decreased significantly as temperatures increased • Host of origin, prior storage at 4°C, and season of collection were also significantly associated • Effect of temperature on developmental stages is best described as a power relationship • Laboratory findings were applied to estimating molting times of ticks in natural environments
Category	Insects
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

833. Ogden, N.H., I.K. Barker, G. Beauchamp, S. Brazeau, D.F. Charron, A. Maarouf, M.G. Morshed, C.J. O'Callaghan, R.A. Thompson, D. Waltner-Toews, M. Waltner-Toews and L.R. Lindsay (2006) Investigation of ground-level and remote-sensed data for habitat classification and prediction of survival of *Ixodes scapularis* in habitats of southeastern Canada. *Journal of Medical Entomology*. 43(2): 403-414.

Category	Insects
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

834. O'Neil, T. (1970) Preliminary field report on Long Point Marsh for the summer of 1970. Unpublished Report. Long Point Company. 25 pp.

Category	General
Source	CWS London

835. Ongley, E.D. (1976) Sediment yields and nutrient loadings from Canadian watersheds tributary to Lake Erie: An overview. *Journal of the Fisheries Research Board of Canada* 99: 471-484.

Category	Hydrology and Sediments, Water Quality/Limnology
Source	McMaster Libraries

836. Ontario Department of Economics and Development (1965) Lake Erie Region: Economic Survey 1965. 154pp + map

Category	Land Use and Management
Source	McMaster Libraries

837. Ontario Department of Lands and Forests, Conservation Authority Branch (1963) Big Creek Region Conservation Report. 1963 Summary. 121pp

Category	Land Use and Management
Source	McMaster Libraries

838. Ontario Ministry of Agriculture and Food (1984) Soils of the Regional Municipality of Haldimand-Norfolk. Volumes 1 and 2.

Category	Terrestrial Geography
Source	McMaster Libraries CWS London

839. Ontario Ministry of the Environment (1989) Influence of Industrialization on the Aquatic Environment of Long Point Bay. Nanticoke Environment Committee, Hamilton, Ontario.

Category	Human Impacts
Source	

840. Ontario Ministry of the Environment (1989) Long Point Provincial Park Management Plan. Parks Planning Branch, Toronto, Ontario.

Study Date	n.d. (non-research)
Location	• Long Point Provincial Park • Various maps in text – location map, site map (ownership parcels, Provincial Park Map
Findings/Purpose	• Park management plan includes information on the classification, goal, and objectives of the provincial park • Park resource maintenance, boundaries, and client services (visitor services, research, marketing) and Development
Category	Land Use and Management
Source	MNR Library – Peterborough

841. Ontario Ministry of Natural Resources (1963+) Long Point waterfowl management unit annual reports.

Category	Waterfowl, Land Use and Mangement
Source	

842. Ontario Ministry of Natural Resources (1976) Long Point Area Bird Checklist.

Category	Birds
Source	

843. Ontario Ministry of Natural Resources (1981) Great Lakes Shore Processes and Shore Protection. OMNR. Booklet.

Category	Hydrology and Sediments, Land Use and Management, Water Levels
Source	McMaster Libraries

844. Ontario Ministry of Natural Resources (1987) Twelve year study of the fish community in the Nanticoke region of Long-Point Bay, Lake Eerie: 1971-1983 Summary Report.

Category	Fish, Human Impacts
Source	McMaster Libraries

845. Ontario Ministry of Natural Resources (1987) Long Point Provincial Park Management Plan. Simcoe District.

Study Date	n.d. (non-research)
Location	• Long Point Provincial Park
Findings/Purpose	• Park management plan includes information on the classification, goal, and objectives of the provincial park • Park resource maintenance, boundaries, and client services (visitor services, research, marketing) and Development
Category	Land Use and Management
Source	MNR Library

846. Ontario Herpetological Summary (OHS) Database. Natural Heritage Information Centre, OMNR, Peterborough District Office

Category	Amphibians, Reptiles
Source	http://nhic.mnr.gov.on.ca/herps/about.html

847. Ouellette, A.J.A., S.M. Handy and S.W. Wilhelm (2006) Toxic *Microcystis* is widespread in Lake Erie: PCR detection of toxin genes and molecular characterization of associated cyanobaceterial communities. *Microbial Ecology* 51(2): 154-165.

Study Date	1999, 2000, 2002
Location	• Eastern, central and western basins • Sampling map in text
Findings/Purpose	• Relatively little is known about the distribution of *Microcystis* in Lake Erie • *Microcystis* was found in both the Eastern and Western basin for all years, and central basin for 1999 and 2002 • The microbial community was characterized at 7 of 13 sampling sites • Picoplankton were identified as important in the lake system
Category	Water Quality/Limnology
Source	McMaster University, Thode library Available digitally from publisher at cost

848. Owen, K. (1980) 1980 summer creel census on Long Point Bay, Lake Erie. Unpublished technical report to Ontario Ministry of Natural Resources, Simcoe, Ontario. 54 pp.

Category	Fish
Source	

849. Page, G. (1967) Mist netting shorebirds at Long Point, Lake Erie. *Ontario Bird Banding* 3: 79-83.

Study Date	1966
Location	• LP – ponds located near the Tip
Findings/Purpose	• Trapping birds at the location using a new application of mist netting (premis is not new, but application at LP was) • Innovation from previous applications: nets wer eused during the crepuscular hours when the birds vision is reduced

	• Nets were placed based on behaviour of the desired species – flying behaviour, preferred locations, etc. • Future application of decoys is considered •
Category	Birds
Source	BSC Library

850. Page, G., J. Bradshaw and G. Fairfield (1967) Thrity-first breeding-bird census: Sand dunes with scattered cottonwoods. *Audubon Field Notes* 21:657-658.

Category	Birds
Source	McMaster Libraries CWS London

851. Page, G. and M. Bradstreet (1968) Size and composition of a fall population of Least and Semipalmated Sandpipers at Long Point. *Ontario Bird Banding* 4: 82-88.

Category	Birds
Source	CWS London

852. Page, G. and A. Salvadori (1969) Weight changes of Semipalmated and Least Sandpipers at Long Point, Ontario. *Ontario Bird Banding* 4: 82-88.

Category	Birds
Source	CWS London

853. Page, G. (1970) The relationship between fat deposition and migration in the Semipalmated Sandpiper. M.Sc. thesis, University of Guelph, Guelph, Ontario. 49 pp.

Category	Birds
Source	CWS London

854. Page, G. and A.L.A. Middleton (1972) Fat deposition during autumn migration in the semiplamated sandpiper. *Bird-banding*. 43(2) 85-160

Category	Birds
Source	

855. Page, A.M. (1994) Updated Status Report on the King Rail. COSEWIC.

Study Date	Various (up to 1994)
Location	• Canada – Southern Ontario
Findings/Purpose	• King Rail was assigned rare status in 1985, is assigned endangered status in 1994 • King Rail breeds at only 3-5 locations in Canada (Southern Ontario – including LP) • Numbers have been declining steadily since the late 1800s • Estimated number of pairs is 35-47 • Further information regarding the preferred habitat, biology, population and impacts on population are discussed
Category	Birds
Source	MNR Library

856. Palmer, M.J. (1992) Breeding bird census #41, red oak-white birch savannah. *Journal of Field Ornithology* 63 (Supplement):59-60.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

857. Parker, B. and P. McKee (1980) Rare, threatened and endangered fishes in southern Ontario: Status reports. Unpublished report for Dep. Supply and Services, Department of Fisheries and Oceans, and National Museum of Natural Sciences. 221 pp.

Category	Fish
Source	CWS London

858. Parker, B. and B. Craig (2004) Monitoring Ecosystem Change in Carolinian Forests and Oak Savannahs of Southwestern Ontario. Leading Edge 2004: The working biosphere. (1-8). Niagara Escarpment Commission.

Category	Forests, Land Use and Management
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

859. Parker, D., J. Dawson, and A. Gracie (1984) Wetland Data Record and Evaluation – Long Point. Ontario Ministry of Natural Resources, World Wildlife Fund & Long Point Foundation

Category	General Wetlands
Source	

860. Parker S.L., L.D. Witzel, L.G. Rudstam, D.W. Einhouse, and E.L. Mills (2005) Energetic consequences of diet shifts in Lake Erie rainbow smelt (Osmerus mordax) *Canadian Journal of Fisheries and Aquatic Sciences*. 62: 145–152

Study Date	1961-1999
Location	• Lake Erie
Findings/Purpose	• Diet of rainbow smelt has changed over time, and reductions in populations may be at least in part a result of these changes • Indigestible prey items may have slowed fish growth capabilities – indigestible *Bythotrephes* spines were shown in the study to occupy stomach space without providing nutritional value & thus decreasing growth capabilities
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

861. Pathy, D.A. and G.L. Mackie (1992) Comparative shell morphology of *Dreissena polymorpha*, *Mytilopsis leucophaeta*, and the "quagga" mussel (Bivalvia: Dreissenidae) in North America. *Canadian Journal of Zoology* 71:1012-1023.

Study Date	?? – ND
Location	• LP – general
Findings/Purpose	• Shell structure (internal and external), ultrastructure, and composition are examined in order to provide clearer differentiation between similar mussel species • Full description of morphological differences are given with photographs, diagrams
Category	Macro-Invertebrates
Source	McMaster University, Thode library periodicals

862. Pauls, K. and R. Knapton (1993) Submerged Macrophytes of Long Point's Inner Bay: Their Distribution and Value for Waterfowl. Long Point Environmental Folio Publication Series – Technical Paper 1. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 37 pp.

Study Date	1991-1992 (active field work), 1976-1992 (time covered)
Location	• LP Inner Bay
Findings/Purpose	• Examine macrophyte composition in LP Inner Bay • Determine food resources available for migrating waterfowl during fall migration • Species are identified and distribution maps are provided for the LPIB • Each species is examined in terms of abundance, coverage and importance to waterfowl • Stomach analysis of waterfowl revealed that *C. vulgaris* was the most commonly consumed macrophyte • Other important species: *V. americana, E. canadensis, M. spicatum* • Migratory habits have been shown to change when available food sources change, consideration of this impact must be given when management plans are made

Category	Waterfowl, Aquatic Vegetation
Source	BSC Library

863. Peck, G.K (1976) Recent revisions to the list of Ontario's breeding birds. *Ontario Field Biologist 30(2):* 9-16.

Category	Birds
Source	CWS London

864. Peck, G.K. and R.D. James (1983) Breeding birds of Ontario: Nidiology and distribution. Vol. 1: Nonpasserines. *Life Science Misc. Publications.* Royal Ontario Museum, Toronto, ON. 321pp.

Category	Birds
Source	McMaster Libraries CWS London

865. Peter, G., D. Dlauchy, and J. Tornai-Lehoczki (2006) *Candida* *floccosa* sp. nov., a novel methanol-assimilating yeast species. International Journal of Systematic and Evolutionary Microbiology 56(2006): 2015-2018.

Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

866. Petrie, S. A. (1998) Waterfowl and wetlands of Long Point Bay and old Norfolk County: present conditions and future options for conservation. Unpublished Norfolk Land Stewardship Council Report. Long Point Waterfowl and Wetlands Research Fund, Port Rowan, Ontario. 182pp.

Category	Waterfowl, General Wetlands
Source	

867. Petrie, S. A., and R. W. Knapton (1999) Rapid increase and subsequent decline of zebra and quagga mussels in Long Point Bay, Lake Erie: possible influence of waterfowl predation. *Journal of Great Lakes Research*. 25:772-782.

Study Date	1991-1995 (diet investigation), 1986-1997 (aerial surveys)
Location	• Inner LPB
Findings/Purpose	• Availability of zebra mussels has been suggested to influence the patterns of birds that feed on them • Investigation was made into this using the diet of 12 duck speciesas well as aerial surveys • Initial introduction saw a sharp rise followed by a wide-spread reduction of total numbers, density and coverage • Birds predatory to them increased their numbers following the increase in mussel populations are are in time with decreases in mussel populations • Waterfowl preferentially select medium-large size mussels • Other considerations for decline is plankton and chlorophyll decline and lack of suitable substrates
Category	Invasive Species, Macro-Invertebrates, Waterfowl
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London office

868. Petrie, S. A. (2002) Mute Swans make noise: Lower Great Lakes population scrutinized. *Birding*. February: 34-36.

Category	Waterfowl
Source	

869. Petrie, S. A. (2004) Review of the status of Mute Swans on the Canadian side of the lower Great Lakes. Pages 23-28 IN: Mute Swans and their Chesapeake Bay Habitats: Proceedings of a Symposium (M.C. Perry, ed.) U.S. Geological Survey, Biological

Resource Discipline Information and Technology Report USGS/BRD/ITR-2004-0005, 44 0.

Category	Waterfowl
Source	

870. Petrie, S. A. and M. L. Schummer (2002) Waterfowl response to zebra mussels on the lower Great Lakes. *Birding*. August: 346-351.

Category	Waterfowl, Macro-Invertebrates, Invasive Species
Source	

871. Petrie, S. A., and K. L. Wilcox (2002) Trek of the Tundra Swan. BirdWatch Canada: Spring 2002, No. 19:4-7.

Category	Waterfowl
Source	

872. Petrie, S. A., S. S. Badzinski, and K. L. Wilcox (2002) Population trends and habitat use of Tundra Swans staging at Long Point, Lake Erie. *Waterbirds*. 25(Supplement 1):143-149.

Study Date	1971-2000
Location	• Long Point
Findings/Purpose	• Assesses habitat use and trends in numbers at Long Point, an important staging area in both spring and fall • Over the study period, numbers increased greatly (442 swans in the 1970's to 7177 swans in the 1990's) • Agricultural fields are more readily used in spring migration with, which resulted in wetland habitats in close proximity to these sites being used more readily than those far from agricultural locations • Autumn sees aquatic plants as the main foraging, such that swans used aquatic habitat closer to the tip of Long Point • The relative importance of Long Point for the Eastern population increased from <1% use to ~8%
Category	Waterfowl
Source	BSC (Digital Copy) Available from publisher at cost

873. Petrie, S. A., and C. M. Francis (2003) Rapid increase in the lower Great Lakes population of feral Mute Swans: A review and a recommendation. *Wildlife Society Bulletin* 31: 407-416.

Study Date	1971-2000
Location	• Long Point
Findings/Purpose	• Average population increase rates were found to be 10-18% per year • With conservative value or 10%, mute swan population is set to double every 7-8 years • This indicates the non-native species has found favorable habitat in the lower Great Lakes • If population increase is sustained, potential ecological damage is significant • Study suggests management and control measures be implemented before population becomes too large
Category	Waterfowl
Source	McMaster University, Thode library Available digitally from publisher at cost

874. Petrie, S. A., and K. L. Wilcox (2003) Migration Chronology of Eastern Population Tundra Swans. *Canadian Journal of Zoology* 81(6): 861-870.

Study Date	1998-2000
Location	• Capture at LP, monitored through spring & fall migration
Findings/Purpose	• Transmitters were used to track migratory path, duration, and staging lengths

	• Tundra swans spent 20% annual cycle on wintering sites, 28% at spring staging areas, 29% at breeding areas, 23% at fall staging areas • Results highlight the need to protect tundra swan migratory habitat
Category	Waterfowl
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London office

875. Petrie, S. A., and S. S. Badzinski (2004) Biologists take to the sky to count waterfowl. *BirdWatch Canada*: Spring 2004, No. 27:25-26.

Category	Waterfowl
Source	

876. Petrie, S.A. (2004) Selenium in scaup: a disturbing trend in the Great Lakes. *BirdWatch Canada*: Summer 2003, No. 28:9-13.

Category	Waterfowl
Source	

877. Petrie, S.A., and S.S. Badzinski (2006) Unravelling the migration strategies of scaup. *BirdWatch Canada*: Fall 2006, N0 37: 25-26.

Category	Waterfowl
Source	

878. Petrie, S. A., S. S. Badzinski, and K.G. Drouillard (2007) Contaminants in Lesser and Greater Scaup staging on the lower Great Lakes. *Archives of Environmental Contamination & Toxicology* 52(4): 580-589

Study Date	1999-2000
Location	• Canadian sides of Lakes Ontario and Erie
Findings/Purpose	• Scaup collected and tested for organic contaminants and trace elements to determine if concentrations are increased • All organic contaminants found to be below toxic levels • Only Se was found at increased levels • Se suggested as a potential issue for some breeding females once they leave the Lower Great Lakes
Category	Waterfowl
Source	McMaster University, Thode library Available digitally from publisher at cost

879. Petzold, G.K. and J.R. Paine (1978) Population characteristics of Yellow Perch in Long Point Bay, Lake Erie in the fall of 1976. Lake Erie Assessment Unit Report 1978-3. Ontario Ministry of Natural Resources, Wheatley, Ontario. 69 pp.

Study Date	Fall 1976
Location	• Long Point Bay
Findings/Purpose	• Study used to evaluate the enforcement and regulation requiring commercial fisherman follow a minimum fish length for catch • Primary concern was for the Long Point Bay populations in LPB and Lake Erie – intense commercial fishery. •
Category	Fish
Source	MNR Library

880. Phillips, J.E. (1972) The Climate of the Great Lakes Basin. Information Canada, Ottawa, EN57-7/20. 40pp

Category	Climate Change, Weather and Air Quality
Source	CWS London

881. Phillips, J.E. (1978) The Long Point Spit – Past, present and future. Unpublished Report. School of Landscape Architecture, University of Guelph (W.G. Sargent). 11pp.

Category	General
Source	

882.Philpott Associates (1990) Shoreline Management Plan. Report prepared for the Long Point Region Conservation Authority, Simcoe, Ontario.

Category	Land Use and Management
Source	CWS London

883.Planck, J.T. (1981) Amphibian and reptile distributions along the proposed Gravelly Bay Walking Trail, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service, London, Ontario.

Category	Amphibians, Reptiles
Source	CWS London

884.Planck, J.T. (1981) Proposed Gravelly Bay Walking Trail IEE highlights: Major impacts and mitigating measures. Canadian Wildlife Service Report, London, Ontario. 12pp.

Category	Human Impacts
Source	CWS London

885.Planck, J.T. (1981) Amphibian and reptile distributions at Bluff Point, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service. 39 pp.

Category	Amphibians, Reptiles
Source	CWS London

886.Planck, J.T. (1981) A brief preliminary report on waterfowl activity in southwestern Thoroughfare Point Unit, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service, London, Ontario.

Category	Waterfowl
Source	CWS London

887.Planck, J.T. (1981) Management implications of autumn waterfowl activity in the Thoroughfare Point Unit, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service, London, Ontario.

Category	Waterfowl, Land Use and Management
Source	CWS London

888.Planck, J.T. (1981) Bluff Point Interpretive Centre IEE highlights: Major impacts and mitigating measures. Unpublished report to the Canadian Wildlife Service. London, Ontario.

Category	Human Impacts
Source	CWS London

889.Planck, J.T. (1982) An environmental evaluation of the proposed Gravelly Bay Walking Trail, Long Point National Wildlife Area. Unpublished report; Canadian Wildlife Service, London, Ontario.

Category	Human Impacts
Source	CWS London

890.Planck, J.T. (1983) Eastern Spiny Softshell nesting at Long Pont National Wildlife Area: Management concerns at critical habitats. Canadian Wildlife Service Report, London, Ontario. 37 pp.

Category	Reptiles
Source	CWS London

891.Platzman, G.W. (1963) The dynamic prediction of wind tides on Lake Erie. *Meteorological Monographs* 4: 44 pp.

Category	Hydrology and Sediments
Source	McMaster Libraries CWS London

892. Platzman, G.W. (1966) The daily variation of water level on Lake Erie. *Journal of Geophysical Research* 71(10): 2471-2483.

Category	Water Levels
Source	McMaster Libraries CWS London

893. Platzman, G.W. (1963) The 14-Hour period of Lake Erie. Great Lakes Research Division, University of Michigan Publication 10:231-234

Category	Water Levels
Source	CWS London

894. Plissner J.H. and S.M. Haig (2000) Status of a broadly distributed endangered species: results and implications of the second International Piping Plover census. *Journal of Canadian Entomology 78*: 128-139.

Study Date	1991-1996
Location	• Various – Canada, US, Mexico, Bahamas, and others
Findings/Purpose	• Reviews the outcomes of the 1996 Piping Plover census and investigates the issues surrounding constructive monitoring and rehabilitation of a braodly distributed endangered species • Changes in populations are discussed as well as the achievement of targets and future efforts
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London office

895. PLUARG (1978) Environmental management stategy for the Great Lakes system. Final report to the International Joint Commission.

Category	Land Use and Management
Source	CWS London

896. Poff, Christine (1995) Long Point Area Monitoring Assessment Project (LPAMAP). Port Rowan, ON: Long Point Biological Reserve (Manuscript), and up-dated information, 1999.

Category	General
Source	

897. Potts H.W. (1950) The Lower Big Creek Watershed. B.A. Thesis. McMaster Universtiy

Category	General
Source	McMaster Libraries

898. Powell, S.W. (1980) Summer creel census of Long Point Bay, Lake Erie, 1979. Unpublished technical report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 45 pp.

Study Date	May – September 1979
Location	• Long Point Bay
Findings/Purpose	• Quantify fish harvest • Quantify angler effort and success • Fish population numbers are given in text for various species (yellow perch, smallmouth bass, pumpkinseed, bluegill and others) • Significantly less effort was directed toward the yellow perch and rock bass fisheries than others
Category	Fish
Source	MNR Library

899. Prior, P.N. (1992) Breeding bird census #37, red ash-red oak savannah. *Journal of Field Ornithology* 63 (Supplement):55-56.

Category	Birds

Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

900.Prior, P.N. and M.J. Palmer (1992) Breeding bird census #38, red oak-ironwood savannah. *Journal of Field Ornithology* 63 (Supplement):56-57.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

901.Puffer, D.A. (1979) The 1967-1977 Long Point W.M.A. waterfowl harvest as an indicator of kill and migration of common ducks in Ontario. Unpublished report; Ontario Ministry of Natural Resources. 56 pp.

Category	Waterfowl
Source	CWS London

902.Purves, S. (1980) Turtle studies in the Big Creek National Wildlife Area in 1980. Unpublished report; Canadian Wildlife Service, London, Ontario.

Category	Reptiles
Source	CWS London

903.Purves, S. (1980) Turtle studies in the Long Point National Wildlife Area in 1980. Unpublished report; Canadian Wildlife Service, London, Ontario.

Category	Reptiles
Source	CWS London

904.Pynenburg, M.P. and L.D. Witzel (1984) Description of spawning and nursery areas of Smallmouth Bass (*Micropterus dolomieui*) in Inner Bay, Lake Erie, 1984. Unpublished report; Long Point Foundation for Conservation. 46 pp.

Category	Fish
Source	CWS London

905.Quay, W.B. (1989) Insemination of Tennessee Warblers during spring migration. *The Condor* 91(3): 660-670.

Study Date	1982-1988
Location	• Galveston, Texas • Foley, Missouri • Long Point, Ontario
Findings/Purpose	• Insemination and sperm release during spring migration were investigated • 25% of females caught during migration had been inseminated with those inseminated being of a larger sub-group • Males releasing sperm were also of a larger sub-group • This process may be related to social and nutritional circumstances • It is not known what role migrational insemination plays in fertilization and offspring
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London office

906.Quinney, T. J. Siderius and E. Dunn (1979) Ontario heronry inventory progress report no. 2. Long Point Bird Observatory unpubl. Report. 42 pp.

Category	Birds
Source	

907.Quinney, T.E. (1983) The relation between food abundance and reproductive performance of Tree Swallows. Ph.D. Thesis. University of Western Ontario, London, Ontario. 132 pp.

Category	Birds

Source	

908. Quinney, T.E. (1983) Tree Swallows cross a polygyny threshold. *Auk* 100:750-754.

Study Date	1977-1982
Location	• Long Point (42°30'N, 80°01'W): Backus Field and Sewage Lagoon
Findings/Purpose	• Nest-box observations • Resource-defence polygyny was observed • Multiple females were found sitting on nest cups simultaneously with large clutches below them • Polygyny provided increased parental resources • Polygynous females were less successful than monogomous females
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

909. Quinney, T.E. and C.D. Ankney (1985) Prey size selection by Tree Swallows. Auk 102: 245-250.

Study Date	1979-1982
Location	• Port Rowan (42°37'N, 80°27'W) • Backus Field • Sewage Lagoon
Findings/Purpose	• Differences in diet of tree swallows between two locations where food abundance differed were examined • 99% of prey in diets of both groups were less than 10mm • 95% came from the Diptera and Homoptera insect orders • Regardless of location, swallows were selected of prey size for bringing to young • More valuable prey was selectively caught and was a larger proportion of diet where food abundance was higher
Category	Birds, Insects
Source	McMaster University, Thode library Available digitally from publisher at cost

910. Quinney, T.E. (1986) Male and female parental care in Tree Swallows. *Wilson Bulletin*. 98:147-150.

Study Date	June 1984
Location	• Port Rowan (42°37'N, 80°27'W) • Sewage Lagoon
Findings/Purpose	• Male involvement is substantion in monogamous bird pairs • Fecal sac removal was conducted by males in the majority of instances • Where food was abundant, both parents were not required to raise nestlings, however increased success
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

911. Quinney, T.E. (1986) Polygyny in Tree Swallows: Response to R.E. Simmons. Auk 103: 442-443.

Study Date	1977-1982 (same as original study in earlier reference)
Location	• Long Point (42°30'N, 80°01'W): Backus Field and Sewage Lagoon
Findings/Purpose	• Rebuttal to comments by another author suggesting different causes for polygyny in tree swallow observed • Author goes through evidence to support original conclusions in rebuttal to suggestions against original findings
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost CWS London office

912. Quinney, T.E. (1986) The importance of male parental care in Tree Swallows. XIX Congressus Internationalis Ornithologicus Abstracts No. 644.

Category	Birds
Source	McMaster Libraries

913. Quinney, T.E., D.J.T. Hussell and C.D. Ankney (1986) Sources of variation in growth of Tree Swallows. Auk 103:389-400.

Study Date	1980-1981
Location	• Long Point (42°30'N, 80°01'W): Backus Field and Sewage Lagoon
Findings/Purpose	• Investigation as to the effect of food abundance on growth of Tree Swallows by examining two different nesting locations where food abundance is the only major difference • Other factors were examined in terms of their influence on nestling growth and included: location of egg laying, incubation, nestling rearing, type of parent (natural or foster) and year of breeding • Insect biomass was ~ 7 fold different between sites regardless of year • Location of egg-laying explained ~51% of differences in nestling size
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

914. Ralph, B. and S.E. Heffernan (n.d.) An environmental management study – Long Point Provincial Park. OMNR unpublished report. 88p

Category	Land Use and Management
Source	CWS London

915. Ralph, B.D. and S.E. Heffernan (1978) Vegetation of Big Creek National Wildlife Area. Unpubl. Maps for Canadian Wildlife Service, Ontario Region. 2 maps.

Category	Terrestrial Vegetation, Aquatic Vegetation
Source	CWS London

916. Ralph, B. and S. Heffernan (1979) A survey of the vegetation of Big Creek National Wildlife Area, Ontario. Unpublished report to the Canadian Wildlife Service. 17 pp.

Category	Terrestrial Vegetation, Aquatic Vegetation
Source	CWS London

917. Ralph, C.J. (1975) Age ratios, orientation, and routes of land bird migrants in the northeastern United States. PhD Thesis, John Hopkins University, Baltimore, Maryland.

Category	Birds
Source	

918. Rao, S.S. and B.K. Burnison (1976) Bacterial distributions in Lake Erie (1967, 1970). *Journal of the Fisheries Research Board of Canada* 33: 574-580

Study Date	1967, 1970
Location	• Lake Erie, one outer LPB site
Findings/Purpose	• Investigate the presence and abundance of bacteria in Lake Erie • Coliform density and aerobic heterotrophic bacteria counts are completed • Epilimnion aerobic heterotrophic populations decreased through summer, concentrations were greater along the S-shore for both study years • Hypolimnion aerobic heterotrophs were greater than epilimnion concentrations • Epilimnion coliform concentrations were highest in specific locations of the central basin • Hypolimnion coliform concentrations were lowest in the eastern basin
Category	Water Quality/Limnology

Source	McMaster University, Thode library periodicals

919.Rasid, H; D. Baker, and R. Kreutzwiser (1992) Coping with Great Lakes Flood and Erosion Hazards: Long Point, Lake Erie, vs. Minnesota Point, Lake Superior. Journal of Great Lakes Research JGLRDE, Vol. 18, No. 1, p 29-42, 1992.

Category	Water Levels, Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

920.Reader, R.J., S.P. Bonser, T.E. Duralia, and B.D. Bricker (1995) Interspecific variation in tree seedling establishment in canopy gaps in relation to tree density. *Journal of Vegetation Science* 6(5): 609-614.

Category	Forests
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

921.Rees, G. and K Suns (1975) Chlorinated hydrocarbon residues from selected sites on Lakes Ontario, Erie and St. Clair, 1975. Ontario Ministry of the Environment.

Study Date	Fall, 1975
Location	• Lakes Erie and Ontario • Port Rowan
Findings/Purpose	• Samples of spottail shiners, sediments and lake waters were collected • All fish samples contained PCB and DDT residues • Concentrations increased with fish age • Sediment samples: 50% contained PCB, 90% - DDT • Within detection range, lake waters did not contain PCB residues • Rainwater collected contained no measurable quantity PCB • Information about fish size, fat content, and various other parameters are included in text
Category	Water Quality
Source	McMaster University, Thode library periodicals

922.Regier, H.A. and W. L. Hartman (1972) Lake Erie fish community 150 years of cultural stresses. Science (Washington D C) 180 (4092) : 1248-1255 1972 – CWS LONDON

Study Date	n.d. – Review article
Location	• Lake Erie, no LP specific
Findings/Purpose	• Identifies and examines major ecological stresses (natural stresses), influence of commercial fisheries and other cultural stresses on fish populations of Lake Erie • Research directions and management practices/considerations are provided • Outcomes: suggested regulation of commercial and recreation fisheries, increased study of limnological conditions and fish communities
Category	Fish
Source	McMaster University, Thode library periodicals

923.Regier, H.A., T.H. Whillans and A.P. Grima (1980) Rehabilitation of the Long Point ecosystem: Initiating a process. *Contact* 12(3): 125-149.

Category	Land Use and Management
Source	McMaster Libraries CWS London

924.Regional Municipality of Haldimand-Norfolk (1978) Official Plan for the Haldimand-Norfolk Planning Area. Department of Planning and Development, Townsend, Ontario.

Category	Land Use and Management
Source	McMaster Libraries

925. Regional Municipality of Haldimand-Norfolk (1983) The Official Plan for the Haldimand-Norfolk Planning Area: Consolidation Copy, Haldimand-Norfolk official plan and amendments 7-8. Department of Planning and Development, Townsend, Ontario.

Category	Land Use and Management
Source	CWS London

926. Reid, D.J. (1977) Spring Pike spearing creel census. Unpublished report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 29 pp.

Category	Fish
Source	CWS London

927. Reid, D.J. (1977) Northern Pike creel census on Long Point Bay of Lake Erie, 1976. Unpublished technical report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 31 pp.

Category	Fish
Source	

928. Reid, D.J. (1978) Distribution and relative abundance of fish along the Long Point Crown Marsh of Inner Bay, Lake Erie. Unpublished report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 79 pp.

Category	Fish
Source	CWS London

929. Reid, D.J. (1978) 1977 May, June, and September creel census on Long Point Bay, Lake Erie. Unpublished report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 42 pp.

Category	Fish
Source	

930. Reid, D.J. (1978) The fish community within a cattail marsh bordering Inner Long Point Bay, Lake Erie. Unpublished report; Ontario Ministry of Natural Resources, Simcoe, Ontario. 38 pp.

Study Date	1977
Location	• Inland part of LP (Long Point Beach Area)
Findings/Purpose	• Seine nets were used to sample fish species – 17 sample locations • Yellow perch, bluntnose minnows, golden shiners, pumpkinseed, Iowa darters, largemouth bass and black crappie were dominant with rock bass, banded killifish, bluegill, brook silverside, carp, northern pike and tadpole madtoms of lesser importance • Long Point area determined as a very important spawning and nursery area
Category	Fish, General Wetlands
Source	MNR Library

931. Reid, D.J. (1979) Survey of the South Walsingham Canada Goose hunt, October 16 – November 4, 1978. Unpublished report; Ontario Ministry of Natural Resources. 45 pp.

Category	Waterfowl
Source	

932. Reid, D.J. (1981) A survey of spawning bass in Long Point Bay during 1979. Unpublished report; Ontario Ministry of Natural Resources. 36 pp.

Category	Fish
Source	CWS London

933. Reid D.J. (1978) Summer creel census in Long Point Bay lake Erie, 1977. Unpublished technical report; Ontario Ministry of Natural Resources; 31pp + appendices

Study Date	May-June, September, 1977
Location	• LPB
Findings/Purpose	• ~45,000 rod hours were spent fishing over the study time period • Weekends used ~86% of total estimated effort (may-June) and 74%

	in September • Species specific fishing was common with Pike and Northern Pike being the primary species goal • Non-resident angling pressure was small for the entire study period • 980 pike were caught between May-June, 320 caught in September
Category	Fish
Source	MNR Library

934. Reid, D.J. (1984) Summer creel census in Long Point Bay, Lake Erie, 1982. Unpublished technical report; Ontario Ministry of Natural Resources; 46 pp.

Category	Fish
Source	

935. Reid, D.J. (1984) Summer creel census in Long Point Bay, Lake Erie, 1983. Unpublished technical report; Ontario Ministry of Natural Resources; 53 pp.

Category	Fish
Source	

936. Revill, A.D., Associates (1972) Feasibility study of dyking Big Creek Marsh. Unpublished report to Canadian Wildlife Service. 72 pp.

Category	Land Use and Management
Source	CWS London

937. Reynoldson, T.B. (1994) A field test of a sediment bioassay with the oligochaete worm *Tubifex tubifex* (Muller, 1774). *Hydrobiologia* 278(1-3): 223-230.

Category	Hydrology and Sediments, Macro-Invertebrates
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

938. Reynoldson, T.B., P. Rodriguez, and M. Martinez Madrid (1996) A comparison of reproduction, growth and acute toxicity in two populations of *Tubifex tubifex* (Muller, 1774) from the North American Great Lakes and northern Spain. *Hydrobiologia* 334(1-3): 199-206.

Category	Macro-Invertebrates
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

939. Reynoldson, T.B., S.P. Thompson, and D. Milani (2002) Integrating multiple toxicological endpoints in a decision-making framework for contaminated sediments. *Human and Ecological Risk Assessment* 8(7): 1569-1584.

Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

940. Reznicek, A.A. and P.M. Catling (1979) Long Point vascular plant list based on field notes, 20-23 Sept. 1979. Unpublished report to Canadian Wildlife Service. 30 pp.

Category	Terrestrial Vegetation
Source	CWS London

941. Reznicek, A.A. and P.M. Catling (1981) Floristic and vegetation studies of Long Point, Norfolk County, Ontario. Published abstracts. Canadian Botanical Association, American Botanical Association, University of Guelph. P. 40.

Category	Terrestrial Vegetation
Source	CWS London

942. Reznicek, A.A. and P.M. Catling (1982) Cyperaceae new to Canada from Long Point, Norfolk County, Ontario. *Canadian Field Naturalist* 96(2): 184-188.

Study Date	1979, 1980
Location	• Long Point (35.5 km length of sandspit)

Findings/Purpose	• Floristic survey of LP • Contains records of particular importance – additions to native Cdn flora, species needing further work as rare or endangered.
Category	Terrestrial Vegetation, Aquatic Vegetation
Source	McMaster University, Thode library periodicals

943. Reznicek, A.A. and P.M. Catling (1989) Flora of Long Point, Ontario. The Michigan Botanist 28: 99-175.

Study Date	1979-1980 (intensive), to 1988 (occasional site visits)
Location	• Long Point
Findings/Purpose	• Historical perspective on flora in the Long Point area – old floristic surveys, and specimen collecting habits with reference to other earlier sources • Species lists, specimen status, date collected, and rarity are provided • Vegetation communities are considered separately with descriptions of dominant vegetation types, photos, and diagrams of structure • Factors affecting vegetation spread and health are also discussed, including: logging, fire, deer browsing, climate and microclimate and physical disturbances • Identified species are also subdivided based on their general geographic distribution (eastern, western, northern, southern or Great Lakes) • An extensive species list with occurrence descriptions is in the rear of the special issue
Category	Terrestrial Vegetation, Aquatic Vegetation, Human Impacts
Source	BSC Library

944. Richards, T.L. (1965) Meterological factors affecting Great Lakes water levels. Canadian Department of Transport, C1R-4182. 17 pp.

Category	Water Levels, Weather and Air Quality
Source	

945. Richardson, A.H. (1953) Big Creek Valley Conservation Report, 1953. Ontario Conservation Branch.

Category	Land Use and Management
Source	McMaster Libraries

946. Richardson, W.J. (1966) Weather and Late Spring Migration of Birds into Southern Ontario. *Wilson Bulletin* 78(4): 400-414

Study Date	1961-1963
Location	• Long Point and other locations in S-Ontario
Findings/Purpose	• Investigations into the influence of weather characteristics on migration timing • Following winds and high temperatures are correlated to major waves of migrants, but changes in temperature themselves do not appear to cause immediate changes in migration volumes • Pressure characteristics are also well correlated with size of migration waves • A negative correlation occurs between rain and migration wave, but is not as significant as might be expected
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

947. Richardson, W.J. (1973) Whistling swans at staging areas in southern Ontario and Michigan – spring, 1972. Unpublished report; LGL Ltd. 15 pp.

Category	Waterfowl
Source	CWS London

948. Ridgway, M.S., G.P. Goff, and M.H.A. Keenleyside (1989) Courtship and Spawning Behavior in Smallmouth Bass (Micropterus dolomieui). *American Midland Naturalist*, 122(2), pp. 209-213.

Study Date	n.d.
Location	• LPB (42°39'N, 80°22'W) • Provoking Lake • Lake Opeongo
Findings/Purpose	• Underwater observations of mating and spawning behaviour was monitored at 3 sites in Ontario • Courtship is generally bi-phasal: initially away from the nest site, and the second phase at the nest site • Behaviour of each sex is described during both phases
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

949. Ridout, R. (1990) Long Point Bird Observatory – 1990 Hawk-Banding Station Report. *Ontario Bird Banding* 23: 20-22

Study Date	1990
Location	• Clear Creek, LP
Findings/Purpose	• Station was moved from Backus Conservation Area to it's original location at Clear Creek • Very high success rate in both number of species caught (10) and birds banded (358) • An account of the species caught and information regarding the number and date of occurrence are provided • A higher number of hawks were banded in 1990, other bird species were within previous years numbers
Category	Birds
Source	BSC Library

950. Risley, C. (1978) Eagles Over Long Point. Long Point Bird Observatory Newsletter 10(2): 7-8.

Category	Birds
Source	CWS London

951. Roberts, J.O.L. and D.J.T. Hussell (1967) A review of the history and function of bird observatories. *Ontario Bird Banding* 3:84-89

Study Date	Review paper
Location	• Various – worldwide
Findings/Purpose	• Provides a brief history of bird observatories • Impact of the world ward • Naming and invention of the Heligoland trap (named after a German Island) • Canada-specific history is provided – though brief, with mention of LP
Category	Birds, Land Use and Management
Source	BSC Library

952. Robertson, W.D. and J. Harman (1999) Phosphate plume persistence at two decommissioned septic system sites. *Ground Water* 37(2): 228-236.

Category	Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

953. Robertson, W.D., D.W. Blowes, C.J. Ptacek, and J.A. Cherry (2000) Long-term performance of *in situ* reactive barriers for nitrate remediation. *Ground Water* 38(5): 689-695.

Study Date	1992-1999
Location	• Long Point

	• Killarney • Borden • North Campus
Findings/Purpose	• Test the use of a porous reactive barrier to control and mitigate the impacts of nitrate contamination • Barriers were installed in different formats at test sites to examine efficacy • Trials have been successful at attenuating influent NO_3^- • Results indicate effectiveness of up to a decade without Carbon replenishment
Category	Water Quality/Limnology
Source	McMaster University, Thode library Available digitally from publisher at cost

954. Robinson, J.T. and W. Fick (1979) A partial list of the insects found in the Big Creek National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, ON. 5pp.

Category	Insects
Source	CWS London

955. Robinson, J.T. (1979) A Preliminary Small Mammal Survey of the Big Creek Marsh Conducted During the Summer of 1979. Canadian Wildlife Service unpublished report.

Category	Mammals
Source	CWS London

956. Robinson, J.T. and J. Barbeau (1982) Summary of breeding bird surveys for 1981 and 1982 in Gravelly Bay study corridor. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Birds
Source	CWS London

957. Robinson, J.T. (1984) Summary report of hoop netting in Bluff Pond, Long Point National Wildlife Area, 1984. Unpublished report; Canadian Wildlife Service, London, Ontario. 10 pp.

Category	Birds
Source	CWS London

958. Robinson, J.T. (1985) Long Point Bald Eagle programme. *Long Point Bird Observatory Newsletter* 17(2): 1-3.

Category	Birds
Source	CWS London

959. Robinson, J.T. (1986) Deer track count at base of Long Point. Canadian Wildlife Service memorandum. 1 p.

Category	Mammals
Source	CWS London

960. Robinson, J.T. and G. McCullough (1988) Project Summary Report: Long Point National Wildlife Area Bald Eagle Project: 1983-1987. Unpublished report to Canadian Wildlife Service, London, Ontario. 32 pp.

Category	Birds
Source	CWS London

961. Robinson, J.T. (2003) Canadian Update In. NYS Grant, OS Grant, PS Grant, NY Buffalo – Proceedings by Helen M. Domske, 2003. Botulism in Lake Erie Workshop Proceedings. Pp 25-29.

Study Date	Status discussions, not a findings paper
Location	• Dominantly Lake Erie, some Lake Ontario references – LP highlited in Canadian Report, but no detailed information

Findings/Purpose	• Review of past and current issues related to botulism-related mortality in birds – particularly focusing on fish-feeders • Canada-focused portion is included (although overall document focus is US) in which LP is highlighted with confirmed outbreaks of botulism • Suggestions for moving forward with concerns and research conducted to understand transfer and infection pathways are discussed
Category	Water Quality/Limnology
Source	Available digitally (internet)

962.Roe, S.L. and H.J. MacIsaac (1997) Deepwater population structure and reproductive state of quagga mussels (*Dreissena bugensis*) in Lake Erie. *Canadian Journal of Fisheries and Aquatic Sciences*54: 2428-2433.

Category	Macro-Invertebrates
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

963.Rogers, C.M. (1963) Yellow Flowered Species of Linum in Eastern North America Brittonia, 15(2): 97-122.

Category	Terrestrial Vegetation
Source	

964.Rosenthal, B.M. and A. Spielman (2004) Reduced variation among northern deer tick populations at an autosomal microsatellite locus. *Journal of Vector Ecology* (December 2004): 227-235.

Category	Insects
Source	

965.Ross, D.I. and Y. Hamdy (1983) The spatial distribution of chlorinated hydrocarbon residues in the sediment of Inner Long Point Bay, Lake Erie. Ontario Ministry of the Environment, Water Resources Branch. 29 pp.

Category	Hydrology and Sediments, Water Quality/Limnology
Source	CWS London

966.Ross, R.K. et al. (2003) Ontario Shorebird conservation plan. Environment Canada. 48pp

Study Date	Not specific Study – population information covers time up to publication
Location	• Various across Ontario, including Long Point
Findings/Purpose	• Breeding and migratory shore birds of Ontario are identified including discussion about current population trends, important staging/breeding locations and major concerns and management issues facing these groups in Ontario at time of publication • Conservation priorities are identified which include habitat protection, and anthropogenic management issues • Implementation of the program is highlited
Category	Birds
Source	Available free online (internet) http://www.on.ec.gc.ca/wildlife/plans/shorebirdplan-e.html

967.Rukavina, N.A. and A.J. Zeman (1987) Erosion and sedimentation along a cohesive shoreline: The north-central shore of Lake Erie. *Journal of Great Lakes Research* 13(2): 202-217.

Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

968.Russell, R.P., Jr. (1983) The Piping Plover in the Great Lakes region. *American Birds* 37(6): 951-955.

Study Date	1963-1982 – other studies, minimal field work
Location	• Several states discussed, Ontario

Findings/Purpose	• 8 nesting sites recorded on Lake Erie • Last 'large' populations occurred on Long Point – 1927 population of 100 pairs. Population fell to 4 pairs in 1972, 3-5 in 1976, 1 pair in 1977, some unmated males were spotted in later years • No pairs have been seen since 1977 (at time of publication) • Gull egg predation significant cause of falling population on LP, other human impacts likely also contributed to decrease
Category	Birds
Source	McMaster University, Thode library periodicals

969. Ruttan, N. and C.D. Ankney (1976) Some aspects of the 1975 waterfowl migration at Long Point Bay, Ontario. Unpublished report; University of Western Ontario, London, Ontario. 31 pp.

Study Date	Fall 1975
Location	• Long Point Bay
Findings/Purpose	• Migration was indexed using hunter kills • Population levels in the LP area were high, but hunter kills varied • Adult male mallards migrated later in the season than all other classes • Migration of adult male canvasbacks and redheads took place before and after the main flow of migration • Migration of male lesser scaup all migrated in the first of three peaks of lesser scaup • A higher proportion of female lesser scaup were killed than expected given known sex ratios
Category	Waterfowl
Source	MNR Library

970. Sahota, H., P. Kiely and M. Lusis (1985) Air quality impact of the Nanticoke Industrial Development. *Water, Air and Soil Pollution 25(1985):* 249-263.

Category	Weather and Air Quality
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

971. Saltonstall, K. and J. Court Stevenson. (2006) The effect of nutrients on seedling growth of native and introduced *Phragmites australis*. *Aquatic Botany* 86(4): 331-336.

Study Date	Seed collection: Fall 2002 Growth Experiment: May 2003
Location	• All sites were for seed collection, rather than *in situ* growth experiments • Long Point Marsh (43°36'N, 80°27'W) • Block Island, Rhode Island • Trappe, Maryland
Findings/Purpose	• Response to abiotic stresses and nutrient availability may play an important role in the spread and invasion of non-native *Phragmites* species compared to native varieties • A growth experiment was conducted using collected seeds under two nutrient treatments • Both native and non-native responded to increased nutrient availability, however the invasive far out-performed the native with the low-nutrient invasive approximately equalling the size of the native under high-nutient conditions
Category	Aquatic Vegetation, Water Quality/Limnology
Source	McMaster University, Thode library Available digitally from publisher at cost

972. Saumure, R.A. (1992) A Report on the Pilot Year of a Mark-Recapture Study on Four Species of Turtles Inhabiting Big Creek Marsh National Wildlife Area, Long Point, Ontario. Unpublished report.

Category	Reptiles
Source	

973.Saumure, R.A., A.D. Walde and T.A. Wheeler (2006) Non-predatory fly larvae (*Delia platura*: Anthomyiidae) in a nest of a Northern Map Turtle (*Graptemys geographica*). *Chelonian Conservation and Biology* 5(2): 274-275.

Study Date	1997 (sample collection)
Location	• Gravelly Bay, LP (42°33'15''N, 80°06'00''W)
Findings/Purpose	• Investigate and validate the existence of non-predatory worm species found in turtle nest that had failed • Identified fly larvae found are phytophagous or saprophagous and thus not likely to have been involved in nest failure • Study findings stress need to collect, incubate and precisely identify species in nests to identify predatory vs non-predatory presence
Category	Insects, Reptiles
Source	McMaster University, Thode library Available digitally from publisher at cost

974.Saunders, K.E. and R.G.D. Davidson-Arnott (1990) Coastal dune response to natural disturbances. Proceedings of the Canadian Symposium on Coastal Sand Dunes 12-14 September 1990, Guelph, Ontario. National Research Council of Canada, Ottawa. Pp. 321-346.

Category	Hydrology and Sediments
Source	

975.Saunders, W.E. (1930) The destruction of birds at Long Point Light-house, Ontario, on four nights in 1929. *Auk* 47(4) 507-511.

Study Date	1929
Location	• LP lighthouse
Findings/Purpose	• Historical view of the occurrence of bird mortality at the long point lighthouse • A count of birds (including species) is provided in the document – counts are large ~600 one day, and ~200 on a second, ~350 on a third • Inference into the cause related to migratory path, light intensity and migration timing are proposed
Category	Birds, Human Impacts
Source	McMaster University, Thode library Available digitally from publisher at cost

*976.*Saunders, W.E. (1932) Notes on the mammals of Ontario. *Transaction of the Royal Canadian Institute 18(2):271-309*

Category	Mammals
Source	McMaster Libraries CWS London

977.Schueler, F.W. (1975) Relationship between bird species abundance and spring migration dates. *Ontario Bird Banding* 10(1):1-8.

Study Date	n.d
Location	• Long Point
Findings/Purpose	• Pairs of similar species of birds observed in spring migration • The more abundant species generally migrated first • Attributed to the more intense territorial conflict of the more abundant species, may migrate in more distinct waves & therefore create higher daily counts
Category	Birds
Source	BSC Library

978.Schueler, F.W. (1975) Notes on the Garter Snake (*Thamnophis sirtalis*) spring mortality and behaviour at Long Point, Ontario. *Ontario Field Biologist* 29(1): 75.

Category	Reptiles
Source	CWS London

979. Schueler, F.W. (1979) Geographic variation in skin pigmentation and dermal glands in the Northern Leopard Frog, *Rana pipiens*. Ph.D. thesis, University of Toronto, Toronto, Ontario.

Category	Reptiles
Source	CWS London

980. Schugar, M., G.L. Holroyd, G. Johnston, D. Nakashima and G.W. Miller (1974) Thirty-eighth breeding bird census. Bluegrass-milkweed grassland. *American Birds* 28:1052.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University CWS London

981. Schugar, M., N. Bernstein, G. Miller and K. McGowan (1974) Thirty-eighth breeding bird census. White pine-white cedar forest. *American Birds* 28:1018-1019.

Findings/Purpose	See: Van Velzen, W.T. (1974)
Category	Birds
Source	McMaster University CWS London

982. Schuldt, A.A. (1980) Air quality research and management in the Long Point, Haldimand-Norfolk areas: Commentary. *Contact* 12(3): 80-84.

Category	Weather and Air Quality
Source	McMaster Libraries CWS London

983. Scoggan, H.J. (1978) The flora of Canada. *National Museum of Natural Sciences, Publications in Botany 70(0)*

Category	Terrestrial Vegetation, Aquatic Vegetation
Source	McMaster Libraries CWS London

984. Scott, W.B. (1952) Records of the Western Lake Chubsucker, *Erimyzon sucetta kennerleyi*, from Ontario, Canada. *Copeia* 1952 (3): 203.

Study Date	1949
Location	• Ponds on Long Point, Point Pelee and St. Clair Lake
Findings/Purpose	• First known reportings of species in Ontario waters, however it is speculated by the author that they may have been present for some time given the relative inaccessibility of the areas in which it was found • Fish size of all specimens collected is given
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

985. Scott, J.D., K. Fernando, S.N. Banerjee, L.A. Durden, S.K. Byrne, M.Banerjee, R.B. Mann and M.G. Morshed (2001) Birds Disperse Ixodid (Acari: Ixodidae) and Borrelia burgdorferi-Infected Ticks in Canada. J. Med. Entomol. 38(4): 493–500

Category	Birds, Insects
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

986. Scott, J.D., K. Fernando, L.A. Durden, and M.G. Morshed (2004) Lyme Disease Spirochete, Borrelia burgdorferi, Endemic in Epicenter at Turkey Point, Ontario. *Journal of Medical Entomology* 41(2): 226-230

Category	Insects

Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

987.Scrutton, N. (1980) Fish sampling at Long Point National Wildlife Area, 1980. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Fish
Source	CWS London

988.Sea Grant (2002) Botulism in Lake Erie Workshop Proceedings. February 28, 2002. Buffalo New York. (ONLINE: http://www.seagrant.sunysb.edu/botulism/Botulism-Proc02.pdf, accessed Sept. 10, 2007)

Study Date	Status discussions, not a findings paper
Location	• Dominantly Lake Erie, some Lake Ontario references – LP highlited in Canadian Report, but no detailed information
Findings/Purpose	• Review of past and current issues related to botulism-related mortality in birds – particularly focusing on fish-feeders • Canada-focused portion is included (although overall document focus is US) in which LP is highlighted with confirmed outbreaks of botulism • Suggestions for moving forward with concerns and research conducted to understand transfer and infection pathways are discussed
Category	Water Quality/Limnology
Source	Availble free online (internet)

989.Seasons. (1981). Special Issue on Long Point. 21(1) Spring.

Category	General
Source	McMaster Libraries

990.Serafin, R. (1989) Research and Monitoring for Environmental Protection: Twenty Years of Research and Monitoring at the Nanticoke Industrial Complex on the North Shore of Lake Erie. Final Report to the Canadian Environmental Assessment Research Council, Ottawa, Ontario.

Category	Human Impacts, Water Quality/Limnology, Fish
Source	

991.Shaw, J.R. and W.S. Haras (1980) Beach changes at the Long Point light station, Lake Erie: A progress report on the monitoring of a shore protection system. Unpublished report; NWRI tech. Series 80-3. 22 pp.

Category	Hydrology and Sediments
Source	CWS London

992.Sheppard, R.W. (1935) Mid-summer Bird Notes from Long Point, Norfolk County, Ontario. *Auk* 52: 196

Study Date	July 1933
Location	• South beach of Long Point
Findings/Purpose	• Visits to breeding colonies of Piping Plovers and Common Terns were made • General numbers of pairs are presented • It is noted that the number of young in the Piping Plover colonies was down significantly from the previous year (either earlier hatching, or fewer chicks) • A list of other observed bird species is provided
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

993.Shutler, D, Hussell, DJT, Horn, AG, Leonard, ML, Shutler, RW, Lepage, D. (2004) Breeding between Tree Swallows from the same brood. *Journal of Field Ornithology* 75:353-385.

Study Date	1969-2000
Location	• Port Rowan (42°37'N, 80°27'W): 4 sites in vicinity • Long Point Tip • Sewage Lagoons • Backus Field • Mud Creek • Sites in Nova Scotia as well
Findings/Purpose	• Investigation is made into the mating of broodmates in subsequent breeding years • Evidence of two brood-mate pairs was found for LP • Inbreeding occurred at higher instances than expected by chance • Unknown if identical natal dispersal responses is related to gene similarity or rearing environments
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

994. Singh, R.P. and D. B. McMillan (1966) Karyotypes of Three Subspecies of *Peromyscus*. *Journal of Mammalogy*. 47(2): 261-266.

Category	Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

995. Singleton, M. (1980) Planning and management of Long Point and Turkey Point Provincial Parks: Commentary. *Contact* 12(3): 49-50.

Category	Land Use and Management
Source	McMaster Libraries

996. Skafel, M.G. (1983) Shore recession at Long Point lighthouse. Technical Notes, Hydraulics Div., NWRI rep. No. 83-17. 4 pp.

Category	Hydrology and Sediments
Source	CWS London

997. Skibicki, A.J. (1993) The Long Point Region: An Institutional and Land Tenure History and Examination of Management Needs. Long Point Environmental Folio Publication Series – Working Paper 2. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

Category	Land Use and Management
Source	Natural Heritage Resource Centre, University of Waterloo http://www.kwic.com/~longpointbio/Reserve/Publications/FOLIO/content/content.htm

998. Skibicki, A.J. and J. Gordon Nelson (1993) A human ecological approach to biodiversity planning and management : Point Pelee, Rondeau, and Long Point peninsulas, Lake Erie, Canada Waterloo, Ont. : Heritage Resources Centre, University of Waterloo. 105p.

Category	Land Use and Management
Source	Natural Heritage Resource Centre, University of Waterloo http://www.kwic.com/~longpointbio/Reserve/Publications/FOLIO/content/content.htm

999. Skibicki, A. (1996) Land Management in the Long Point Area. J. G. Nelson, and Kerrie Wilcox (Editors), Long Point Environmental Folio. Waterloo, Ontario: Heritage Resources Centre, Faculty of Environmental Studies, University of Waterloo.

Category	Land Use and Management
Source	Natural Heritage Resource Centre, University of Waterloo http://www.kwic.com/~longpointbio/Reserve/Publications/FOLIO/content/content.htm

1000. Skibicki, A. (1996) Land Management in the Long Point Area. Chapter 16: Long Point Environmental Folio. Waterloo, Ontario. Heritage Resources Centre, Faculty of Environmental Studies, University of Waterloo. 19pp.

Study Date	1900s – time of publication

Location	• Long Point
Findings/Purpose	• Brief history of the different land management techniques and governing bodies that have been involved in the Long Point area • Government involvement is given special consideration with a list of all agencies involved in lands management in the area listed in a table including a list of relevant policies and documents from each group • Other lands management models are discussed in regards to their influence on the area: Private stewardship • Constraints and issues encountered in lands planning are also reviewed • Various maps are included in text showing: CA lands ownership, areas with land use regulations, private stewardship areas, significant natural areas, provincially significant wetlands, areas of management conflict
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

1001. Sly, P.G. (1976) Lake Erie and its basin. *Journal of the Fisheries Resource Board of Canada. 33(3):355-370*

Study Date	Non-field study – literature review
Location	• Lake Erie
Findings/Purpose	• General information regarding the formation, composition, morphology, climate, watershed characteristics, human historical influence and biology of Lake Erie, with attention paid to each basin
Category	Water Levels, Terrestrial Geography
Source	McMaster University, Thode library periodicals

1002. Smith, D.W. (1979) Ecological Isolation Between *Aythya* Species at Long Point Bay, Ontario. M.Sc. thesis, University of Western Ontario, London, Ontario.

Category	Waterfowl
Source	CWS London

1003. Smith H.A. and A.H. Richardson (1958) Big Creek Region conservation report: Land. Ontario department of planning and development, Conservation Branch. 48pp

Category	Land Use and Management
Source	McMaster Libraries CWS London

1004. Smith, H.L. (1976) Identification of social classes by physical features, and management implications for White-tailed Deer (*Odocoileus virginianus*). M.Sc. thesis, University of Guelph, Guelph, Ontario. 200 pp.

Category	Mammals
Source	CWS London

1005. Smith, H.L. (1983) White-tailed Deer in Ontario – its ecology and management. Ontario Ministry of Natural Resources, Wildlife Branch.

Category	Mammals
Source	McMaster Libraries CWS London

1006. Smith, H. (1992) Breeding bird census #122, bluegrass grassland. *Journal of Field Ornithology* 63 (Supplement):107-108.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1007. Smith, H. (1992) Breeding bird census #36, dry cottonwood sand dune. *Journal of Field Ornithology* 63 (Supplement):54-55.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1008. Smith, J.J, V. Gavrilovic and D. R. Smitley (2001) Native Vaccinium spp. and Gaylussacia spp. Infested by Rhagoletis mendax (Diptera: Tephritidae) in the Great Lakes Region: A Potential Source of Inoculum for Infestation of Cultivated Blueberries. *Journal of Economic Entomology* 94(6): 1378-1385

Category	Terrestrial Vegetation, Insects
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1009. Smith, L.A., E. Nol, D.M. Burke and K.E. Elliot (2007) Nest-site selection of Rose-breasted Grosbeaks in southern Ontario. *The Wilson Journal of Ornithology* 119(2):151–161, 2007

Study Date	2000-2004
Location	• Port Rowan (42°35'N, 80°15'W) – woodlot
Findings/Purpose	• Woodlots examined were at different stages of partial harvest • Investigation focused on the influence of harvest activities (habitat alteration) affect nest success and selection • Many models were created to test sensitivity of various elements • Positive slopes were found for: canopy cover, sapling cover, nest height with increased nest survival as these elements increased • The Grosbeaks however preferred less canopy cover causing more open harvested areas to create 'preferred' sites, however reducing nest success
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1010. Smith, M. Alex, and Green, D. M. (2002) Bufo fowleri: Predation. *Herpetological Review*. 33(2): 125.

Category	Amphibians
Source	

1011. Smith, M.A. and Green D.M (2006) Sex, isolation and fidelity: unbiased long-distance dispersal in a terrestrial amphibian. *Ecography. 29:* 649-658.

Study Date	1988-2000
Location	• Long Point
Findings/Purpose	• Predictions using the resource-competition hypothesis and behavioural characteristics of amphibians suggests that dispersal should be biased towards juveniles and males • This was tested by following *Bufo fowleri* in a mark and recapture survey • Findings did not concur with predictions • Although juveniles had higher dispersal it is believed to be more related to abundance than to non-site fidelity • No sex differences were observed
Category	Amphibians
Source	McMaster University, Thode library Available digitally from publisher at cost

1012. Smith, M. A., and D.M. Green (2004) Spatial ecology of Bufo fowleri. 89th Annual Meeting of the Ecological Society of America – Lessons of Lewis and Clark: Ecological Exploration of Inhabited Landscapes, August 01-06, 2004, Portland, OR, USA Ecological Society of America Annual Meeting Abstracts 89 : 475 2004

Category	Amphibians

Source	

1013. Smith, M.A, and D.M. Green (2004) Phylogeography of Bufo fowleri at its northern range limit. *Molecular Ecology* 13 (12) : 3723-3733 December 2004

Study Date	n.d.
Location	• *Bufo fowleri* samples collected from Ross & Union counties (Ohio), Leigh county (Pennsylvania) • *Bufo americanus* samples were taken from Long Point, Niagara County and Montreal QC
Findings/Purpose	• Evidence of multiple invasion routes has been found • Phylogeographic differences should thus exist in different populations • 2 phylogenitic groups were identified: Group 2 was created by populations at Long Point and the Indiana Dunes (Lake Huron), all other areas formed group 1 • Evidence of partial introgression from one species to the other was also found
Category	Amphibians
Source	McMaster University, Thode library Available digitally from publisher at cost

1014. Smith, M.A. (2005) Spatial Ecology of *Bufo Fowleri* (this is his Phd thesis, it may be a work in progress KJ)

Category	Amphibians
Source	

1015. Smith, M.A., and D. M. Green (2005) *Bufo fowleri* (Fowler's toad). Predation. *Herpetological Review* 36 (2) : 159-160 JUN 2005

Category	Amphibians
Source	

1016. Smith, M.A. and D.M. Green (2005) Dispersal and the metapopulation paradigm in amphibian ecology and conservation: are all amphibian populations metapopulations? *Ecography* 28 (1), 110–128.

Study Date	Review Paper
Location	• Various cited (including Long Point references)
Findings/Purpose	• Although the assumptions of metapopulation theory and function within amphibian groups is often assumed, they are rarely tested in existing literature • Paper investigates the foundations of the assumptions based on existing literature • Where large distances separate populations, metapopulation characteristics are more likely to become apparent • Study does not suggest the abandonment of metapopulation theory, but instead suggests caution in its application without case testing
Category	Amphibians
Source	McMaster University, Thode library Available digitally from publisher at cost

1017. Snyder, L.L. (1928) Cryptotis parva, a new shrew for the Canadian list. *Journal of Mammals 10:79-80*

Category	Mammals
Source	CWS London

1018. Snyder, L.L. and E.B.S. Logier (eds) (1931) A faunal investigation of Long Point and vicinity, Norfolk Co., Ontario. *Transactions of the Royal Canadian Institute* 18: 117-236.

Category	Mammals
Source	McMaster Libraries

1019. Soper, J.H. (1962) Some genera of restricted range in the Carolinian flora of Canada. *Transactions of the Royal Canadian Institute*. 34(Part 1): 3-56.

Category	Forests
Source	McMaster Libraries CWS London

1020. Soper, R. (1981) A small mammal survey of the interior ponds, Gravelly Bay area, Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Mammals
Source	CWS London

1021. Spytz, C.P. (1989) The Plants, Birds and Herpetofauna of the Great Lakes Shoreline of Ontario.

Category	Aquatic Vegetation, Terrestrial Vegetation, Birds, Waterfowl, Amphibians, Reptiles
Source	

1022. St. Jacques, D.A. and N.A. Rukavina (1973) Lake Erie nearshore sediments-Mohawk point to Port Burwell, ON. *Proceedings from the Conference of Great Lakes Research. 16:454-467*

Category	Hydrology and Sediments
Source	McMaster Libraries CWS London

1023. Staple, T. (1993) Climate Change and Long Point Bay: A Preliminary Analysis with Some Implications. Long Point Environmental Folio Publication Series – Working Paper 2. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 20 pp.

Study Date	1935-1985 (uses historical data – not field oriented)
Location	• LP
Findings/Purpose	• Preliminary analysis of the potential implications of climate change on the LPB area under the 2xCO_2 scenario • Using historical values for climate parameters, and the 2xCO_2 scenario parameters, GCM outputs are examined in the area of LP • LP could experience warmer temperatures of up to 5.7°C above current, a decrease in precipitation of 6.3%, lowering Lake Levels bu up to 1.35m • Inner bay may retain diversity, submerged macrophytes would be hard hit as open water areas decrease • The northeast, southwest and southern shores of Inner Long Point Bay are considered areas of importance relative to the sustainability of th wetland character of Long Point and are most sensitive to changes under the 2xCO_2 scenario
Category	Climate Change
Source	BSC Library Waterloo Heritage Resource Centre

1024. Staple, T. (1996) Climate Change and Long Point Bay: A Preliminary Analysis. Chapter 15: Long Point Environmental Folio. Heritage Resource Centre, University of Waterloo, Waterloo, Ontario. 6pp

Study Date	Historical and evidence up to time of publication
Location	• Long Point
Findings/Purpose	• Climate change as a process is introduced • Influence of human processes/activities on the development of the greenhouse effect • Climate models are introduced and results from the 2xCO_2 model is discussed (decreases in lake levels, increasing temperatures shoreline alterations – influences on wetlands) • Economic impact of significant climate change are also considered

Category	Climate Change
Source	BSC Library Waterloo Heritage Resource Centre

1025. Standke, S. J. and B. P. Monroe (1981) Forms of physical damage and related effects to zooplankton as a result of entrainment at Nanticoke generating station Lake Erie Canada. Journal of Great Lakes Research 7 (2): 136-143 1981

Study Date	June-July, 1976
Location	• Nanticoke nearshore
Findings/Purpose	• Investigate the effects of entrainmnent on zooplankton passing through the condenser cooling system – physical damage and related effects (dislodgement of eggs or embryos) • Damage attributed to the entrainment process ranged between 0.25% and 22.43% (species dependent) • Only one genus was found to sustain any egg loss • Some immediate mortality was also observed but not quantified • Damage was dominantly confined to the effluent channel with diminishing impact with distance from the channel mouth
Category	Zooplankton and Phytoplankton, Human Impacts
Source	McMaster University, Thode library Available digitally from publisher at cost

1026. Stauffer, R.E. (1980) Windpower Time Series Above a Temperate Lake. *Limnology and Oceanography, 25(3)*: 513-528

Category	Land Use and Management, Human Impacts
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1027. Stenson, R. (1993) The Long Point Area: An Abiotic Perspective. Long Point Environmental Folio Publication Series – Technical Paper 2. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 41 pp.

Study Date	Review
Location	• LP
Findings/Purpose	• More detailed report of Stenson, R (1996) • The abiotic components of the region are examined in increasing detail • Formation of the Great Lakes Basins - geology, glaciation, hydrology • More detailed information of the Lake Erie System – bathymetry, historical changes in water level • Long Point characteristics are examined in terms of physiography, hydrology (surface), climate, local geology, sedimentology, long point formation (sediment transport and modification, stability, etc.), shoreline protection – evolution of the spit • What factors are currently influencing the evolution of LP? These are investigated in the final section of the paper
Category	Terrestrial Geography, Hydrology and Sediments
Source	BSC Library

1028. Stenson, R. (1996) Evolution of the Long Point Area: Geomorphology, Glaciation, Climate, Hydrology and Current Processes. Chapter 2, Long Point environmental Folio. Heritage Resource Centre, University of Waterloo, Waterloo, ON. 18pp.

Study Date	Review
Location	• LP
Findings/Purpose	• Brief historical/geologic description of the development of Long Point • Influence of water level fluctuations is considered • Current processes consist of chemical, biological and anthropogenic processes affecting the point
Category	Terrestrial Geography, Human Impacts, Water Quality/Limnology
Source	BSC Library

	Waterloo Heritage Resource Centre

1029. Stepien, C., D.J. Murphy, R.M. Strange (2007) Broad- to fine-scale population genetic patterning in the small-mouth bass *Micropterus dolomieu* across the Laurentian Great Lakes and beyond: an interplay of behaviour and geography. *Molecular Ecology 16(8): 1605-1624*

Study Date	n.d. (no sampling date information given)
Location	• Long point Bay (42.66°N, 80.26°W) • Various other locations – not restricted to Lake Erie
Findings/Purpose	• 4 research questions are asked: i) are spawning groups in interconnected waterways genetically separable, ii) what is the degree of isolation across and among lakes, basins and tributaries, iii) do genetic divergences correspond to geographic distances, iv) are historical colonization patterns from glacial refugia retained • Marked genetic differences between riverine and lake populations and relatively close geographic populations in rivers • On large geographic scale – isolation by distance patterns are present (weak) but are not evident at smaller scales
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

1030. Stewart, B. (2000) Relationship between ultraviolet plumage colouration and parental care in Tree Swallows (*Tachycineta □icolour*): a test of the good parent hypothesis. Honours B.Sc thesis, Queen's University, Kingston, Ontario.

Category	Birds
Source	

1031. Stewart, C.J. (1986) Nearshore morphology and collective alongshore sediment movement, Long Point, Lake Erie. M.Sc. thesis, University of Guelph, Guelph, Ontario. 167 pp.

Category	Hydrology and Sediments
Source	CWS London

1032. Stewart, C.J. and R.G.D. Davidson-Arnott (1988) Morphology, formation and migration of longshore sandwaves, Long Point, Lake Erie, Canada. *Marine Geology* 81: 63-77.

Category	Hydrology and Sediments
Source	McMaster Libraries

1033. Stewart, L. (1980) Aquatic invertebrate collection, Big Creek National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Macro-Invertebrates, Zooplankton and Phytoplankton
Source	CWS London

1034. Stewart, L. (1980) Aquatic vegetation monitoring at Big Creek National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Aquatic Vegetation
Source	CWS London

1035. Stewart, L. (1980) Road kills on the Causeway, Long Point, Ontario: September and October 1980. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Amphibians, Reptiles, Mammals
Source	CWS London

1036. Still, L. (1985) The Varden site faunal analysis: A seasonal fishing station on Long Point, Ontario. Unpublished report; Zooarchaeological Identification Centre, National Museum of Natural Sciences, Ottawa, Ontario. 84 pp.

Category	Fish

Source	CWS London

1037. Stock. N.L., F.K. Lau, D.A. Ellis, J.W. Martin, D.C.G. Muir and S.A. Mabury (2004) Polyfluorinated Telomer Alcohols and Sulfonamides in the North American Troposphere. *Environmental Science & Technology,* **38** (4), 991 –996

Category	Weather and Air Quality
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1038. Stone M., M.C. English and G. Mulammottil (1991) Sediment and nutrient transport dynamics in two tributaries of Lake Erie: A numerical model. *Hydrological Processes* 5: 371-382.

Category	Hydrology and Sediments, Water Quality/Limnology
Source	McMaster Libraries

1039. Stone M. and H. Saunderson (1992) Particle size characteristics of suspended sediment in southern Ontario rivers tributary to the Great Lakes. *Hydrological Processes* 6: 189-198.

Category	Hydrology and Sediments
Source	McMaster Libraries

1040. Stone M. and M.C. English (1993) Geochemical composition, phosphorus speciation and mass transport of fine-grained sediment in two Lake Erie tributaries. *Hydrobiologia* 253: 17-29.

Category	Hydrology and Sediments
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1041. Strauch. J.G., Jr. (1974) First Ontario specimen of the Yellow-throated Warbler. *Canadian Field Naturalist* 88: 368.

Category	Birds
Source	McMaster Libraries BSC Library

1042. Strayer, D.L., V.T. Eviner, J.M. Jeschke, and M.L. Pace (2006) Understanding the long-term effects of species invasions. *Trends in Ecology and Evolution* 21(11): 645-651.

Study Date	Review Paper
Location	• General with case information from Long Point (zebra mussel predation)
Findings/Purpose	• Reviews the ecological and evolutionary processes that moderate the affect of invasive species over time & emphasize the importance and wide-spread nature of these processes in ecosystems • Current research on invase species does not examine long term considerations – not enough temporal context • Development of successful management and predictive strategies require further research on longer time scales to understand the interaction of these impacts
Category	Invasive Species
Source	McMaster University, Thode library Available digitally from publisher at cost

1043. Sung, H., E.H. Miller, and S.P. Flemming (2005) Breeding vocalizations of the piping plover (*Charadrius melodus*): structure, diversity, and repertoire organization. *Canadian Journal of Zoology*. 83: 579–595 (2005) (note this work does not occur at long point but the methods used include the use of breeding recordings produced at Long Point in 1965).

Study Date	1998-1999 (active research)
Location	• Cape Ray Cove (Nfld) • Summit Creek (SK)

	• PEI national park
Findings/Purpose	• Soundings recorded at Long Point are included – historical data (1963) as well as other locations with older recordings • Vocalization estimates underestimate sounds made because specifically examine breeding period sounds and are biased towards loud sounds (those easily evident in recordings) • Similarities between species in acoustic traits, call types, and organization (syntax) within calls and across call types are suggested
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1044. Sweeney, R.A. (ed.) (1969) Proceedings of the Conference on Changes in the Biota of Lakes Erie and Ontario, April 16-17, 1968. *Bulletin of the Buffalo Society of Natural Science* 25(1): 1-75.

Category	Water Quality/Limnology, Fish, Macro-Invertebrates
Source	

1045. Szeicz, J.M. and G.M. MacDonald (1991) Post glacial history of oak savanna in southern Ontario. *Canadian Journal of Botany* 69(7): 1507-1519.

Category	Forests, Terrestrial Vegetation
Source	McMaster Libraries

1046. Sztramko, L. and G.C. Teleki (1977) Annual variations in the fecundity of Yellow Perch from Long Point Bay, Lake Erie. *Transactions of the American Fisheries Society.* 196(6): 578-582.

Study Date	April-May, 1974-1976
Location	• Long Point Bay
Findings/Purpose	• Fecundity decreased 1974-1975 and increased 1975-1976 • Variations may be related to a density-dependent mechanism causing a change in available fish habitat (space availability in good habitat locations) • Differences in fecundity were signicant between years of study
Category	Fish
Source	McMaster University, Thode library MNR Library – Peterborough CWS London Available digitally from publisher at cost

1047. Sztramko, L. and J.R. Paine (1984) Sport fisheries in the Canadian portion of Lake Erie and connecting waters, 1948-80. Ont. Fish. Tech. Rep. Series No. 13. 43 pp.

Study Date	1948-1980 (literature review)
Location	• Lower Detroit River, Western Lake Erie, Rondeau Bay, Long Point Bay (42°17'30''N, 81°53'30''W), Eastern Lake Erie, Upper Niagara Area
Findings/Purpose	• Summer boat, winter ice, and spring rainbow smelt fisheries are considered • Trends in changing fishery demands, use and history are discussed • Lake use and catch (species, quantity) are provided as well as original source of information
Category	Fish
Source	McMaster University, Thode library periodicals

1048. Sztramko, L. (1985) Effects of a sanctuary on the Smallmouth Bass fishery of Long Point Bay, Lake Erie. *North American Journal of Fisheries Management* 5: 233-241

Study Date	1956-1981
Location	• Long Point Bay
Findings/Purpose	• Angler success was greater during period over which sactuary was in existence (1956-1967) than following its closure

	• Could be related to pre-season harvest or reduced recruitment • No indication of exploitation stress or reduced recruitment was found
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

1049. Sztramko, L. (1988) Summer Creek Census at Long Point, Lake Erie, 1987. Ministry of Natural Resources.

Study Date	1987
Location	• Long Point
Findings/Purpose	• Quantify angling catch and harvest • Estimate angling effort and success • Determine length and age composition of harvest • Angler use characteristics • 710 anglers were contacted, 269 interviewed • 93% of anglers indicated they were seeking coho salmon with ~601 harvested • Angler success rates were between 0.002 to 0.59 fish per rod hour depending on the species • 99% of those interviewed were from Ontario, 60% of which were from Haldimand-Norfolk
Category	Fish, Land Use and Management
Source	MNR Library

1050. Tagg, N., C.P. Doncaster and D.J.Innes (2005) Resource competition between genetically varied and genetically uniform populations of Daphnia pulex (Leydig): does sexual reproduction confer a short-term ecological advantage? Biological Journal of the Linnean Society 85, 111–123.

Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1051. Taverner, P.A. and B.H. Swales (1911) Notes on the migration of the Saw-whet Owl. Auk 28: 329-334.

Study Date	1910
Location	• Long Point • Point Pelee
Findings/Purpose	• Previous works suggested that Saw-whet owls were non-migratory (several citations given) and was held as dominant opinion • Use of nets at Long Point for owl capture is discussed as a novel method • 4 migratory massings are presented in the paper with approximate timing
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1052. Taylor, T. and R. Mahon (1977) Hybridization of Cyprinus carpio and Carassius auratus, the first two exotic species in the lower Laurentian Great Lakes. *Environmental Biology of Fishes*. 1(2): 205-208

Study Date	n.d.
Location	• Long Point • Hamilton Bay
Findings/Purpose	• Carp-goldfish hybrids are often difficult to identify as they have characteristic similarities to both parents • While previous studies have indicated that hybrids are fertile, no evidence of fertility was found in this study
Category	Fish
Source	McMaster University, Thode library

	Available digitally from publisher at cost

1053. Teleki, G.C. (1973) An evaluation of the aquatic ecosystem (fisheries) on Long Point Bay, Lake Erie, relative to shoreline industrialization. Rep. No. 3, 1973. Post-construction semi-operational year. Ontario Ministry of Natural Resources, Port Dover, Ontario. 121 pp.

Category	Fish, Human Impacts
Source	CWS London

1054. Teleki, G.C. (1976) The Incidence and Effect of Once-Through Cooling on Young-of-the-Year Fishes at Long Point Bay, Lake Erie: A Preliminary Assessment In Thermal Ecology II, Proceedings of a Symposium held at Augusta Georgia April 2-5, 1975. CONF-750425, 1976. p 387-393

Study Date	June-August, 1974
Location	• Nanticoke Generating Station – LPB
Findings/Purpose	• Larval and young fish were sampled in the forebay, outfall gates and effluent channel • Use of condenser cooling systems (once-through cooling technique) exposes fish to high heat, pressure and mechanical abrasion • Operating at 25% maximum capacity, 7708-134,820 laravae of six species were entrained every 24 hours • Peak output an estimated 30,8000-539,000 fish entrained every 24 hours • At maximum capacity ~2.9% of the study-area water is removed – with it's organisms in tow • Smelt constituted 95% of the total larvae entrained • 49.5% of mortalities are due to mechanical injuries, 34.5 due to condense-passage shock • Potential loss to fisheries is 43 tonnes (based on a 1% survival rate) = 12% of the average (1972-74) annual catch
Category	Fish, Human Impacts
Source	MNR Library – Peterborough

1055. Teleki, G.C. (1976) The influence of shoreline industrialization on the fish populations in Long Point Bay, Lake Erie. Rep. No. 4; 1974 findings and 1971-1974 trends. Ontario Ministry of Natural Resources, Port Dover, Ontario. 149 pp.

Category	Human Impacts, Fish
Source	

1056. Teleki, G.C., N.G. MacLean and K. Sztramko (1977) The influence of shoreline industrialization on the fish populations in Long Point Bay, Lake Erie. Rep. No. 5; 1975 findings and 1971-1975 trends. Ontario Ministry of Natural Resources, Port Dover, Ontario. 127 pp

Category	Human Impacts, Fish
Source	

1057. Teleki, G.C. and A.J. Chamberlain (1978) Acute effects of underwater construction blasting of fishes in Long Point Bay, Lake Erie. *Journal of the Fisheries Research Board of Canada* 35: 1191-1198.

Study Date	Summer, 1975
Location	• Nearshore waters – Stelco (Nanticoke)
Findings/Purpose	• Blasts were used to deepen nearshore waters, and this study aims to examine the effects of different blast types and weights on fish species • Fish were exposed at differing distances from blasts (contained in cages) • Mortality and damage was assessed for caged fish, and mortalities of free-swimming fish was also assessed • Effects and blast type and size are presented in tables

Category	Fish, Human Impacts
Source	McMaster University, Thode library periodicals MNR Library – Peterborough CWS London

1058. Terrell, C.B (1929) More ducks for Long Point, Norfolk County, Ontario Report I, October, 1929. Unpublished Report. 11pp.

Study Date	1929
Location	• Long Point
Findings/Purpose	• Information is tailored to the further management of the area – planting potential, hunting, duck and waterfowl introduction, abundance, etc. • Provides information on the general layout of the area (pH of the ponds in the area, ponds, open water, etc.) • Waterfowl numbers are approximate values based on observations.
Category	Waterfowl
Source	MNR Library

1059. The Nature Conservancy (1995) Significant Areas of Biological Diversity in the Great Lakes Basin.

Category	Terrestrial Geography, General Wetlands
Source	

1060. Thomas, K.M. (1992) Breeding bird census #95, sedge-tamarack dune pond. *Journal of Field Ornithology* 63 (Supplement):93-94.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1061. Thomas, K.M., and M.J. Palmer (1992) Breeding bird census #104, sedge-rush swale I. *Journal of Field Ornithology* 63 (Supplement):98-99.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1062. Thomas, K.M. and M.J. Palmer (1992) Breeding bird census #105, sedge-rush swale II. *Journal of Field Ornithology* 63 (Supplement): 99-100.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1063. Thomas, R.L. and W.S. Haras (1978) Contribution of sediment and associated elements to the Great Lakes from erosion of the Canadian shoreline. PLUARG Tech. Rep., Task D, Activity 1.

Category	Hydrology and Sediments
Source	McMaster Libraries

1064. Thomas, L., Geupel, G.R., Nur, N., and G. Ballard (2004) Optimizing the allocation of count days in a migration monitoring program. *Studies in Avian Biology* No. 29: 97-111.

Category	Birds
Source	

1065. Timmerman, A.J. (1988) Assessmnet of the 1982-1986 Big Creek Walleye Transfer Project. OMNR, Simcoe District.

Study Date	1982-1987
Location	• Big Creek • LPB
Findings/Purpose	• Study purpose was to establish a self-reproducing walleye population that inhabits LPB and spwans in Big Creek

	• Aggregations of adults were found at spawning sites in 1984, 1985 and 1987 • Viable eggs were found in Big Creek in 1984, 1985 – some of which reared to hatching • No juveniles were captured (various methods attempted), although some sighting were reported • Evidence suggests that some of the transferred population has become stream resident in Big Creek
Category	Fish
Source	MNR Library

1066. Timmerman, A. J. (1989) Winter creel surveys on Inner Long Point Bay, Lake Erie, 1978-1988. Lake Erie Fisheries Assessment Unit. 29p

Study Date	1978-1988
Location	• Long Point Bay
Findings/Purpose	• Winter angler surveys at St. Williams and Port Rowan • An average 250,276 yellow perch were caught with ~188,444 harvested per year from St. Williams • Average of 30,294 were caught at Port Rowan with 21, 563 harvested at that location • Yellow perch were the target species and made up 95% of fish caught and 96% of those harvested • Angler success rate for Yellow perch were highest 1979-1984, and relatively low since 1985 • Rainbow smelt and northern pike constituted small components of total catch • Ontario residents accounted for 95-100 % of angerls interviewed
Category	Fish
Source	MNR Library

1067. Timmerman, A. J. (n.d.). The fish community of selected marshes bordering Inner Long Point Bay. Lake Erie, 1983-1985. OMNR 57pp.

Category	Fish, General Wetlands
Source	

1068. Timmermans, S.T. and G.E. Craigie (2002) The Marsh Monitoring Program 2002 Report: Monitoring Great Lakes Wetlands and their Amphibian and Bird Inhabitants. Bird Studies Canada. Unpublished report.

Study Date	Review of 2002 operations and results over 7 years of operation
Location	• Great Lakes wetlands
Findings/Purpose	• Current operations and methods are described including changes or updates to protocols • Overview of findings to date through the program, discussion of issues surrounding surveys and improvements seen since program establishment • Species information, occurrence and counts are presented where available and applicable for both birds and anurans • Provides direction for future analysis, expansion and research
Category	General Wetlands, Birds, Waterfowl, Amphibians
Source	McMaster University, Thode library periodicals

1069. Timmermans, S.T. and G.E. Craigie (2003) Great Lakes Coastal Wetlands Consortium Year-One Pilot Project Indicator Research Activities: A Technical Report by Bird Studies Canada. Unpublished report.

Study Date	2002
Location	• Great Lakes coastal wetlands
Findings/Purpose	• Investigate the coordination and applicability of the Marsh Monitoring Program with Great Lakes Coastal Wetland Consortium Great Lakes wetlands monitoring

	• Data is presented from the first pilot year of the program • 19 community attributes from marsh bird and anuran species assemblages were evaluated for their response to wetland disturbance rankings developed for 11 Long Point and 12 Lake Ontario coastal wetlands • Generally, most attributes were not able to predict site disturbance rankings, and were not consistent through communities
Category	General Wetlands, Birds, Waterfowl, Amphibians
Source	McMaster University, Thode library periodicals

1070. Todd, M.A. (1987) The foraging behaviour of a Coyote population on the Long Point National Wildlife Area, southern Ontario. M.Sc. thesis, University of Waterloo, Waterloo, Ontario. 103. 159 pp.

Category	Mammals
Source	CWS London

1071. Toms, I.D. and J.T. Planck (1981) Mammalian fauna of the Gravelly Bay and Bluff Point areas of Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario. 103 pp.

Category	Mammals
Source	CWS London

1072. Tozer, D. C., K.F. Abraham and E. Nol. (2006) Improving the accuracy of counts of wetland breeding birds at the point scale. Wetlands, 26(2): 518–527

Study Date	2000-2001
Location	• Long Point (42°35'N, 80°23'W) • Matchedash Bay (44°44'N, 79°43'W) • Peterborough (44°19'N, 78°23'W)
Findings/Purpose	• Point counts conducted in predominantly cattail-dominated wetlands to examine the influence of number of visits, point placement, and vegetation type on bird species richness and abundance • Compared performance of MMP (Marsh Monitoring Program) point counts vs flushing lines • Increasing visit count significantly increased species richess • Point placement in large wetlands (edge vs central) had no impact in large wetlands • Flushing lines detected fewer species than point counts and did not improve relative abundance of individual species
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1073. Tucker, P. (1980) Resident waterfowl survey for Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service.

Category	Waterfowl
Source	CWS London

1074. Umpherson, D.K. (1983) Waterfowl use of Duncan's Pond, Long Point National Wildlife Area, fall 1982. Unpublished report; Canadian Wildlife Service. 45 pp.

Category	Waterfowl
Source	CWS London

1075. University of Waterloo (1996) Long Point Environmental Folio: Providing Environmental , Land Use and Planning Information for People Interested in the Long Point Area. Heritage Resources Center. University of Waterloo, Waterloo, ON.

Study Date	--
Location	• Long Point
Findings/Purpose	• Online access to the 1996 Long Point Environemental Folio – All chapters • Invididual Chapters are noted in this bibliography as individual entries

	• Topics include: Human and natural history, local economies – historical and current, forests, birds, herpetofauna, mammals, waterfowl, land cover change, water quality, shoreline management and changes, climate change, land management
Category	General
Source	http://www.kwic.com/~longpointbio/Reserve/Publications/FOLIO/content/content.htm

1076. Uzarski, D.G., T.M. Burton, M.J. Cooper, J.W. Ingram and S.T.A. Timmermans (2005) Fish habitat use within and across wetland classes in coastal wetlands of the five Great Lakes: Development of a fish-based Index of Biotic Integrity. *Journal of Great Lakes Research* 31(suppl. 1): 171-187.

Study Date	2002
Location	• 61 sites throughout the lower Great Lakes (including LP)
Findings/Purpose	• Examines the importance of Great Lake, ecoregion, wetland type and plant zonation on fish community composition • Study encompasses 9 ecoregions, and 4 coastal wetland types • Plant zonation is the dominant determinent for fish community composition
Category	Fish, General Wetlands
Source	McMaster University, Thode library Available digitally from publisher at cost

1077. Val, E. and J.G. Nelson (1983) Offshore petroleum and commercial fishery interactions: The case of Long Point, Port Dover, Lake Erie. *Geo Journal* 7(3): 247-260.

Study Date	1913-1981
Location	• Long Point • Port Dover
Findings/Purpose	• Ecological, cultural, technological and policy & institutional factors are considered • Fishermen perceived negative effects of petroleum industry through equipment damage, loss of access, however overall saw the industry as beneficial • Policy makers believed the industries to be compatible – it is noted that the *ad hoc* nature of management, and lacking review process would be most detrimental from the fisherman standpoint • Recommendations are made for the continued management of these two industries while occupying similar territories
Category	Fish, Land Use and Management, Human Impacts
Source	McMaster University, Thode library Available digitally from publisher at cost

1078. Van Osch, K., K.L. Wilcox and J.G. Wilson (1997) Marine Conservation and Protection Areas: with special reference to the Great Lakes and Lake Erie. Proceedings of a workshop held at the University of Waterloo, January 10, 1997.

Category	Land Use and Management
Source	McMaster Libraries

1079. Van Meter, H.D. and M.B. Trautman (1970) An annotated list of the fishes of Lake Erie and its tributary waters exclusive of the Detroit River. *Ohio Journal of Science 70(2):65-78*

Category	Fish
Source	CWS London

1080. Van Patter, M. and S. Hilts (1985) Some Important Wetlands of Ontario South of the Precambrian Shield. Federation of Ontario Naturalists, Don Mills, Ontario. 103 pp.

Category	General Wetlands
Source	McMaster Libraries

1081. Van Velzen, W.T. (editor) (1973) Thirty-seventh Breeding Bird Census. *American Birds*

Study Date	1973
Location	• Various. Those of interest listed below. • 13 mi E of Port Rowan: 42°33' N, 80°14' W • 2 mi W of Long Point Lighthouse: 42°33' N, 80°33' W • 3.5 mi W of Long Point Lighthouse: 42°32'56'' N, 80°06'01'' W • 3.2 mi W of Long Point Lighthouse: 42°31; 30'' N, 80°07' W • 2.5 mi W of Long Point Lighthouse: 42°32'48'' N, 80°05' W • 3.2 mi W of Long Point Lighthouse: 42°32'30'' N, 80°07' W • 6.08 mi W of Long Point Lighthouse: 42°32'45'' N, 80°09'45'' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Red oak-Sugar maple forest, Tamarack-white cedar slough, White pine-white cedar forest, Dry cottonwood sand dune, Dry juniper-cottonwood savannah, sedge-rush swale, bluegrass-milkweed grassland • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1082. Van Velzen, W.T. (editor) (1974) Thirty-eighth Breeding Bird Census. *American Birds* 28: 987-1030

Study Date	1974
Location	• Various, Those of interest listed below. • 2 mi W of Long Point Lighthouse: 42°33' N, 80°33' W • 3.5 mi W of Long Point Lighthouse: 42°32'56'' N, 80°06'01'' W • 3.2 mi W of Long Point Lighthouse: 42°31; 30'' N, 80°07' W • 2.5 mi W of Long Point Lighthouse: 42°32'48'' N, 80°05' W • 3.2 mi W of Long Point Lighthouse: 42°32' N, 80°07' W • 8 mi SSE of Port Rowan: 42°35' N, 80°23' W • 3.2 mi W of Long Point Lighthouse: 42°32'30'' N, 80°07' W • 6.08 mi W of Long Point Lighthouse: 42°32'45'' N, 80°09'45'' W
Findings/Purpose	• Habitat types of interest (listed in correspondance with order of above locations): Tamarack-white cedar slough, White pine-white cedar forest, Dry cottonwood sand dune, Dry juniper-cottonwood savannah, Dune grass-cottonwood beach, Recreational dune area, sedge-rush swale, bluegrass-milkweed grassland • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1083. Van Velzen, W.T. (editor) (1975) Thirty-ninth Breeding Bird Census. *American Birds* 29: 1080-1145.

Study Date	1975
Location	• Various, Those of interest listed below. • 13 mi E of Port Rowan: 42°33' N, 80°14' W • 2 mi W of Long Point Lighthouse: 42°33' N, 80°33' W • 3.5 mi W of Long Point Lighthouse: 42°32'56'' N, 80°06'01'' W • 3.2 mi W of Long Point Lighthouse: 42°31; 30'' N, 80°07' W
Findings/Purpose	• Habitat types of interest (listed in correspondance with order of above locations): Red oak-Sugar maple forest, Tamarack-white cedar slough, White pine-white cedar forest • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and

	other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1084. Van Velzen, W.T. (editor) (1977) Thirty-eighth Breeding Bird Census. *American Birds* 28:987-1030

Study Date	1976
Location	• Various. Those of interest listed below. • 3 mi SE of Port Rowan: 42°35'40'' N, 80°23'80'' W
Findings/Purpose	• Habitat types of interest (listed in correspondance with order of above locations): Cattail Marsh • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1085. Van Velzen, W.T. (editor) (1978) Forty-First Breeding Bird Census. *American Birds*

Study Date	1977
Location	• Various. Those of interest listed below. • Concession 3, Lots 15-16, S Walsingham Twp: 42°40' N, 80°29' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Mixed Forest • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1086. Van Velzen, W.T. (editor) (1979) Forty-Second Breeding Bird Census. *American Birds*

Study Date	1978
Location	• Various. Those of interest listed below. • 5.9 mi W of LP Light House, Little Creek Ridges: 42°32' N, 80°07' W • 3.2 mi W of LP Light House, Gravelly Bay: 42°32' N, 80°07' W • 5.7 mi W of LP Light House, Little Creek Ridges: 42°33'N, 80°05' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Birch-Oak Savannah and Wetland, Dune grass-Cottonwood Beach, Sedge-Tamarack dune pond • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1087. Van Velzen, W.T. (editor) (1980) Forty-Third Breeding Bird Census. *American Birds*

Study Date	1979
Location	• Various. Those of interest listed below. • 6 mi E of LP Provincial Park, Big Rice Bay: 42°33' N, 80°16' W • 5 mi E of LP Provincial Park, Courtright Ridge: 42°33' N, 80°17' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Red oak-Sugar maple Savannah, Red oak – American Basswood Savannah • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1088. Van Velzen, W.T. (editor) (1981) Forty-fourth Breeding Bird Census. *American Birds*

Study Date	1980
Location	• Various. Those of interest listed below. • 5.9 mi W of LP Light House, Little Creek Ridges: 42°32' N, 80°07' W • 9.3 mi W of LP Light House, Little Creek Ridges: 42°33' N, 80°13' W
Findings/Purpose	• Habitat types of interest (listed in correspondence with order of above locations): Birch-Oak Savannah and Wetland, Buttonbush Swamp • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1089. Van Velzen, W.T. and A.C. Van Velzen (1982) Forty-fifth Breeding Bird Census. *American Birds* 36: 49-105

Study Date	1981
Location	• Various. Those of interest listed below. • 5 mi E of LP Provincial Park on Courtright Ridge:42°33' N, 80°17' W • 0.2 mi NE of LP Provincial Park, Big Rice Bay: 42°35' N, 80°22' W • 2 mi W of Long Point Lighthouse: 42°33' N, 80°33' W • 3.5 mi W of Long Point Lighthouse: 42°32'56'' N, 80°06'01'' W • 3.2 mi W of Long Point Lighthouse: 42°31; 30'' N, 80°07' W • 2.5 mi W of Long Point Lighthouse: 42°32'48'' N, 80°05' W • 3.2 mi W of Long Point Lighthouse: 42°32' N, 80°07' W • 8 mi SSE of Port Rowan: 42°35' N, 80°23' W • 3.2 mi W of Long Point Lighthouse: 42°32'30'' N, 80°07' W • 6.08 mi W of Long Point Lighthouse: 42°32'45'' N, 80°09'45'' W
Findings/Purpose	• Habitat types of interest (listed in correspondance with order of above locations): Red oak-American Basswood Savannah, Cattail Marsh, Tamarack-white cedar slough, White pine-white cedar forest, Dry cottonwood sand dune, Dry juniper-cottonwood savannah, Dune grass-cottonwood beach, Recreational dune area, sedge-rush swale, bluegrass-milkweed grassland • Each habitat location includes a brief description of the characteristics of the landscape, a list of breeding birds observed in the area, and other notes of interest such as nests locations, etc.
Category	Birds
Source	McMaster University, Thode library periodicals

1090. Verburg, P. (1980) Forty-third breeding bird census. Red oak-sugar maple savannah. *American Birds* 34:51.

Category	Birds
Source	McMaster Libraries

1091. Verburg, P. (1980) Forty-third breeding bird census. Red oak-American basswood savannah. American Birds 34:65.

Category	Birds
Source	McMaster Libraries

1092. Verburg, P. (1980) Forty-fourth breeding bird census: Birch – oak savannah and wetland. *American Birds 35:74*

Category	Birds
Source	McMaster Libraries

1093. Wade, P.J. (1979) Big Creek Marsh 1979: A biolimnological survey and evaluation of changes in water quality. Unpublished report to Canadian Wildlife Service, London, Ontario. 14 pp.

Category	Water Quality/Limnology

Source	CWS London

1094. Wainman, B. C., S. S. Hincks, N. K. Kaushik. And G. L. Mackie (1996) Biofilm and substrate preference in the dreissenid larvae of Lake Erie. Canadian Journal of Fisheries and Aquatic Sciences 53 (1) : 134-140

Study Date	July-August, 1993
Location	• Nanticoke
Findings/Purpose	• Larval recruitment of *Dreissena* mussels was examined by placing various treatment plates in the water and recording recruitment at the end of a 24-hr period • Living mussels, shells, and stone treatments were used both with and without biofilm • Biofilm resulted in higher recruitment rates by approximately 10-20% • Findings also show that shells (living or dead) were the preferred substrate for recruitment
Category	Macro-Invertebrates
Source	McMaster University, Thode library Available digitally from publisher at cost

1095. Walker, R.B. (1980) Road kills on the Causeway, Long Point, Ontario; 1979 and 1980. Unpublished report to Canadian Wildlife Service

Category	Amphibians, Reptiles, Mammals, Human Impacts
Source	CWS London

1096. Wallace, G.E. (1989) Gracklepox – A bander's disease. *North American Bird Bander* 14:98-99.

Category	Human Impacts
Source	

1097. Wassenaar, L.I. and K.A. Hobson (2001) A stable-isotope approach to delineate geographical catchment areas of avian migration monitoring stations in North America. Environmental Science and Technology 35 (9): 1845-1850 May 1, 2001

Study Date	1997
Location	• Long Point (42°34'N, 80°15'W) • Delta Marsh (Manitoba; 50°11'N, 98°19'W) • Sample collection from above – catchments encompass larger areas
Findings/Purpose	• Migration monitoring stations were found to be a reliable means of associating population productivity with regional conservation issues • Catchment area is determined and described for Swainson's Thrush • Age determination is also possible with technique described
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1098. Watson, N.H.F. (1974) Zooplankton of the St. Lawrence Great Lakes – species composition, distribution and abundance. *Journal of the Fisheries Research Board of Canada, 31:783-794*

Study Date	Literature Review – no field component
Location	• St. Lawrence Great Lakes – with general Lake Erie data
Findings/Purpose	• Species composition, seasonal variations, horizontal and vertical distribution patterns, biomass, and long-term changes in population are examined for each lake with comparisons between different studies • Lake Erie had the highest abundance of zooplankton and highest biomass estimates
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals

1099. Watson, N.H.F. (1976) Seasonal distribution and abundance of crustacean zooplankton in Lake Erie, 1970. *Journal of the Fisheries Research Board of Canada*. 33: 612-621.

Study Date	April-December, 1970
Location	• Lake Erie general, with some LP data
Findings/Purpose	• Species were generally short-lived with high reproduction potential • cyclopoids were dominant for much of the year (offshore centers of abundance) • Some species were found to have a population maxima in both spring and fall, others with only one maxima • Concentrations were generally highest in the west basin, lowest in the eastern basin
Category	Zooplankton and Phytoplankton
Source	McMaster University, Thode library periodicals

1100. Watson, T.G. and R.C. Anderson (1975) Seasonal changes in louse populations on White-tailed Deer (*Odocoileus virginianus*). Canadian Journal of Zoology 53: 1047-1054. Journal of Wildlife Diseases Vol. 12, January, 1976

Category	Insects, Mammals
Source	McMaster Libraries

1101. Watson, T.G. and R.C. Anderson (1984) Ixodes scapularis say on white-tailed deer (Odocoileus virginianus) from Long Point, Ontario. *Journal of Wildlife Diseases* 12, January, 1976 : 66-71

Category	Insects, Mammals
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1102. Watts, T.R. (1962) Grain size variations in the beach sands of Long Point, Lake Erie. M.Sc. thesis, Department of Geography, McMaster University, Hamilton, Ontario.

Category	Hydrology and Sediments
Source	McMaster Libraries

1103. Wei, A. (2007) Forecasting the response of coastal wetlands to declining water levels and environmental disturbances in the Great Lakes. PhD Thesis. McMaster University.

Category	General Wetlands, Water Levels
Source	McMaster Libraries

1104. Weiler, R.R. and R. MacGregor (1984) The aquatic environment of Long Point Bay in the vicinity of Nanticoke on Lake Erie 1968-1978. Nanticoke Environmental Committee. 55 pp.

Category	Water Quality/Limnology, Fish, Human Impacts
Source	CWS London

1105. Welbe, J.B. Ltd. (1983) Watershed Plan: Long Point Region Conservation Authority

Category	Land Use and Management
Source	

1106. Weller, P. (1989) Interest and Concerns of Non-Governmental Groups in the Long Point Area. A Report to the Long Point Biosphere Reserve Committee. University of Waterloo, Waterloo, Ontario.

Category	Land Use and Management
Source	

1107. Weseloh, D.V., R.B. Sutherland and M.S.W. Bradstreet (1975) Movements of Ring-billed Gulls in the lower Great Lakes. P. 12-18. IN: Long Point Bird Observatory Annual 1973 Annual Report (E.H. Dunn ed.).

Category	Birds
Source	CWS London

1108. Whillans, T.H. (1977) Fish community transformation in three bays within the lower Great Lakes. M.S. thesis, Department of Geography, University of Toronto, Toronto, Ontario. 328 pp.

Category	Fish
Source	CWS London

1109. Whillans, T.H. (1979) Response of fish communities to stress: A historical study of Inner Bay Long Point. *Contact* 11(1): 1-18.

Category	Fish
Source	McMaster Libraries

1110. Whillans, T.H. (1979) Historic transformations of fish communities in three Great Lakes bays. Journal of Great Lakes Research 5(2): 195-215.

Study Date	Early settlment – 1976
Location	• Long Point Bay • Burlington Bay • Toronto Bay
Findings/Purpose	• Changes in fish communities are considered in relation to historical changes in water level, temperature, shoreline configuration, circulation, inflow, watershed conditions, bathymetry, bottom materials, siltation, water conditions, aquatic macrophytes, plankton, benthic invertebrates, stocked fish and commercial and sport fishing • Exploitation was the most detrimental for Long Point Bay, however was not the key cause of change in the other sites examined, however some similarities in community changes do exist during various time-frames
Category	Fish
Source	McMaster University, Thode library Available digitally from publisher at cost

1111. Whillans, T.H. (1985) Related Long-term Trends in Fish and Vegetation Ecology of Long Point Bay and Marshes, Lake Erie. Ph.D. dissertation, Department of Zoology, University of Toronto, Toronto, Ontario.

Study Date	1945-1978
Location	• Inner Long Point Bay
Findings/Purpose	• Fish community is examined with respect to aquatic vegetation, water level regime and to a lesser degree – morphometric restructuring, detrital and sedimentary accumulation, fish and fishing within the Inner Bay • Provides a retrospective assessment of the fish community • Soil cores, airphotos, old observers, comparative information • Vegetation type was strongly linked to water level changes • Study found no cyclic pattern of fish response to water levels, when pooled as 'back water' and 'open water' fish taxa and abundance in five marshes over 7 years show relationship to water level • A strong relationship between fish community and vegetation community however is not clear
Category	Fish, Aquatic Vegetation, Terrestrial Vegetation, Water Levels
Source	MNR Library – Peterborough BSC Library

1112. Whillans, T., G.R. Francis, A.P. Grima, H.A. Regier, and F. Berkes (1987) Stemming a dirty tide: Long Point Bay, Lake Erie. *International Journal of Environmental Studies* 29(1): 41-52.

Study Date	Review paper – case study from existing literature
Location	• Long Point Bay
Findings/Purpose	• Developing a framework for preventative management and protection of resources within Long Point Bay

	• A long list of potential and existing threats and stresses to the area are listed and discussed • Management implications and suggestions are given with focus on resource management within the area of interest
Category	Land Use and Management, Water Quality/Limnology, Human Impacts
Source	McMaster University, Thode library Available digitally from publisher at cost

1113. Whitelaw, G. S., and Daniel D. P. McCarthy. (2006). Exploring Sustainable Development Activities for the Long Point World Biosphere. Waterloo, Ontario: Long Point World Biosphere Reserve Foundation Board.

Category	Land Use and Management
Source	

1114. Whittam, B., N. Bradstreet and G. Fairfield (1968) Thirty-second breeding-bird census: sand dunes with scattered cottonwoods. *Audubon Field Notes 22:721-722*

Findings/Purpose	See: Lineham (1968)
Category	Birds
Source	McMaster University

1115. Whittam, B. and J.D. McCracken (n.d.) Productivity and Habitat Selection of Hooded Warblers in Southern Ontario. An interim report to the Endangered Species Recovery Fund of World Wildlife Fund Canada. Year One of a Two-year Study. 42pp.

Category	Birds
Source	

1116. Whittam, R.M., J.D. McCracken, C.M. Francis, and M.E. Gartshore (2002) The effects of selective logging on nest-site selection and productivity of hooded warblers (Wilsonia citrina) in Canada Can. J. Zool. 80: 644–654 (2002)

Study Date	1999-2000
Location	• Norfolk county – Williams Crown Forest, South Walsingham Forest
Findings/Purpose	• Comparison monitoring of nesting preference between dominantly pine plantation and deciduous forest, and disturbance (selecting logging vs. no logging) • Successful nests did not differ from successful nest in any habitat combination • Selective logging to simulate natural gap creation would be a good management practice for preferential nest-site selection leaving a minimal basal mature tree cover of 12 m^2/ha
Category	Forests, Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1117. Wiancko, P.M. (1981) Environmental Design and Operation of Nanticoke Thermal Generating Station. J. Great Lakes Res. 7(2): 96-104

Study Date	~1978 (surrounding time that plans became known and the Nanticoke Environmental Committee was formed)
Location	• Nanticoke
Findings/Purpose	• Schematics and descriptions of all the major systems of the Nanticoke Generating Station (NGS) are provided • Environmental considerations are discussed including pollutant reduction mechanisms and onsite remedial actions
Category	Land Use and Management, Human Impacts
Source	McMaster University, Thode library Available digitally from publisher at cost

1118. Wiebe, J.B. (1983) Watershed Plan, Long Point Region Conservation Authority, 91pp.

Category	Land Use and Management
Source	CWS London

1119. Wilcox, D.A. (2004) Implications of hydrologic variability on the succession of plants in Great Lakes wetlands. *Aquatic Ecosystem Health and Management 7(2):* 223-231

Study Date	Review paper
Location	• Non-specific – uses various locations for examples of processes
Findings/Purpose	• Looks into the transient nature of plant communities within wetlands and how their community composition and succession is influenced by changes in hydrologic conditions • Plant response periods are considered in terms of long-term and short-term changes to plant communities
Category	Hydrology and Sediments, Aquatic Vegetation
Source	McMaster University, Thode library Available digitally from publisher at cost

1120. Wilcox, K. and R. Knapton (1994) An Ecosystem Approach to Management of an Internationally Significant Waterfowl Staging Area: Long Point's Inner Bay. Long Point Environmental Folio Publication Series – Technical Paper 5. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 31 pp.

Study Date	Review Paper & 1991-1992
Location	• LP Inner Bay
Findings/Purpose	• Relatively detailed information on the abiotic, biotic and cultural factors influencing Long Point's Inner Bay (water depth, sediments, marshes, waterfowl dietary preferences, waterfowl use, hunting, development) • Criteria are developed for assessing the significance of each factor on the quality of LPB and its management • Based on these significance ratings, priority areas are identified (Open water area, Big Creek area, North Shore of the Inner Bay) • Future research directions are suggested
Category	General Wetlands, Waterfowl, Land Use and Management
Source	BSC Library

1121. Wilcox, K. L. (1994) Planning for waterfowl in Long Point Inner Bay. MES. thesis, University of Waterloo. Waterloo, Ontario.

Study Date	1969-1988 – waterfowl data 1991-1992 – active research
Location	• Long Point Inner Bay
Findings/Purpose	• Assess Long Point's Inner Bay as a critical staging area for waterfowl • Significance and constraints for planning and managing staging waterfowl are explored • Findings indicate that different areas within the Inner Bay play different and complementary roles for waterfowl and that some areas may be of greater significance than others (food and refuge areas) • Management of the area in terms of human activity and disturbance is necessary to ensure benefit to waterfowl • Research recommendations are made
Category	Waterfowl, Land Use and Management
Source	BSC Library

1122. Wilcox K.L, and R. Knapton (1996) Waterfowl of Long Point's Inner Bay. Chapter 9: Long Point Environmental Portfolio Publication Series. Heritage Resource Centre, University of Waterloo, Waterloo, Ontario. 16pp.

Study Date	Historical ~ up to time of publication
Location	• Long Point Bay
Findings/Purpose	• Physical characteristics of LP are discussed in relation to waterfowl use • Food abundance and variety in relation to availability within long point and changes to these resources is discussed (invertebrate distribution, submergent-emergent vegetation) • Characteristics of waterfowl use of Long Point

	• Impacts on waterfowl populations – hunting, development (marina, cottage and recreational uses) • Planning considerations and management concerns are included
Category	Waterfowl, Human Impacts
Source	BSC Library Waterloo Heritage Resource Centre

1123. Wilcox, K.L. (1996) Mammals of the Long Point Area. Chapter 10: Long Point Environmental Portfolio Publication Series. Hertiage Resource Centre, University of Waterloo, Waterloo, ON. 9pp.

Study Date	Historical ~ up to time of publication
Location	• Long Point Bay
Findings/Purpose	• Historical overview of research on mammals in the LP area and reported listings of mammals known to be in the LP area (list of species is provided) • Regional, Provincial and Canadian status of listed mammals is given with both scientific and common names • A selection of provincially rare species known to occur in the area of given special attention with maps showing sighting locations and years of sightings • The impact of deer on LP is given special attention including management strategies employed
Category	Mammals
Source	BSC Library Waterloo Heritage Resource Centre

1124. Wilcox, K. L. and S. A. Petrie (2000) Monitoring *Phragmites australis* at Long Point, Ontario: Past, Present and Future. 10th International Aquatic Nuisance Species and Zebra Mussels conference. February 13-17, 2000. Toronto, Ontario.

Category	Aquatic Vegetation, Invasive Species
Source	

1125. Wilcox, K. L., and S. A. Petrie (2000) Monitoring *Phragmites australis* at Long Point, Ontario. Proceedings of the Leading Edge Conference, 6-8 October, 1999. S. Carty, S. Powell, M. Baran, and R. Murzin (eds). Burlington, Ontario, Canada. ISBN # 0-77940039-9 CD ROM.

Category	Aquatic Vegetation, Invasive Species
Source	

1126. Wilcox, K. L., and S. A. Petrie (2000) Monitoring *Phragmites australis* at Long Point, Ontario. *Waterfowl* 13(1): 15.

Category	Aquatic Vegetation, Invasive Species
Source	

1127. Wilcox, K. L. S. A. Petrie, L. A. Maynard, and S. W. Meyer (2003) Historical distribution and abundance of *Phragmites australis* at Long Point, Ontario. Journal of Great Lakes Research 29:664-680.

Study Date	1945-1999
Location	• Long Point Wetlands
Findings/Purpose	• Areas of Phragmites dominated wetland were mapped digitally from airphotos (1945-1999) • Aerial cover of Phragmites was determined through digitized vegetation boundaries, ground-truthing and using a GIS – change detection of extent • A geometric growth formula was determined • Phragmites cover fluctuated between 1945-1995, and expanded exponentially from 1995-1999 (+ ~0.5 ha yr^{-1}) • Phragmites was dominantly (28 of 30 sites investigated) of the non-native *australis* variety – study suggests that the exponential growth

	observed is due to the exotic invasion • Invasion has been exacerbated by waterlevel fluctuations, warm temperatures, anthropogenic & natural disturbances • Under global warming estimates, expansion may continue at high rates
Category	Aquatic Vegetation, Invasive Species
Source	McMaster University, Thode library Available digitally from publisher at cost

1128. Wilcox, S. (1993) The Historical Economies of the Long Point Area. Long Point Environmental Folio Publication Series - Working Paper 1. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 32 pp.

Study Date	Pre-settlement (<1780) to ~1950
Location	• LP
Findings/Purpose	• More detailed look into the historical economic development of the Long Point Bay area than is provided in Wilcox, S. (1996) The Historical Economies of the Long Point Area (Reference #1128)
Category	Land Use and Mangement
Source	BSC Library

1129. Wilcox, S. (1996) The Historical Economies of the Long Point Area. Chapter 4. Long Point Environmental Folio Publication Series. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 11 pp.

Study Date	Pre-settlement (<1780) to ~1950
Location	• LP
Findings/Purpose	• Important crops for survival or for commercial purposes as they change over time • The development of commercial fishing and hunting practices, lumber industry and agricultural expansion are all discussed briefly • Introduction of tourism and manufacturing as an industrial base • Maps and tables provide location and quantified information about these industries
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

1130. Wilcox, S. A. (1994) Local Economies of the Long Point Area. Long Point Environmental Folio Publication Series - Working Paper 5. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 43 pp.

Study Date	Recent industrialization (1950-1990s)
Location	• Long Point
Findings/Purpose	• This working paper is a more detailed investigation of local economic influence and activities in the LP area than Reference #1130 (Wilcox S.A (1996) Local Economies of the Long Point Area. • Areas of significance are identified and discussed as well as issues for planning and future research
Category	Land Use and Management
Source	BSC Library

1131. Wilcox, S. A. (1996) Local Economies of the Long Point Area. Chapter 5. Long Point Environmental Folio Publication Series. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 17pp.

Study Date	Recent industrialization (1950-1990s)
Location	• Long Point
Findings/Purpose	• Location maps and trend information is presented for a variety of major resource-based industry in the Long Point area • The discussed economies include naturalist use, both sport and commercial fisheries, hunting, tourism/cottaging, and more heavy land use activities – agriculture, manufacturing

	• Population pressures and significance of economies within the area are very briefly discussed
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

1132. Williams, J.D.M., J.M. Jaquet and R.L. Thomas (1976). Rates of accumulation of phosphorus forms in Lake Erie sediments. *Journal of the Fisheries Research Board of Canada* 33: 413-429.

Study Date	July 1971
Location	• Various in Lake Erie – 3 sites near LPB • Sample map in text
Findings/Purpose	• Phosphorous was found in three major forms: phosphorus associated with apatite, nonapatite inorganic phosphorus (NAIP), and organic phosphorus • Apatitie form was of natural, detrital origin • NAIP and organic phosphorus collected in offshore depositional areas
Category	Water Quality/Limnology, Hydrology and Sediments
Source	McMaster University, Thode library periodicals

1133. Williams, O. (1978) Long Point dead deer survey, May 1978. Unpublished report for Ontario Ministry of Natural Resources, Wildlife Research Files.

Category	Mammals
Source	CWS London

1134. Williams, O. (1979) Plant and soil samples taken from Long Point deer. Field Notes in Ontario Ministyry of Natural Resources Wildlife Research Files.

Category	Mammals
Source	CWS London

1135. Wilson, D.L. (1974) Long Point: Its Historical Geography. Honours thesis, Department of Geography, University of Western Ontario, London, Ontario.

Category	Terrestrial Geography, Land Use and Management
Source	CWS London

1136. Wilhelm, S.W., M. J. Carberry, M. L. Eldridge, L. Poorvin, M. A. Saxton, and M. A. Doblin (2006) Marine and Freshwater Cyanophages in a Laurentian Great Lake: Evidence from Infectivity Assays and Molecular Analyses of g20 Genes*. Applied and Environmental Microbiology*. 72(7): 4957-4963

Study Date	2000-2003
Location	• Lake Erie (including LPB sampling locations)
Findings/Purpose	• Investigate the occurrence of cyanophages within the Great Lakes and examine their relationship to marine cyanophages • Marine and freshwater cyanophages (found in Lake Erie) are related, however the freshwater cyanophages form a unique clade – which raises questions about their native hosts • Results suggest that freshwater cyanophages may be as important in ecologic cycle as marine cyanophages are in their own
Category	Water Quality/Limnology
Source	McMaster University, Thode library Available digitally from publisher at cost

1137. Witzel, L.D. (1985) YOY Length Criteria of Yellow Perch in Long Point Bay, 1981. Ontario Ministry of Natural Resources.

Study Date	1980-1981
Location	• Nanticoke
Findings/Purpose	• Part of the Nanticoke Fish Study (NFS) wishing to quantify the abundance of Lake Erie fish – primarily young-of-year (YOY) • Length criteria is used to differentiate between YOY and older fish

	• YOY are a major component of commercial catches, providing an effective means of testing the length characteristic • Growth rates differ between areas, such that length criterion may not suffice for all areas nor may it suffice between months as growth occurs • Study assess the impact of the differences noted above in determining YOY • Investigates use of fork length to differentiate yearlings and YOY • Study found that month to month length differences are not sufficient to warrant multiple length criteria
Category	Fish
Source	MNR Library – Peterborough

1138. Witzel, L.D (1989) A Description and Ecological Perspective of Smallmouth Bass Spawning Areas in Long Point Bay, Lake Erie, with Emphasis on Sanctuary Boundaries in Inner Bay. Ontario Ministry of Natural Resources, Port Dover, ON.

Category	Fish
Source	

1139. Wojnowski, J.K. (1993) Breeding bird census #31, Red oak-ironwood savannah. Journal of Field Ornithology 64 (Supplement):52-53.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1140. Wojnowski, J.K., and D.L. Goodyear (1993) Breeding bird census #30, red ash-red oak savannah. Journal of Field Ornithology 64 (Supplement):52.

Category	Birds
Source	McMaster University, Thode library periodicals Available digitally from publisher at cost

1141. Wood, D.J.B. (1966) Human Settlement in the Long Point Region: 1790 – 1825. MA thesis, McMaster University, Hamilton, Ontario.

Category	Land Use and Management
Source	McMaster Libraries

1142. Wood, H.A.H. (1951) Erosion on the shore of Lake Erie: Point aux Pins to Long Point. M.A. thesis, McMaster University, Hamilton, Ontario. 209 pp.

Category	Hydrology and Sediments, Water Levels
Source	McMaster Libraries

1143. Wood, H.A.H. (1960) Wave transport of beach materials on Long Point, Lake Erie. *Canadian Geographer* 16: 27-35.

Category	Hydrology and Sediments
Source	McMaster Libraries

1144. Woodford, J, D.H. Baldwin (1961) First Blue Grosbeak collected in Ontario. *Auk* 78: 97.

Study Date	May 1960
Location	• Long Point (42°34’N, 80°15’)
Findings/Purpose	• Record of the first specimen of this species taken in Ontario
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

1145. Woodford, J. and D.J.T. Hussell (1961) Construction and use of heligoland traps. *Bird-Banding* 32:125-141.

Category	Birds
Source	

1146. Woodrey, M.S. and C.R. Chandler (1997) Age-related timing of migration: Geographic and interspecific patterns. *Wilson Bulletin* 109(1): 52-67.

Study Date	1990-1991
Location	• LPBO (42°33'N, 80°10'W) • Powdermill Nature Reserve (40°10'N, 79°16'W) • Fort Morgan Peninsula (30°10'N, 88°00'W)
Findings/Purpose	• Compares age-specific differences in timing of autumn migration in 5 species of passerine at 3 locations in E-North America • 2 species showed consistent differential migration timing based on age • For the other species age-related timing varied between years and locations • Further work is suggested to better understand why some species show these characteristics
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost Free Access online: http://elibrary.unm.edu

1147. Woulfe and McKay-Kuja (1991) Long Point Biosphere Reserve – Site Basic Record (ONCDC) 9pp.

Category	General
Source	

1148. Yakutchik, T.J., and W. Lammers (1970) Water resources of the big creek drainage basin. Ontario Water Resources Commission, Division of water resources.

Category	Water Quality/Limnology, Land Use and Management
Source	McMaster Libraries

1149. Yeung, C.L. (1993) Analysis of Land Use/Land Cover Change of the Long Point Region from 1974 to 1984 Using Landsat MSS Images. Long Point Environmental Folio Publication Series - Technical Note 1. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 12 pp.

Study Date	1974-1984
Location	• Long Poing and Surrounding Area
Findings/Purpose	• Change detection of land cover using a static classification scheme (principles for developing the classification scheme are given) • A map of the outcome from the classification is given in text • Some subtle changes in land cover were noted, however no significant changes were observed during the 10 year study period • Multidate MSS data can be used to produce useful multi-year pictures of change in regional landscape structure
Category	Land Use and Management
Source	BSC Library Waterloo Heritage Resource Centre

1150. Young, C.M. (1961) The Long Point Project: Progress Report. May to September. Unpublished report to the Long Point Company. 19 pp.

Category	Land Use and Management, Waterfowl
Source	CWS London

1151. Young, C.M. (1972) A management plan for a section of the Long Point marsh. Unpublished report to Long Point Region Conservation Authority. 15 pp.

Category	Land Use and Management, General Wetlands
Source	CWS London

1152. Young, M. (1980) A Survey of the Faunal Use of the South Beach of Long Point. Unpublished report to Canadian Wildlife Service, London, Ontario.

Category	Mammals
Source	CWS London

1153. Young, M. (1980) Breeding birds in the Buttonbush Swamp – 1980. Unpublished report to Canadian Wildlife Service

Category	Birds
Source	CWS London

1154. Young, M. (1981) Forty-fourth breeding-bird census: Buttanbush swamp. *American Birds 35:98-99.*

Category	Birds
Source	McMaster Libraries

1155. Young, R.J. and R.W. Griffiths (1986) Impact of Industrial Development on the Nearshore Benthic Fauna of Lake Erie Near Nanticoke: Part 3: Ontario Hydro. Aquatic Ecostudies Limited: Ecological Research Specialists report to Ontario Ministry of the Environment.

Study Date	1969-1978
Location	• Nanticoke thermal generation station near-shore waters
Findings/Purpose	• Assess impact of the Nanticoke TGS on water quality in the nearshore areas • No pollution related changes in the taxonomic or functional organization of the benthic invertebrate community was observed • No significant change in the seasonal distribution of major taxonomic and functional groups occurred during the study period • Conclusion: no significant negative impact on water quality as reflected by the benthic invertebrate community in LPB
Category	Human Impacts, Fish, Zooplankton and Phytoplankton, Macro-Invertebrates
Source	MNR Library – Peterborough

1156. Young, R.J. and R.W. Griffiths (1987) Impact of Industrial Development on the Nearshore Benthic Fauna of Lake Erie Near Nanticoke: Part 2: Stelco. Aquatic Ecostudies Limited: Ecological Research Specialists report to Ontario Ministry of the Environment.

Study Date	1978-1983
Location	• Stelco, Nanticoke
Findings/Purpose	• Assess the impact of Stelco effluent on water quality of the Nanticoke area of Long Point Bay • No pollution related changes of the benthic invertebrate community was observed • No significant changes to the taxonomic and functional groups occurred during the study period • Conclusion: Stelco's effluent did not have any significant negative effect on the water quality indicated through the benthic community of LPB
Category	Human Impacts, Fish, Zooplankton and Phytoplankton, Water Quality/Limnology
Source	MNR Library – Peterborough

1157. Zammit, A.E. (1994) A Preliminary Bibliography for the Herpetofauna of Ontario, with Special Emphasis on Long Point and the North Shore of Lake Erie. Long Point Environmental Folio Publication Series - Technical Note 3. Heritage Resources Centre, University of Waterloo, Waterloo, Ontario. 26 pp.

Study Date	Review
Location	• LP specific references
Findings/Purpose	• Contains a list of categories (with descriptions) into which references fall (e.g. Introducing Canadian Herpetofauna, Parasitism, Mortality, etc.) • Current issues in research are briefly described

	• A preliminary list of species and sub-species is given for the LP area • A preliminary bibliography is given based on the described categories – good reference for further research
Category	Amphibians, Reptiles
Source	BSC Library

1158. Zammit, A.E. (1996) The Herpetofauna of Ontario, with Special Emphasis on Long Point and the North Shore of Lake Erie. Chapter 11: Long Point Environmental Folio Publication Series. Heritage Resource Centre, University of Waterloo, Waterloo, Ontario.

Study Date	Historical ~ up to time of publication
Location	• Ontario with focus on Long Point
Findings/Purpose	• Background of herpetology, amphibians and their relatives • Definitions of the various status ratings of animals in Canada • Provides a short list of amphibians and reptiles that are in need of special conservation efforts (Fowler's Toad, Spiny Softshell turtle, Eastern Hognose Snake, Black Rat Snake, Eastern Fox Snake, Spotted Turtle) • A list of known herps is given in table with species abundance rankings • Provides distribution maps for several species
Category	Amphibians, Reptiles
Source	BSC Library Waterloo Heritage Resource Centre

1159. Zimmerling, J.R., E. Craigie, and A.E. Robinson (2004) A Comparison of Techniques for Marking Passerine Nestlings. *Wilson Bulletin* 116(3):240–245

Study Date	2001-2002
Location	• Arnprior • Long Point (42°34'N, 80°25'W)
Findings/Purpose	• Investigate the success and use of various marking techniques: coloured polishes, coloured bands of different kinds, stains and superciliary down clipping • Superciliary down clipping was the fastest in application and was the most effective, however is only applicable to new hatchlings with this down • Other methods were also easily applied, but did not last through nesting period
Category	Birds
Source	McMaster University, Thode library Available digitally from publisher at cost

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Wave exposure and hydrologic connectivity create diversity in habitat and zooplankton assemblages at nearshore Long Point Bay, Lake Erie

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ABSTRACT

During an 11-day period in August 2008, we visited 102 sites along the nearshore (~60 km) of Long Point Bay. The purpose of our study was to evaluate the effects of wave exposure and hydrologic connectivity on zooplankton distributions. Long Point is located within the UNESCO Long Point Biosphere Reserve (26,250 ha) and encompasses the largest wetland complex in the Great Lakes system. We sampled for zooplankton, aquatic vegetation, temperature, specific conductance, pH, dissolved oxygen, dissolved organic carbon, water clarity, total nitrogen and depth. We evaluated the impacts of exposure using wind and fetch data to calculate a Relative Exposure Index (REI). Ordination techniques revealed a large variation in physical disturbance, water clarity, nutrient concentrations, water chemistry and aquatic vegetation that explained the distribution pattern of zooplankton at the 102 sites. Gradients of REI are strongly positively correlated with environmental variables, such as pH, dissolved oxygen and temperature and highly negatively correlated with conductivity and dissolved organic carbon. Visual inspection of the ordination site scores revealed the 102 sites clustering into six main groups based on spatial location and degree of surface-water connectivity to Long Point Bay. Sheltered sites (low REI) have much higher abundance of zooplankton whereas sites that have high REI scores are characterized by relatively low zooplankton abundance with a high prevalence of *Polyarthra* sp. This is the largest study on the distribution pattern of zooplankton in Long Point Bay, and it highlights the importance of wave exposure and hydrologic connectivity in structuring the zooplankton community.

Introduction

Zooplankton live in a three-dimensional environment where they must forage for food, reproduce and escape predation, often within a very localized setting. In shallow areas along the lakeshore, these settings can be windswept, open water or quiescent with dense floating, emergent and submergent vegetation. Such habitats can be highly variable with respect to physical and chemical characteristics. Zooplankton that are distributed in these littoral habitats are largely governed by their tolerances and preferences for environmental variables such as dissolved oxygen (Stenson, 1983), temperature (Edmondson, 1965; Stenson, 1983), dissolved organic carbon (Strecker et al., 2008) and wind and wave action (Cardinale et al., 1998). Their distribution can also be influenced by the presence of aquatic vegetation. Research has shown that zooplankton biomass and diversity tend to be higher in vegetated environments (Pennak, 1966; Schriver et al., 1995), where cladocerans and copepods escape predation from fish (Duggan, 2001; Timms and Moss, 1984), where sessile rotifers and cladocerans find substrate (Edmondson, 1944; Fairchild, 1981) and where many zooplankton (e.g. chydoridae) feed on epiphytic algae that grow on macrophytes (Duggan, 2001; Fryer, 1968).

Within the Laurentian Great Lakes basin, studies that examine factors governing the distribution of zooplankton have been conducted at two spatial scales. At the large regional scale, synoptic surveys have been conducted over hundreds of sites across the Great Lakes and have confirmed trends in zooplankton distributions that are associated with gradients in turbidity and nutrients, often related to human disturbance (e.g. Lougheed and Chow-Fraser, 2002; Patalas, 1972; Watson and Wilson, 1978). At the local scale, focused studies conducted at a single wetland have demonstrated that site-to-site variation in zooplankton abundances can be related to differences in the plant community and distance from point-source pollution (Krieger and Klarer, 1991; Lougheed and Chow-Fraser, 1998; Thomasen and Chow-Fraser, 2012). Lake-wide patterns offer important information on general trends and patterns; however at this large scale, information specific to smaller areas is lost. Studies focused on specific wetlands reveal trends and patterns on a finer scale, but fail to address what is occurring among wetlands. To address this knowledge gap we have chosen an ecosystem which provides the unique opportunity to study specific wetland complexes as well as the adjoining nearshore area. This allowed us to analyze sites with varying levels of exposure, while reducing the effects of

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confounding factors that arise across large basins, such as climate effects.

No study has demonstrated the importance of physical turbulence (wind and wave action) in structuring the rotifer community and very few have examined this effect on the cladoceran community (e.g. Cardinale et al., 1998), presumably because of the overriding influence of other factors. One reason for this may be related to the scale used in the previous studies. In this paper, we show how a strategic sampling program conducted at an appropriate scale can be used to evaluate the influence of wave exposure and hydrologic connectivity on zooplankton distributions. We hypothesize that in sites receiving low levels of human-induced disturbance, variation in physico-chemical characteristics induced by wind and wave exposure can be as important a structuring variable as nutrients and macrophytes.

Methods

Site description

We conducted our study at Long Point Bay, a large embayment located in north central Lake Erie. The Long Point area (26,250 ha) has been designated as a UNESCO Biosphere Reserve due to its many habitat types (e.g. marsh, undisturbed sand dunes, grassy ridges) supporting high biodiversity of flora and fauna. Its sports fishery is considered the best in Lake Erie (Nelson and Wilcox, 1996). Recreational use of the marsh is primarily fishing, but also includes waterfowl hunting, nature-viewing, and water-based activities such as canoeing and swimming (Kreutzwiser, 1981). The bay and surrounding marsh provide important resources for migratory waterfowl (Leach, 1981; Nelson and Wilcox, 1996; Prince et al., 1992) because of the good water quality (Leach, 1981) and abundant aquatic vegetation (Herdendorf, 1992; Knapton and Petrie, 1999). The Long Point Marsh complex experiences relatively low levels of human impact and as such is considered a reference site for Lake Erie (Chow-Fraser, 2006; Lougheed and Chow-Fraser, 2002). The biotic community of this ecosystem has been examined extensively, including studies on fish, marsh birds and waterfowl (see a list of projects at http://www.longpointbiosphere.com), but data on the zooplankton community do not exist for the nearshore area. In order to understand the current health and stressors of this ecosystem to guide future management direction, the Ontario Ministry of Natural Resources (OMNR) began a large-scale comprehensive survey of the entire food web in Long Point Bay (Long Point Bay Assessment (LPBA)), funded in part by the Canada-Ontario Agreement respecting the Great Lakes Basin Ecosystem.

The 102 sites in this study are part of the LPBA. Sites were selected by the OMNR to represent thorough coverage of the nearshore system, with historical sites and suitability for fish sampling with beach seines taken into consideration. The sites were located throughout Long Point Bay, extending from the southern shore (Bouck's Creek) to the northern shore (Turkey Point Marsh), and included 27 interior coastal wetland sites within Crown Marsh (Fig. 1). Fifteen of the Crown Marsh sites have no surface water connection with the bay, having been excavated and enclosed by berms several years ago (designated PDN — "ponds not connected"). The other twelve sites are still hydrologically connected to Long Point Bay via boat channels that are maintained by dredging (designated PD — "ponds connected"). All sites were sampled for water characteristics, zooplankton and aquatic macrophyte species richness and composition between August 11 and 21, 2008.

Sampling design

We used a hand-held Global Positioning System unit (GPS; Garmin GPSmap76; accuracy of 10 m) to georeference all sites. We sampled for nine physico-chemical variables and analyzed all water samples in triplicate. Water temperature (TEMP), dissolved oxygen (DO), specific conductance (COND), and pH were measured with a hand-held YSI™ 600 QS multi-parameter monitoring unit (YSI, Yellow Springs, Ohio). We collected water samples (1-L capacity) in polyethylene bottles at 20-cm depth for analysis of total nitrite–nitrate nitrogen (TNN), total suspended solids (TSS), dissolved organic carbon (DOC) and chlorophyll *a* (CHL). Subsamples were poured into100-ml polypropylene bottles and preserved with 50% sulfuric acid for later analysis of total Kjeldahl nitrogen (TKN). Total nitrogen (TN) was determined as the sum of TKN and TNN. TNN, TSS, DOC and TKN samples were immediately placed in coolers with ice and then transported on the same day to a walk-in cooler (4 °C). Within one week of collection, samples were

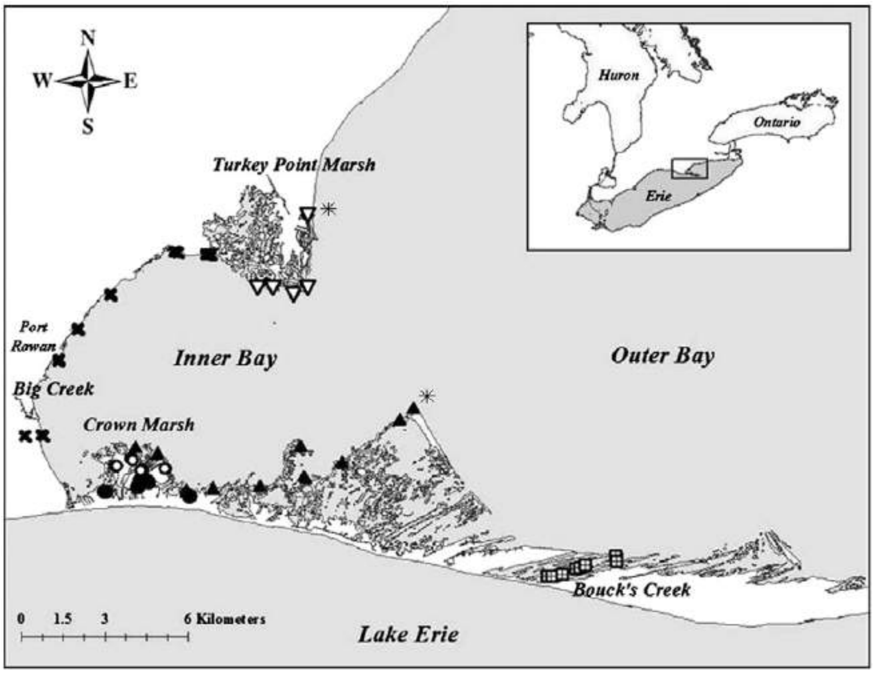

Fig. 1. Location of study sites sampled in August 2008 at Long Point Bay, Lake Erie. Symbols correspond to habitat groupings TP — Turkey Point (▽), WS — West Shore (X), PDN — Ponds Not Connected (●), PD — Ponds Connected (○), SS — South Shore (▲) and CC — Bouck's Creek (⊞). Asterisk (*) indicates sites without any vegetation.

transported on ice to E3 Laboratories Inc. (Niagara-on-the-Lake, ON) and analyzed following standard procedures. CHL water samples were stored in a dark cooler with ice. All CHL samples were processed within 8 h of collection with a vacuum pump and a glass filter unit. Each replicate water sample per sampling point was filtered using a Whatman GF/C glass fiber filter, labeled and combined into a sealed plastic bag with silica gel. Between samples, the filter unit was rinsed three times with distilled water. All filters were stored at −20 °C until analysis at the OMNR's Lake Erie Management Unit laboratory located in Wheatley, ON. Since the DO and TEMP data were collected at different times over the 11-day sampling period, we screened the data to ensure that different measurements at each site were not confounded by differences in air temperature and the hour at which they had been sampled. We did not detect any confoundments.

We assessed the aquatic macrophyte community within 15 1-m^2 randomly distributed quadrats extending from the shoreline out and enclosing the water and zooplankton sampling station. All macrophytes within this grid were identified and ranked for abundance according to a coarse scale: dense (~70–100% coverage); common (~20–60% coverage) and sparse (~1–15% coverage). Voucher samples were collected when samples could not be identified in the field. In plots with both emergent and submergent taxa, percent coverage was estimated separately above and below the water surface. Scientific nomenclature followed Crow and Hellquist (2000) and Gleason and Cronquist (1991).

We sampled for zooplankton at the same time and place of water sample collection. All samples were collected from mid-depth with a 5-L Schindler–Patalas trap, filtered through 63-μm Nitex mesh, backwashed into 60-mL bottles and immediately preserved in 4% sugar formalin. We collected one sample at each site. Organisms were identified, enumerated and measured with a dissection microscope at 40×-magnification. A light microscope at 200–400× magnification aided initial identification. When samples were dense, a stratified sampling approach was applied, where at least 100 individuals of the dominant species were counted, and the entire sample was scanned for rare and large organisms. Copepods were categorized as adult, copepodid or nauplii. Adult copepods were identified to order (cyclopoid, harpacticoid, calanoid). Cladocera and Rotifera were identified to genus or species. Rotifer identification was based on Stemberger (1979) and crustacean identification was based on Pennak (1989).

Quantifying wind and wave action

We refer to the potential effects of wind and wave action as exposure and have modified the Relative Exposure Index (REI), developed by Keddy (1982) in order to quantify these potential effects at each site. The REI is calculated using the following equation:

$$REI = \sum_{i=1}^{12} (V_i \times P_i \times F_i) \quad (1)$$

where *i* is the *i*th compass heading (1 to 12), *V* is the average monthly wind speed (m s^{-1}), *P* is the percent frequency with which wind occurred from the *i*th direction, and *F* is fetch (m). Wind speed and direction were obtained from the Environment Canada weather station located at Long Point. Keddy (1982) found that although the magnitude of the index changed according to the months from which wind data were used, the relative difference did not change. Thus, we calculated the index based on the growing season (May–September) since this is the period of time that we are most interested in. We calculated effective fetch (*F*) using high-resolution (30-cm) imagery from the Southwestern Ontario Orthophotography Project (SWOOP) collected during the leaf-off season of 2006 using ArcView 9.2, measuring the straight-line distance from each site to the nearest shoreline.

Statistical methods

Before carrying out parametric analyses to explore relationships in the dataset, we used SAS JMP software (Version 7.0.1, SAS Institute Inc., Cary, North Carolina, USA) to transform the data using either a least-squares method (Log_{10} $[(X+X_{mean})/X_{Std\ dev}+1]$) or log-transformation (Log_{10} $(X+1)$) in order to reduce the effects of outliers (Lougheed and Chow-Fraser, 2002). For our first ordination technique, we conducted a Principal Components Analysis (PCA; JMP 7.0.1 software). This technique finds the strongest linear correlation structure among the physico-chemical variables (Table 1) and extracts synthetic axes that best explain variation in the dataset (McCune and Grace, 2002). Only axes with an eigenvalue greater than one were retained for further analysis. We interpreted the principal component (PC) axes by using Spearman correlation (JMP 7.0.1 software) to examine the strength of the relationships between the physico-chemical variables and each retained PC axis.

During preliminary analyses of the environmental (physico-chemical and macrophyte) and zooplankton data we determined that the more common method of canonical correspondence analysis (CCA) was inappropriate because the dataset does not have the required unimodal distribution (McCune and Grace, 2002) and analysis required the application of canonical correlation (CANCOR; PASW Statistics 18, IBM software, Chicago, Illinois, USA) instead. This method maximizes the linear relationship between environmental data and zooplankton abundances by finding linear combinations of these variables that have the highest possible between-set correlations (Tabachnick and Fidell, 2007). During initial screening various physico-chemical descriptors (Table 1) and terms describing the macrophyte community (Table 2) were evaluated for their effectiveness. The final form of environmental variables used in these analyses was determined to be the best descriptor based on their loadings in the final and preliminary ordination analyses. The environmental variables were transformed using least-squares to reduce the effects of outliers when necessary. The zooplankton dataset consists of 45 taxa abundances (listed in Table 3) log-transformed to reduce the effects of outliers. In order to interpret the canonical variates, we examined the cross loadings of the environmental variables and the zooplankton species. Redundancy analysis (PASW 18) quantified the amount of variance that the canonical variates of the environmental variables extracted from the zooplankton species, and vice versa.

In order to further assess trends in zooplankton distribution we classified the cladoceran and rotifer taxa based on their habitat preference and functional feeding group (Table 3). Habitat preferences were grouped according to those that favored 1) vegetation, 2) open-water, 3) no strong preference for either, and 4) benthos, based on the following studies: Duggan (2001), Duggan et al. (2001), Fairchild (1981), Fryer (1974), Paterson (1993), Pejler (1962), Pejler and Bērziņš (1994) and Pennak (1966). Feeding groups were classified as being raptorial, planktonic, scraper, or mechanical according to information from Fairchild (1981), Fryer (1968, 1974), Obertegger et al. (2011), Paterson (1993), and Smith (2001). Macrothricidae were the only zooplankton in this study classified as benthic and mechanical feeders; however, due to

Table 1
Description of the physico-chemical variables at 102 sites along the shoreline of Long Point Bay, based on sampling conducted during August 2008.

Environmental variable	Abbreviation	Mean ± SE	Range
Temperature (°C)	TEMP	22.72 ± 0.24	17.42–26.92
Conductivity (μS/cm)	COND	318.38 ± 7.03	240–567
pH	pH	8.22 ± 0.06	7.09–9.65
Dissolved oxygen (mg/L)	DO	8.61 ± 0.34	0.22–16.20
Dissolved organic carbon (mg/L)	DOC	7.17 ± 0.30	2.9–15.5
Total suspended solids (mg/L)	TSS	7.65 ± 1.23	0–101
Total nitrogen (μg/L)	TN	783.17 ± 49.81	300–3190
Chlorophyll *a* (μg/L)	CHL	2.93 ± 0.40	0.77–24.09
Depth (m)	DEPTH	0.72 ± 0.02	0.3–1.9
Relative Exposure Index	REI	$5.9\times10^6 \pm 6.5\times10^5$	$0–2.4\times10^7$

Table 2
Macrophyte species detected at 102 sites along the shoreline of Long Point Bay, based on sampling conducted during August 2008. Asterisk indicates non-native species.

Scientific name	Common name	% occurrence
Floating		
*Hydrocharis morsus-ranae**	Frogbit	9
Nelumbo lutea	Yellow water lotus	2
Nuphar variegatum	Yellow pond lily	9
Nymphaea odorata	Fragrant white water lily	25
Potamogeton natans	Floating pondweed	27
Emergent		
Eleocharis smallii	Marsh spikerush	2
Juncus sp.	Rush	1
Phragmites australis subsp. *americanus**	Common reed	1
Pontederia cordata	Pickerelweed	1
Schoenoplectus acutus	Hardstem bulrush	17
Schoenoplectus cyperinus	Woolgrass	2
Schoenoplectus pungens	Common three-square	5
Schoenoplectus tabernaemontani	Soft-stem bulrush	2
Sagittaria latifolia	Broad-leaved arrrowhead	2
Sagittaria rigida	Stiff arrowhead	10
Sparganium eurycarpum	Large-fruited burreed	6
*Typha angustifolia**	Narrow-leaved cattail	7
Typha latifolia	Common cattail	1
Zizania aquatica	Southern wild rice	31
Submergent		
Callitriche verna	Common water-starwort	8
Ceratophyllum demersum	Coontail	10
Chara spp.	Stonewort	74
Elodea canadensis	Common waterweed	24
v*Megalodonta beckii*	Water marigold	5
Myriophyllym exalbescens	Northern water milfoil	3
*Myriophyllum spicatum**	Eurasian water milfoil	23
Myriophyllum sp.	Milfoil	5
Myriophyllum verticillatum	Bracted water milfoil	14
Najas flexilis	Slender naiad	6
Nitella spp.	Nitella	34
Potamogeton amplifolius	Bigleaf pondweed	3
Potamogeton epihydrous	Leafy pondweed	1
Potamogeton gramineus	Variable pondweed	3
Potamogeton pectinatus	Sago pondweed	24
Potamogeton zosteriformis	Flat-stemmed pondweed	2
Utricularia pusilla	Tiny bladderwort	1
Utricularia vulgaris	Common bladderwort	23
Vallisneria americana	Wild celery	33

Table 3
Common zooplankton species detected at 102 sites along the shoreline of Long Point Bay, based on sampling conducted during August 2008. Species that occurred at less than 5% of sites are not listed. Dash (–) indicates the zooplankton could not be classified.

Code	Species	Habitat preference[a]	Feeding classification[b]	% occurrence	Mean density (#/L)
Cladoceran					
ACHA	*Acroperus harpae*	Vegetation	Scraper	59	5.9
AL	*Alona* sp.	Vegetation	Scraper	27	2.6
AO	*Alonella* sp.	Vegetation	Scraper	5	0.9
BOLO	*Bosmina longirostris*	Generalist	Planktonic	85	19.6
BUSE	*Bunops serricaudata*	Benthic	Mechanical	13	10.9
CE	*Ceriodaphnia* sp.	Generalist	Planktonic	78	10.9
CH	*Chydorus* sp.	Vegetation	Scraper	51	4.5
CM	*Camptocercus* sp.	Vegetation	Scraper	6	0.5
DIBI	*Diaphanosoma birgei*	Generalist	Planktonic	4	2.6
DIBR	*Diaphanosoma brachyurum*	Open-water	Planktonic	47	2.2
EHRO	*Echinisca rosea*	Benthic	Mechanical	10	4.3
ER	*Eurycercus* sp.	Vegetation	Scraper	7	0.5
EU	*Eubosmina* sp.	Generalist	Planktonic	6	0.7
GR	*Graptoleberis* sp.	Vegetation	Scraper	6	0.7
OPGR	*Ophryoxus gracilis*	Vegetation	Scraper	5	0.5
PE	*Pleuroxus* sp.	Vegetation	Scraper	19	8.3
SA	*Scapholeberis* sp.	Generalist	Planktonic	6	5.7
SICR	*Sida crystallina*	Vegetation	Planktonic	7	1.5
SM	*Simocephalus* sp.	Vegetation	Planktonic	13	8.7
Rotifer					
AP	*Asplanchna* sp.	Generalist	Raptorial	19	1.4
AS	*Ascomorpha* sp.	Vegetation	Raptorial	32	1.9
CO	*Collotheca* sp.	Vegetation	Raptorial	22	7.9
EC	*Euchlanis* sp.	Vegetation	Planktonic	75	8.3
FIBR	*Filinia brachiata*	Open-water	Planktonic	75	77.3
KELO	*Kellicotia longispina*	Open-water	Planktonic	12	0.2
KR	*Keratella* sp.	Generalist	Planktonic	69	13.9
LE	*Lecane* sp.	Vegetation	Planktonic	100	2.6
MA	*Macrochaetus* sp.	Generalist	Planktonic	26	1.6
MO	*Monostyla*	Vegetation	Planktonic	65	2.2
MY	*Mytilina* sp.	Vegetation	Planktonic	11	1.2
NO	*Notommata* sp.	Vegetation	Raptorial	8	0.5
PLPA	*Platyias patulus*	Vegetation	Planktonic	30	5.5
PO	*Ploesoma* sp.	Generalist	Raptorial	12	1.0
PY	*Polyarthra* sp.	Generalist	Raptorial	82	16.2
SC	*Scaridium* sp.	Vegetation	Raptorial	5	1.4
TR	*Trichocerca* sp.	Vegetation	Raptorial	58	1.1
TT	*Trichotria* sp.	Vegetation	Planktonic	17	0.5
Copepod					
CA	Calanoid	–	–	42	6.3
CP	Copepodid	–	–	83	12.9
CY	Cyclopoid	–	–	78	20.9
HA	Harpacticoid	–	–	32	3.4
NA	Nauplius	–	–	100	63.8

[a] Duggan (2001), Duggan et al. (2001), Fairchild (1981), Fryer (1974), Paterson (1993), Pejler (1962), Pejler and Bērziņš (1994), Pennak (1966).
[b] Fairchild (1981), Fryer (1968, 1974), Obertegger et al. (2011), Paterson (1993), Smith (2001).

their low occurrence they were excluded from further analyses. Sites were grouped into six habitat groups based on geographic location and degree of surface water connection: TP (Turkey Point), WS (west shore), PDN (ponds not connected), PD (ponds connected), SS (south shore) and CC (Bouck's Creek) (sites are shown in Fig. 1). Differences among the six habitat groupings between mean zooplankton biomass for each of the three types of habitat preference (vegetation, open-water, generalist) and three feeding types (raptorial, planktonic, scrapers) were determined with one-way ANOVA and a post-hoc Tukey–Kramer test using JMP 7.0.1 software. We estimated dry-weights (biomass) by applying appropriate length–weight regression equations compiled by Lougheed and Chow-Fraser (1998). The biomass was log-transformed in order to reduce the effects of outliers.

Results

Environmental variables

All of the physico-chemical variables we measured showed large variation among the 102 sites (Table 1). Currently, Long Point is predominantly an alkaline system, with only a few interior sites that are circumneutral (see Fig. 2A). Oxygen levels ranged from anoxic to supersaturated, but most sites were well-oxygenated (mean for 102 sites was 8.6 mg L^{-1}; Fig. 2B). Despite the order-of-magnitude variation in both TN and CHL values, Long Point is primarily oligotrophic with mean values of 0.78 mg L^{-1} and 2.9 μg L^{-1}, respectively (Table 1). Conductivity ranged widely from 240 to 567 μS cm^{-1}, with sites further inland having highest values (Fig. 2C). All sites were less than 2-m deep (Table 1) and the degree of exposure varied from completely protected to relatively exposed (REI of 0–2.4×10^7; Fig. 2D).

A PCA of physico-chemical variables (listed in Table 1) yielded three axes with eigenvalues greater than one, together explaining 76.3% of the variation in the dataset (Table 4). PC1 explained 45.7% of the variation in the dataset, and showed strong positive correlations with REI, pH, DO and TEMP, and strong negative correlations with COND, TN and DOC (Table 4). PC2 explained an additional 19.8% of the variation and was highly positively correlated with TSS, CHL, pH, DEPTH and REI, and was negatively correlated with DOC and COND. PC3 explained

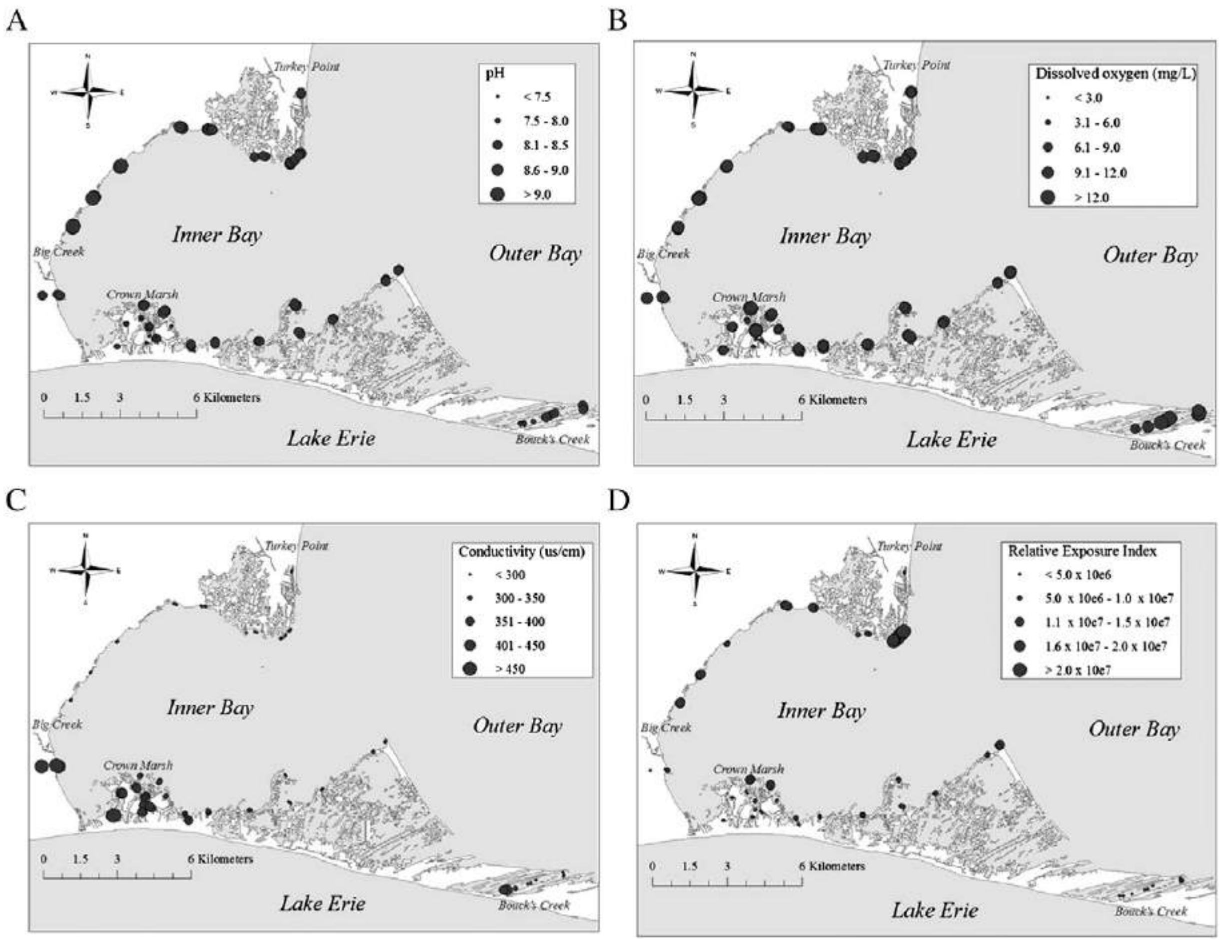

Fig. 2. Map showing A) pH, B) dissolved oxygen, C) conductivity, and D) Relative Exposure Index scores recorded during this study along the nearshore of Long Point Bay.

an additional 10.8% of variation and was strongly positively correlated with DEPTH and negatively correlated with COND. PC1 represents a gradient from highly exposed, alkaline, well-oxygenated, warm water to high COND and high concentrations of TN and DOC. PC2 represents a gradient from deep sites with low water clarity to shallower sites with higher water clarity.

Of the 102 sites, only five did not have any vegetation; in the remaining 97 sites, we identified 39 taxa of aquatic macrophytes (see Fig. 1; Table 2). Submergent taxa were the dominant growth form,

Table 4
Summary of Spearman's rank correlations between environmental variables and the first three principal components (PC) axes ($n = 102$). Only results with $p<0.05$ are shown. Environmental variables associated with the abbreviations are given in Table 1.

Axis	Variance explained (%)	Abbreviated variable	Spearman's rho (ρ)	p-Value
PC1	45.7	REI	0.85	<0.001
		pH	0.84	<0.001
		COND	−0.76	<0.001
		TN	−0.74	<0.001
		DOC	−0.68	<0.001
		DO	0.67	<0.001
		TEMP	0.67	<0.001
PC2	19.8	TSS	0.82	<0.001
		CHL	0.73	<0.001
		DOC	−0.62	<0.001
		pH	0.45	<0.001
		DEPTH	0.37	<0.001
		REI	0.36	<0.001
		COND	−0.34	<0.001
PC3	10.8	DEPTH	0.88	<0.001
		COND	−0.19	0.040

occurring in 91% of all 102 sites. *Chara* spp. (stonewort) was the most common submergent taxa and was detected at 74% of our sites, providing >20% cover in 51 sites. Other common submergent taxa present in our surveys included *Elodea canadensis* (common waterweed), *Nitella* spp., *Potamogeton pectinatus* (sago pondweed), *Utricularis vulgaris* (common bladderwort), *Vallisneria americana* (wild celery) and the non-native species *Myriophyllum spicatum* (Eurasian water milfoil). These taxa were detected at 23–34% of the sites and primarily provided sparse (1–15%) coverage. *Zizania aquatica* (southern wild rice) was the dominant emergent species, providing more than 20% coverage at 12 sites and sparse coverage at additional 20 sites. *Schoenoplectus acutus* (hardstem bulrush) and *Sagittaria rigida* (stiff arrowhead) were less common (17% and 10% occurrence, Table 2), providing only sparse coverage. The most common floating taxa were *Nymphaea odorata* (fragrant white water lily) and *Potamogeton natans* (floating pondweed) which occurred in 25% and 27% of sites, respectively (Table 2). Both species provided sparse coverage, except for 12 sites where white water lily covered at least 20% of the sample quadrats.

Zooplankton and environmental variables

In total we identified 89 zooplankton taxa: 55 rotifers, 29 cladocerans and 3 copepods. Table 3 summarizes characteristics of the zooplankton detected in our surveys. The most common zooplankton were nauplii (mean density 64 L^{-1}) and *Lecane* sp. (rotifer, mean density 3 L^{-1}), which were found at every site (Table 3). The cladoceran *Bosmina longirostris* was also very common, occurring at all but 15 sites with a mean density of 20 L^{-1}. Common rotifers included *Polyarthra* sp., *Euchlanis* sp. and *Filinia brachiata*, which were detected at 75–82% of all sites (Table 3). *Filina brachiata* had the highest density of any rotifer or cladoceran in this study (mean 77 L^{-1}, density 1495 L^{-1}). Common cladocerans included *Ceriodaphnia* sp., *Diaphanosoma brachyurum*, and members of the chydoridae family (*Acroperus harpae* and *Chydorus* sp.). Cyclopoid copepods (78% occurrence) were more prevalent than either calanoid (42%) or harpacticoid (32%) copepods (Table 3).

The Canonical Correlation Analysis (CANCOR) determined the best linear combinations of the ten physico-chemical variables (listed in Table 1) and four macrophyte variables (total macrophyte richness — Tot#PL, submergent species richness — #SUB, floating species richness — #FL, and emergent species richness — #EM) that described variation in zooplankton abundances across the 102 sites (listed in Table 3). The CANCOR yielded five axes that were significantly different from zero. The correlations among the first five synthetic variates ranged from 0.85 to 0.98, with 71–95% of over-lapping variance between the variates (Table 5). The first five canonical variates extracted 58% of the variance from the environmental variables and 28% from the species. Along the first five variates, 24% variance in the species dataset is predicted by the variance in the environmental dataset. The environmental dataset extracted two to three times more variance than the species dataset along the first two variates. The first two variates explained the largest proportion of redundancy for both the environmental variables (0.503, 0.160, Table 5) and the species (0.331, 0.161, Table 5). Despite the large value of the third canonical correlation (0.905), the third canonical variates extracted only a small amount of variance (4% environmental and species, Table 5). The remaining axes explained very little of the remaining variation in the datasets.

To interpret the canonical variates, we examined the canonical loadings of the environmental variables and the species abundances (Fig. 3A). In the figure, we only display species abundances greater than 0.25 to decrease the background noise. The macrophyte community variables were associated with lower loadings than the physico-chemical variables. The loadings contributing to water clarity (TSS and CHL) and number of floating species (#FL) were closely correlated with each other and were only weakly correlated with the other environmental variables. REI, pH, TEMP and DO were strongly positively correlated with each other and negatively correlated with TN, DOC and COND. Axis 1 represents a gradient from exposed well-oxygenated alkaline water (high REI, DO and pH) to sheltered oxygen-poor acidic water (low REI, DO and pH). Axis 2 represents a gradient from high COND and water clarity (low TSS) to low COND and water clarity (high TSS).

Overall, most zooplankton loadings were found in the third quadrant of the biplot and were thus correlated with CHL (Fig. 3A). The rotifers *Asplachna* sp. (AP), *Lecane* sp. (LE), *Euchlanis* sp. (EC), cladocerans *Bosmina longirostris* (BOLO) and *Chydorus* sp. (CH), and copepods (calanoid — CA, cyclopoid — CY, copepodid — CP, nauplii — NA) had higher abundances in locations characterized by higher productivity (high TSS and CHL) and more floating vegetation species. The rotifers *Monostyla* sp. (MO), *Platyias* sp. (PL) and *Collotheca* sp. (CO), and the cladoceran *Ceriodaphnia* sp. (CE) were found in abundance at sites with high concentrations of DOC and TN, many floating species, and low exposure (REI). *Polyarthra* sp. (PY) is the only species whose abundance was highest in the warm exposed alkaline sites. The rotifers *Ploesoma* sp. (PO) and *Trichotria* sp. (TT), and chydoridae *Alonella* sp. (AO) were correlated with higher COND and water clarity (low TSS).

Characteristics of habitat groupings

We were able to discern the characteristics of the habitat groupings using the gradients explained by the ordination techniques (Table 4, Fig. 3A) and the location of the site scores in the ordination diagrams (Figs. 3B and 4). The interior sites in Crown Marsh (PDN and PD) tended to be very sheltered from wind and wave exposure, with more stagnant water that was circumneutral pH and higher in COND and DOC. These conditions promoted growth of dense vegetation that tended to shade out sunlight, keeping the water cooler and creating fewer opportunities for re-oxygenation. This explains why DO levels were also lower in these ponds, with some of the PDN sites approaching anoxic levels. Sites to the west (WS) and north (TP) were more exposed and open to the influence of Long Point Bay. With less vegetation cover, they tended to be warmer and better oxygenated; the greater mixing with bay water meant that these sites had lower COND and DOC, and higher pH. Turkey Point (TP) was one of the most exposed sites and had the lowest nutrients (DOC and TN).

Zooplankton biomass in the Crown Marsh sites without surface water connection (PDN) was up to several orders of magnitude higher than those in other sites (217.2 μg L^{-1}, Fig. 5) and was comprised mostly of habitat generalists (Fig. 5A). Typical species included *Bosmina longirostris* and *Ceriodaphnia* sp., which also comprised a large component of the cladoceran community in the rest of Long Point. Biomass of planktonic feeders was also highest at PDN (Fig. 5B), and was largely driven by high occurrence of the rotifer, *Filinia brachiata*. Scraper biomass was lowest at sites along the southern shore (SS) and in Bouck's Creek (CC) and highest at the Crown Marsh sites hydrologically connected to Long Point Bay (PD) (Fig. 5B).

The outliers of the ordination biplots identify sites with extreme values of the environmental variables and zooplankton communities. The sites circled on the PCA biplot (Fig. 4) labeled as PiP (pig pond) have the highest CHL of any sites sampled (mean CHL = 24 μg L^{-1}). The other set of sites circled and labeled as BC (Big Creek) are located at the outfall of Big Creek, one of the major tributaries emptying into Long Point Bay. They have the highest COND (mean COND = 565 μS cm^{-1}) and TN (mean TN = 3.1 mg L^{-1}) of any sites sampled. On the CANCOR biplot, PDN are clearly distinct from the other sites (Fig. 3B), due to the extremely high abundance of zooplankton. ZZP (zany zooplankton pond) was distinguished from the PD grouping due to the comparatively higher abundance of *Ploesoma* sp. and *Alonella* sp. (Fig. 3B). The sites near Port Rowan on the western shore (labeled PR) have high TSS (mean 28 mg L^{-1}) and a high prevalence of *Asplanchna* sp. and *Macrochaetus* sp.

Discussion

We hypothesized that variation in physico-chemical characteristics induced by wind and wave exposure can be as important a structuring variable for the zooplankton community as are nutrient and macrophyte density. The canonical loadings of the macrophyte variables in the

Table 5
Description of canonical variates 1–5 from the canonical correlation between environmental variables (14) and zooplankton species (45 taxa).

Root	Canonical correlation (R)	R^2	Environmental variable dataset: Variance extracted	Redundancy (Env. by Sp.)	Proportion of total redundancy	Species dataset: Variance extracted	Redundancy (Sp. by Env.)	Proportion of total redundancy
1	0.976	0.953	0.285	0.271	0.503	0.097	0.092	0.331
2	0.950	0.903	0.096	0.087	0.160	0.050	0.045	0.161
3	0.905	0.819	0.044	0.036	0.067	0.043	0.035	0.126
4	0.879	0.773	0.046	0.036	0.066	0.053	0.041	0.147
5	0.845	0.714	0.104	0.074	0.137	0.035	0.025	0.089

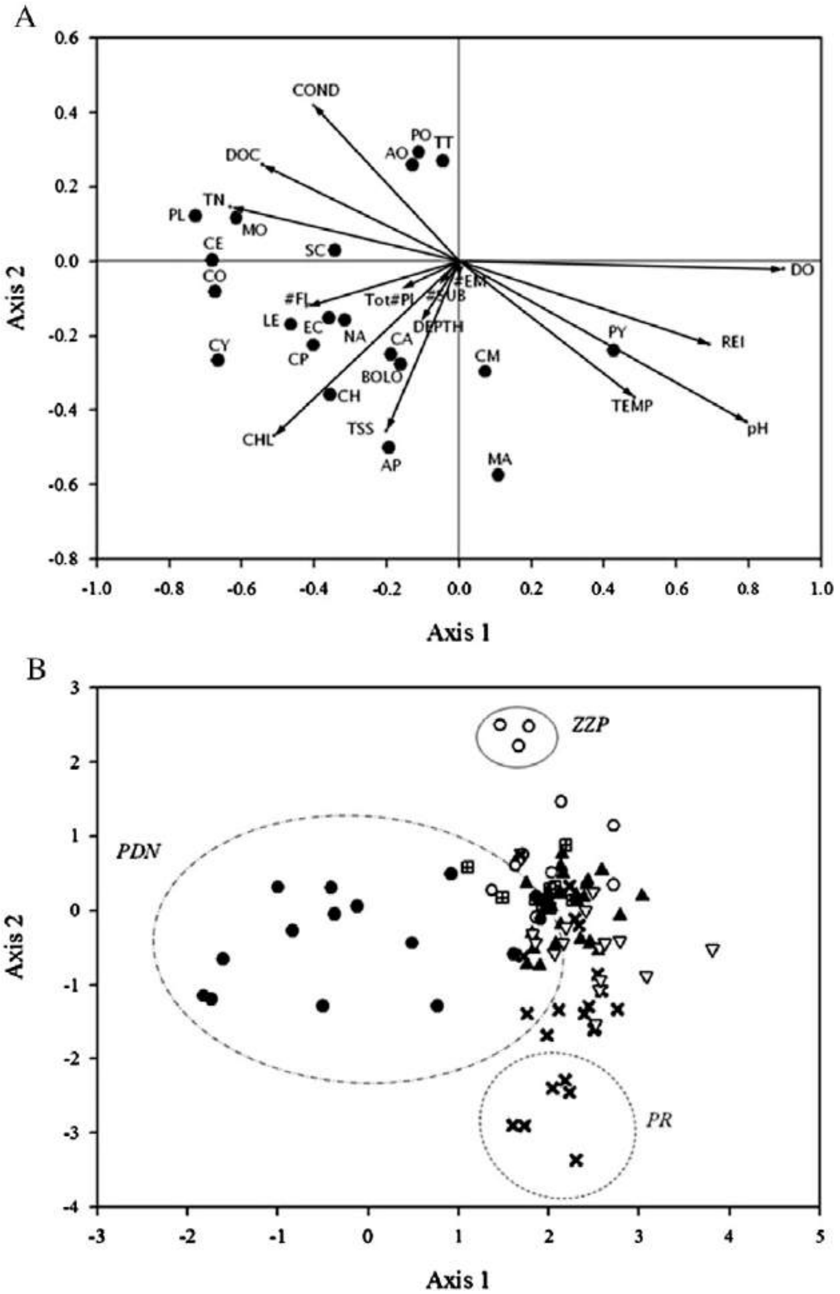

Fig. 3. Results from the CANCOR ordination of zooplankton and environmental variables showing A) canonical loadings of zooplankton > 0.25 and all environmental loadings. Environmental codes are listed in Table 1 and zooplankton codes are listed in Table 3. Filled circles indicate zooplankton and arrowheads indicate environmental loadings. #EM — emergent species richness, #FL — floating species richness, #SUB — submergent species richness, Tot#PL — total macrophyte species richness, and B) site scores corresponding to the first two axes. Symbols correspond to habitat groupings shown in Fig. 1. TP (▽), WS (X), PDN (●), PD (○), SS (▲), CC (⊞). ZZP, PDN and PR are discussed in text.

CANCOR were much lower than all of the physico-chemical variables except for depth (Fig. 3A), indicating that the environmental variables described the variation in the data set better than the macrophyte variables. We interpret the high correlation between exposure (REI) and many of the environmental variables as evidence that site-to-site variation in water chemistry is largely driven by wind and wave action. The spatial scale of this study has allowed us to measure different levels of wind and wave exposure and evaluate their effect on the biotic and abiotic factors within the wetland complex, while reducing the effects of confounding factors that arise across large basins. A smaller spatial scale would not have yielded as many differences in wind and wave exposure, making it more difficult to detect any influence of wind and wave exposure. The intermediate scale used in this study contains enough site variation to create differences in exposure levels, but not so much that confounding factors, such as climate effects, are introduced.

In general, the highly exposed sites (large REI) were well-oxygenated, had lower COND and DOC, and higher pH. By contrast, sheltered sites within Crown Marsh (small REI) that had limited mixing with bay water had poorly-oxygenated water, higher COND, DOC and circumneutral pH. The sheltered sites also had dense vegetative growth, shading the water column, keeping the water temperatures lower than the more exposed sites which did not support vegetation. This created the counter-intuitive pattern of higher temperatures in more exposed sites. The 15 sites in Crown Marsh that had no surface connectivity to Inner Bay (PDN in Fig. 1) were associated with the most extreme conditions relative to the other sites and were the most unique. Factors other than wind and wave exposure can influence the variables studied, such as the influence of land processes, groundwater intrusion, drainage and direct anthropogenic effects. Additional investigation is required to ascertain that exposure is indeed the true cause of the patterns we have observed at the Long Point Complex.

In this system highly exposed sites have characteristics similar to the surrounding bay water whereas less exposed sites are more heavily influenced by the land. Brant and Herdendorf (1972) made similar observations when studying the intrusion of Lake Erie water into drowned river mouths, noticing that highly conductive river water was diluted by the lake water. Wind action also tended to keep the water well oxygenated, consistent with the findings of Brodersen (1995). Wave exposure causes a more turbulent environment that prevents the development of dense vegetation. By contrast, the plant community can become very dense in sheltered sites and the shade results in much cooler conditions as seen in the sites of Crown Marsh. We suspect that higher concentrations of CHL and TN at these sites are related to the lack of dilution from bay water but further investigations are required to verify this. Stations along the Big Creek outfall had higher COND (mean of 565 μS cm^{-1}) and higher concentrations of TN (mean of 3.1 mg L^{-1}), likely due to watershed influence since Big Creek drains primarily agricultural land with a relatively dense road network.

The CANCOR indicated several species whose abundances were highly correlated with exposure. *Polyarthra* sp. was the only taxon whose abundance was positively correlated with REI (Fig. 3A), with higher abundances at exposed sites such as those in Turkey Point and the western shore (Fig. 6A). Smith (2001) observed that this rotifer is mostly found in deep open-water areas, although Pennak (1966) observed no strong preference for open-water when compared with vegetation. Duggan et al. (2001) explain this disparity in the literature with their findings that *Polyarthra* sp. tolerate plant species with small narrow leaves that allow them to swim among the foliage and maintain their planktonic habits. Species that were highly negatively correlated with REI included *Ceriodaphnia* sp. and the rotifers *Monostyla* sp. and *Platyias* sp. (Fig. 3A). These species are more commonly associated with macrophytes in the littoral zone (Fairchild, 1981; Pennak, 1966), and this is consistent with our finding that they were most abundant in the sheltered sites of Crown Marsh with high vegetation coverage (Figs. 6B, C and D). It is interesting to note that the most exposed site, Bouck's Creek, (Fig. 2D) was dominated by *Polyarthra*, and as exposure decreased the abundance of *Ceriodaphnia* sp., *Monostyla* sp. and *Platyias* sp. increased (Fig. 6).

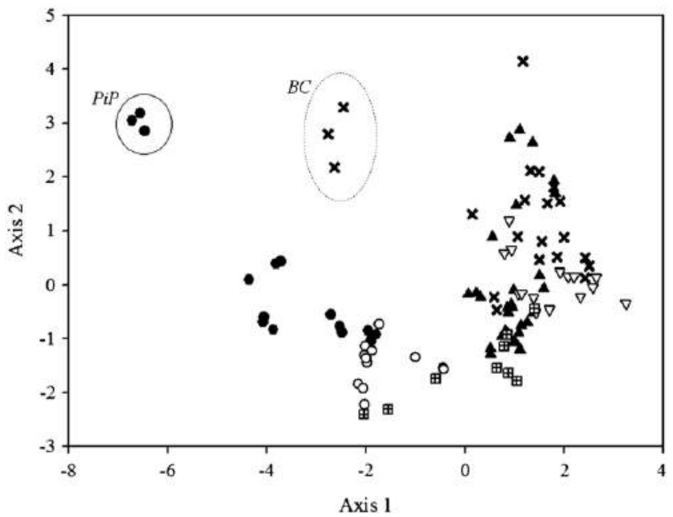

Fig. 4. Biplot showing the site scores from PCA of the physico-chemical variables. Symbols correspond to the habitat groupings shown in Fig. 1. TP (▽), WS (X), PDN (●), PD (○), SS (▲), CC (⊞). Circled scores are discussed in text.

The zooplankton community in the nearshore of Long Point Bay is driven chiefly by physical conditions at the site level. In addition to exposure, hydrological connectivity to the bay is important in structuring the zooplankton community. The most striking feature is the high biomass of zooplankton at the sites that no longer had surface water connection to Inner Long Point Bay (i.e., PDN — Fig. 5). One explanation is that higher food availability (highest CHL at these sites) may be supporting a higher zooplankton biomass. Another explanation could be the absence of predatory fish, since fish predation has profound impacts on the distribution of zooplankton (Dodson, 1974; Luecke and Litt, 1987; Lynch, 1979). These sites are likely uninhabitable by fish because of the low oxygen concentrations and the hydrologic isolation. They also have high DOC and plant cover which suggests that if predators are present, zooplankton have many opportunities to evade capture (Strecker et al., 2008; Timms and Moss, 1984). Further investigation is required to determine the correct explanation for the extremely high zooplankton biomass.

The observation that exposure and connectivity have a large influence on the zooplankton community is an important consideration when predicting the effects of changing water levels and climate on this system. We can predict that if areas become hydrologically disconnected, they will have lower oxygen levels and higher concentrations of DOC, TN, CHL and COND, as well as higher zooplankton biomass. If water levels rise so that connectivity is regained, then such differences may be ameliorated. A second consideration is the impact of predicted increase in severity and frequency of storm

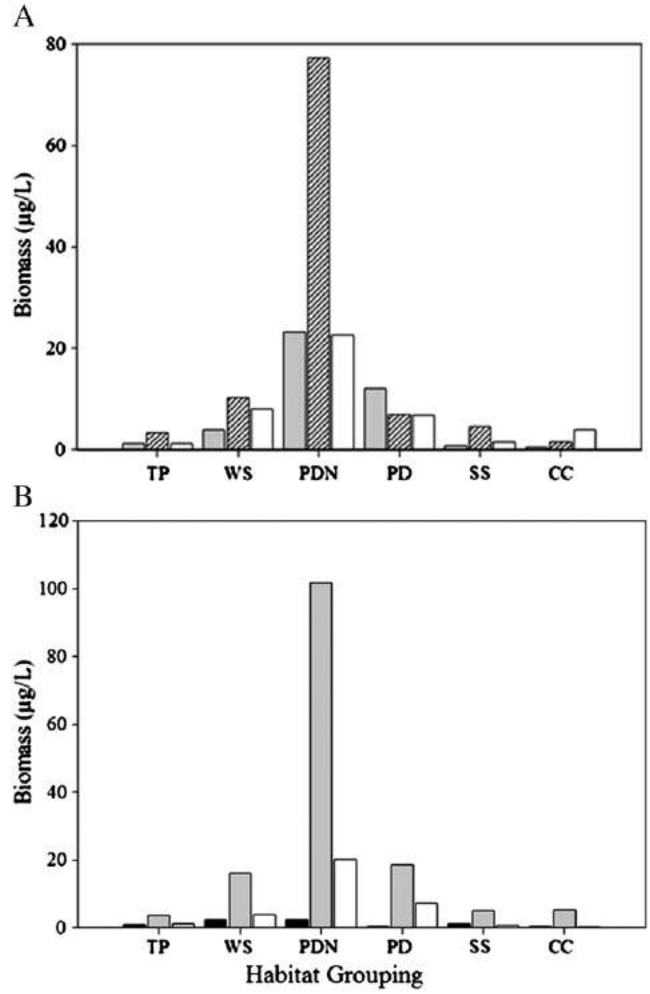

Fig. 5. Mean zooplankton biomass (μg/L) across site groups coded by A) habitat preference (gray = aquatic plant association, hatched = generalist, open = open-water association) and B) feeding mode (black = raptorial, gray = planktonic, open = scraper).

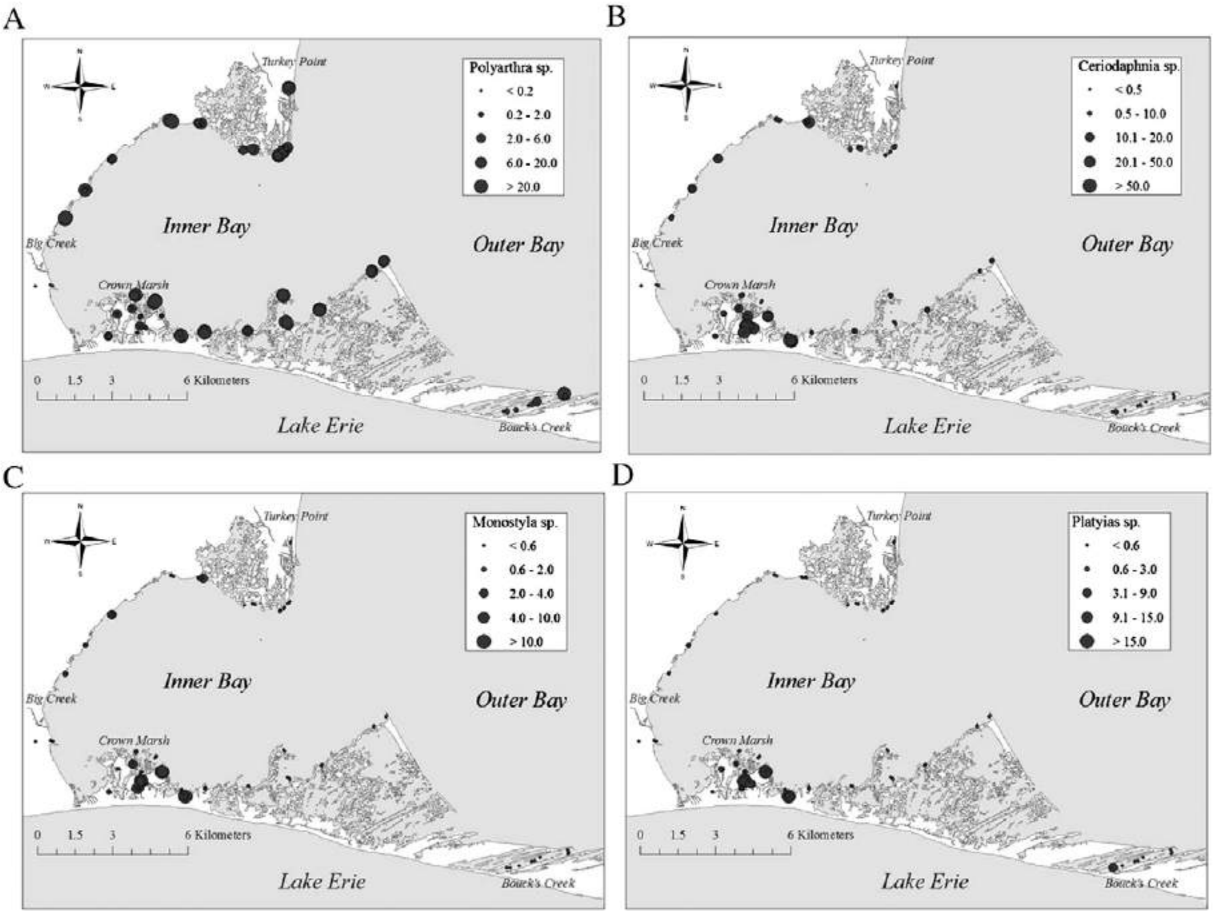

Fig. 6. Abundance (#/L) of A) *Polyarthra* sp., B) *Ceriodaphnia* sp., C) *Monostyla* sp., and D) *Platyias* sp. at study sites in Long Point Bay.

events due to climate change (Bates et al., 2008), which has the potential to amplify the impacts of wave exposure as well.

Abundance of zooplankton has been directly linked to the foraging success of larval fish (Bremigan and Stein, 1994) and the bay provides important spawning and nursery habitat for both local and lake-wide fish populations (MacGregor and Witzel, 1987 as cited in Nelson and Wilcox, 1996). The highest zooplankton biomass in nearshore Long Point was found in the ponds of Crown Marsh (PDN, Fig. 5). However, these sites also have oxygen levels that approach anoxic conditions and they have no surface water connection to the bay. Therefore, sites in Crown Marsh that have adequate oxygen, hydrologic connectivity, and high zooplankton biomass are predicted to offer the best nursery habitat for larval fish (i.e., PD, Fig. 1). By determining which factors influence the zooplankton community we will be able to predict the prime nursery habitat for larval fish. This information will help managers understand the influence of environmental variation on lower trophic levels, and thus make informed management decisions when considering spawning and nursery habitat protection and management.

The lower trophic levels of nearshore Long Point Bay have never been examined before and this study provides a starting point for future research. The data collected for this study cover a brief window of time (11 days in late August) and establish a basic description of the zooplankton community, physico-chemical environment, and aquatic vegetation. The scale of this study allowed us to examine the effects of physical disturbance and understand how it shapes the water chemistry and zooplankton assemblage in the system. Further investigations into temporal trends of the zooplankton community are necessary to fully understand the dynamics of the system. It will also be beneficial to incorporate studies on the habitat and other food web components of nearshore Long Point, such as fish distribution. Long Point is one of the largest remaining coastal habitats in Lake Erie and there is an urgent need to conduct research at the appropriate scale to ensure its protection and conservation for future generations.

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SEASONAL AND LONG-TERM (1995-2009) CHANGES IN THE DISTRIBUTION AND ABUNDANCE OF SUBMERGED AQUATIC VEGETATION AND DREISSENID MUSSELS IN INNER LONG POINT BAY, LAKE ERIE

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1.0 Introduction

1.1 Coastal Wetlands of the Lower Great Lakes

Coastal wetlands associated with the lower Great Lakes (LGL) are critically important to a diversity of wetland-dependent organisms. For example, submerged aquatic vegetation (SAV) in coastal wetlands of the LGL is food for migrating waterfowl (Knapton and Petrie 1999; Badzinski and Petrie 2006) and provides habitat and nursery areas to fish (Richardson *et al.* 1998). In addition, SAV quantity and species distribution are indicators of local water conditions, affect biogeochemical and sedimentological processes, and protect shorelines from erosion by decreasing nearshore wave action (Moore *et al.* 1996). Despite their importance to fish, wildlife and humans, a substantial number of LGL coastal wetlands have been drained for agriculture and other development (e.g., < 5% of western Lake Erie wetlands remain intact), thereby increasing the importance of remaining coastal wetland habitat for wetland-dependent organisms. Inner Long Point Bay – Lake Erie (LPB) is an important remaining habitat that is in a relatively pristine state. LPB is important because it has an extensive SAV community covering more than >99% of the bay (Knapton and Petrie 1999).

1.2 Impact of Exotic Species on SAV

Many of the remaining wetlands in the LGL region have been altered by various stressors, including the introduction of exotic plants and invertebrates (Petrie 1998, Knapton and Petrie 1999, Petrie and Knapton 1999). Invasive species can affect carrying capacity for staging waterfowl and other animals by altering total biomass of SAV or changing species composition within wetlands (Crowder and Bristow 1988). For instance, introduction and proliferation of zebra (*Dreissena polymorpha*) and quagga mussels (*Dreissena burgensis*) (hereafter combined as

Dreissenid mussels) has been associated with changes in the abundance, distribution, and community composition of SAV within the LGL (Blindlow 1992; Knapton and Petrie 1999; Petrie and Knapton 1999). Dreissenid mussels filter large volumes of water, reduce the number of suspended particles in the water column, and thereby increase water clarity and decrease light attenuation (Knapton and Petrie 1999). Wetzel (1983) found that changes in light attenuation enhanced benthic photosynthesis and influenced the distribution and abundance of SAV. In addition, Dreissenid mussels can alter microbially-mediated nutrient cycling and the nearshore phosphorus cycle (Wilson et al. 2006), further altering phytoplankton levels. Altered phytoplankton levels through Dreissenid filtering and the resulting increase in water clarity also resulted in increased SAV abundance at Lake St. Clair during the mid-1990s (Schloesser and Manny 2007).

1.3 Importance of Long Point Bay to Fish and Wildlife

Diving ducks (e.g., *Aythya* spp. and *Bucephala* spp.) feed exclusively in aquatic habitats, thus, the shallow, productive waters of LPB provide foraging habitat necessary to complete migration (Petrie 1998). Introduction of Dreissenid mussels to Lake Erie in the early 1990s led to an initial increase in use of LPB by molluscivorous diving ducks (Petrie and Knapton 1999). Specifically, Lesser and Greater scaup (*Aythya affinis* and *A. marila*), Bufflehead (*Bucephala albeola*), and Common Goldeneye (*B. clangula*) altered traditional migration patterns to take advantage of this novel food source in LPB (Hamilton *et al.* 1994, Petrie 1998, Petrie and Knapton 1999). However, since 2000, diving duck use has declined within LPB, particularly among those species that consume Dreissenid mussels (Long Point Waterfowl, unpublished data; Fig. 1.). In addition, the abundance of economically important fish species, such as yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoideus*), and smallmouth bass

(*Micropterus dolomieu*), have also decreased within LPB since the late 1990s (Ontario Ministry of Natural Resources 2007). Causes of declines in fish populations and diving duck use remain unclear, but it is plausible that a decline in abundance or distribution of Dreissenid mussels may be a direct or indirect contributing factor.

1.4 Relationships Between Dreissenid Mussels and SAV

Following introduction to a suitable, new locale, exotic species often occur in greater abundance than observed in their native range. Often, initial increases in abundance of invasive species are followed by decline until a new regional carrying capacity is reached (McKillup *et al.* 1988). Dreissenid mussels prefer to anchor to hard substrate. LPB does not provide hard attachment substrate so mussels must attach to SAV instead (Knapton and Petrie 1999). Thus, in LPB, abundance of Dreissenid mussels may be influenced by SAV abundance and species distribution. Similarly, Dreissenid mussel abundance can influence water clarity and rates of eutrophication because they filter substantial amounts of water (Knapton and Petrie 1999). A decrease in abundance of Dreissenid mussels may contribute to eutrophication and have implications for SAV communities in LPB. Because angiosperm SAV species that reproduce via flowering vegetative structures can outcompete algal species, including the charophyte muskgrass (*Chara vulgaris*) in eutrophic systems, changes in abundance of Dreissenid mussels may cause measureable changes in LPB SAV plant community composition (Knapton and Petrie 1999). An angiosperm-dominated SAV community in LPB would provide more nutritious food sources for certain species of waterfowl (Knapton and Petrie 1999) and better spawning habitat for some fish species (Richardson *et al.* 1998).

1.5 Seasonal Trends in SAV Biomass

Seasonal changes in SAV biomass may influence availability of food and cover for wetland fish and wildlife. In August, SAV typically reaches maximum above-ground biomass and begins shifting resources to propagules (Rybicki and Landwehr 2007). Specifically, most angiosperm species (e.g., wild celery, *Vallisneria americana* and pondweeds, *Potamogeton* spp.) of SAV typically overwinter as below-ground roots, tubers, and seeds (Kufel 2001). In addition to autumn senescence of above ground SAV biomass, waterfowl and fish can also eat a substantial portion of available biomass (Marklund *et al.* 2002). In December, above-ground biomass nears zero and below-ground biomass occurs as roots, tubers, and dormant seeds (Rybicki and Landwehr 2007). During winter, above-ground biomass in LPB is dominated by muskgrass, a charophyte species capable of over-wintering in above-ground form (Kufel 2001). Although potentially important to migrant waterfowl during spring that require adequate food resources to fuel migration to breeding grounds, seasonal reduction of SAV biomass in LPB has not yet been documented.

1.6 Historical Studies and Available Data

Because LPB is an important wetland habitat used by staging waterfowl and other fish and wildlife in the LGL, researchers have quantified the distribution, relative abundance and long-term temporal dynamics of the SAV community. Smith (1979) mapped the distribution of SAV in LPB during the 1960s and 1970s. Knapton and Petrie (1999) and Petrie and Knapton (1999) assessed the distribution and relative abundance of SAV and Dreissenid mussels in the mid-1990s and compared their findings with those of Smith (1979). However, no studies have determined seasonal dynamics of SAV at LPB between autumn and spring. Seasonal abundance is important in determining carrying capacity of LPB for waterfowl and these data would be beneficial to conservation planners charged with determining habitat suitability and availability through the annual cycle of waterfowl. I studied the current distribution and species composition of SAV and Dreissenid mussels to examine changes since the 1990s in LPB. I also provide an evaluation of factors potentially influencing distribution and relative abundance of SAV in LPB to help predict future changes in availability of fish and wildlife habitat provided by these plants. Further, I quantified changes in autumn, winter, and spring SAV biomass to determine seasonal carrying capacity for waterfowl using LPB.

1.7 Research Objectives and Predictions

My central hypothesis is that the distribution and relative abundance of SAV and Dreissenid mussels (mussels/m^2) in LPB has changed since the 1990s when Dreissenid mussels first colonized the area as a result of naturalization and resultant eutrophication. My first objective was to determine if species composition, distribution, and relative abundance of SAV and Dreissenid mussels changed within LPB between 1976 and 2009. Because of the tendency for exotic species to decline in numbers after an initial increase, I predict that my estimate of Dreissenid mussel abundance in LPB collected in 2009 and 2010 will be lesser than the 1992 estimate reported by Petrie and Knapton (1999). Additionally, I predict that my estimates of angiosperm (e.g., wild celery and pondweeds) and charophyte (i.e., muskgrass) SAV collected in 2009 and 2010 in LPB will be greater and lesser, respectively, as compared to estimates from the 1990s reported by Petrie and Knapton (1999).

My second objective was to determine factors influencing the presence and relative abundance of SAV in LPB. Third, I determined to what extent above and below-ground SAV biomass changed between early autumn and late spring. I predict that my estimates of SAV above-ground biomass will decrease between autumn and spring. Specifically, I predict that muskgrass and Eurasian milfoil (*Myriophyllum spicatum*) will present remaining above-ground biomass that would occur in the late spring, because these are capable of over-wintering as above-ground vegetation (Kufel 2001). Finally, I predict that I will not detect any above-ground biomass associated with wild celery, pondweeds, or naiad (*Najas* spp.) in late spring because these species typically over-winter as below-ground tubers and dormant seeds. Seasonal changes in biomass have implications for foraging ducks that obtain nutrients at LPB necessary to complete migration. Because ducks also use LPB during spring I predicted that energy available from SAV was great enough to feed these ducks during autumn and spring at LPB. Further, as annual ice-cover in the LGL has decreased in recent years (Assel 2003), the potential for autumn migrating waterfowl to overwinter in LPB could further reduce available SAV in spring.

2.0 Methods

2.1 Study Area

This study was conducted at Long Point, Ontario (80° 30' E, 42° 35' N to 80° 03' E, 42° 33' N; Fig. 2.). Long Point is a sand-spit extending 35 km south-east into Lake Erie that has facilitated the formation of the Inner and Outer Long Point Bays and associated freshwater marsh complexes (Petrie 1998). The Inner Bay at Long Point is 78 $km^2$and mean depth (1 to 2 m) varies dependent upon annual and periodic changes in regional water budgets (Berst and MaCrimmon 1966). Coverage of the Inner Bay by SAV is > 90% in most locales (Pauls and Knapton 1993, Petrie 1998, Smith 1979). The mean temperature of the Inner Bay (22^{o}C; Pauls and Knapton 1993, Smith 1979) provides favourable growing conditions for macrophytic SAV including: muskgrass, wild celery, Eurasian milfoil, naiad, pondweeds, Canada water weed (*Elodea canadensis),* and coontail (*Ceratophyllum demersum;* Petrie 1998). Big Creek is the major tributary of the Inner Bay that drains a watershed comprised primarily of agricultural land northwest of Long Point (Berst and MaCrimmon 1966, Leach 1981). Big Creek influences the SAV communities in LPB because it is the primary source of nutrients and sediments in the bay (Leach 1981). LPB substrate is predominantly mud at the mouth of Big Creek, sandy loam over most of the central portion, and sand bordering the eastern and south-eastern portions (Smith 1979).

2.2 Study Design and Sample Collection

I used a grid generated with geographic information system software (GIS) to uniformly distribute 321 sampling stations throughout LPB. I used GPS coordinates to navigate to sampling stations in the field. I collected SAV and Dreissenid mussels at the 321 stations 5-29 August 2009 and 28 April – 25 May 2010 to estimate SAV and Dreissenid mussel availability to ducks foraging during autumn and spring. I collected SAV and Dreissenid mussel samples at 100 stations selected using random stratification 30 November – 07 December 2009. I collected SAV and Dreissenid mussels during these periods to enable comparisons of seasonal biomass of food available to migrating ducks at LPB. I used a 23 foot pontoon boat with a 50 horsepower outboard motor and handheld GPS unit to navigate to sampling stations throughout LPB. At each sampling station, I recorded water and secchi depth using a secchi disc marked at 5cm intervals. I measured water temperature using a digital thermometer (± 0.001^{o}C).(Fisher Scientific 0666426). I dove to the substrate using a Self-Contained Underwater Breathing Apparatus (SCUBA) to collect SAV, Dreissenid mussel, and benthic substrate samples. I estimated SAV percentage cover using a modified Braun-Blanquet scale of abundance and ascended to the surface to record values. I modified the Braun-Blanquet scale using categories 1-4 instead of 0-5 to create continuous values for multivariate analysis. I used scissors to clip all above-ground SAV in a 0.5 m^2 quadrat at substrate level. I used a modified mesh bag to capture and strain samples. I obtained tuber and substrate samples by collecting three horizontal scoops of substrate with a perforated metal can (sample volume = 0.03 m^3) to emulate maximum foraging depth for diving ducks (Badzinski 2003). I used water bottles to separate Dreissenid mussels from SAV on the deck of the boat. I bottled and labelled each of the mussel samples separately. I differentiated between above- and below-ground SAV samples. I froze samples until further processing.

2.3 Laboratory Procedures

I blotted dry all species-specific above-ground vegetation samples using paper towel. I weighed each sample using a (A&D Company Ltd. FX3000i) digital balance (±0.001 g) and recorded values as wet mass. I separated below-ground plant parts (i.e., roots, turions/tubers, and rhizomes) from benthic substrate using a (Fisher Scientific U.S. standard brass) fine mesh sieve (2 mm x 2 mm). I classified substrate type into one of three groups (mud, sandy loam, or sand) based on observed percentage of sand, silt and clay in each sample using the modified Wentworth scale (Wentworth 1922). Three substrate classifications were selected based on previously reported substrate types within LPB (Smith 1979). I selected approximately 30 sub-samples from above-ground samples for each species. I oven-dried all sub-samples separately at 80°C to constant mass (± 0.001 g). I ensured that sub-samples represented the range of wet masses observed in samples of each species. I obtained dry mass of sub-samples to allow for estimation of dry mass for above-ground samples (by species). I used linear regression to estimate dry mass using wet mass measurements (Badzinski 2003). I followed the same protocol when measuring species-specific below-ground plant parts. I measured the length of all Dreissenid mussels using digital calipers (Mastercraft) and counted the number of mussels at each sample site.

2.4 Data Mapping and Analysis

I obtained abundance and distribution data from previous studies (1976, 1991, and 1992) from Bird Studies Canada archives. In 1976, only cover (using the Braun-Blanquet scale) for each plant species was available. In 1991 and 1992, cover data for each plant species as well as water depth, Secchi depth, and Dreissenid mussel abundance. I used inverse distance-weighted (IDW) spatial interpolation (Spatial Analyst tool, ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute) to estimate species-specific distributions and changes in SAV and Dreissenid mussel distribution in LPB (Watson and Philip 1985, Neckles et al. 2012). I mapped the abundances of Dreissenid mussels and the five most abundant SAV species for 1976, 1991, 1992, and 2009 to provide a graphical representation of community changes in LPB. I used the modified Braun-Blanquet scale described above (to ensure data were ordinal) to map SAV. I used relative abundance of Dreissenid mussels (mussels/m^2) to develop maps and showed changes in relative abundance among sampling periods. To test for temporal variation in mussel abundance, I used repeated measures analysis of variance (ANOVA). Spatial interpolation provides a visual representation of SAV coverage in LPB but does not provide statistical comparisons of abundance among years. I used multivariate analysis of variance (MANOVA) to test for changes in plant community (e.g., SAV) among years using SAV relative abundance data. I included muskgrass, wild celery, Eurasian milfoil, naiad, slender pondweed (*Potamogeton pusillus*) and Richardson's pondweed (*Potamogeton richardsonii*) cover (modified Braun-Blanquet) as response variables and year as a repeated measure to account for sampling the same points through time. I included latitude and longitude as covariates to control for spatial autocorrelation and substrate as a covariate to control for potential changes to growing conditions. I inspected studentized residual plots from all models for normal distribution. I log-transformed SAV data to normalize residual distribution (Littell et al. 2007). I selected a 0.10 (α) level of significance *a priori* because it is appropriate for observational data (Tacha et al. 1982). I used Wilks' lambda and F-tests (type III sum of squares) to evaluate statistical significance of year effects within multivariate (MANOVA) and univariate analyses, respectively.

I used backwards elimination logistical regression to determine factors influencing likelihood of detecting a species at a sampling station for the 6 most common species of SAV (Figure 1). I included Dreissenid mussel abundance, substrate type, year, water depth, depth × depth, and substrate × year as fixed effects and latitude and longitude as covariates to correct for spatial autocorrelation. I included substrate × year to detect if changes in likelihood of detecting SAV changed through time within substrate types and within years among substrate types. I did not include Secchi disk reading because it was strongly correlated with water depth ($p < 0.01$; r=0.90), but subject to greater error than water depth because of daily difference in turbidity. I compared means of reduced models using post-hoc Tukey's adjustment.

I used the biomass of SAV, species-specific nutritional quality of plants, and information on energy requirements of ducks to determine how many waterfowl the SAV in LPB could feed during autumn, winter, and spring (i.e., SAV energetic carrying capacity). I compared the energy available from SAV (kcal/m^2) and requirements of migrating waterfowl using LPB to determine energy surplus or deficit and how many ducks SAV could feed during winter if LPB remained ice-free (i.e., climate change scenarios). I determined available energy by calculating g/m^2 (dry mass) for each plant species within the bay. I assigned a true metabolizable energy (TME) value for each plant species from published literature (Table 2). TME values represent energy available to waterfowl corrected for endogenous (non-food) excretory energy and are appropriate for modeling of carrying capacity (Sibbald 1976). Using inputs of dry biomass, TME and area in LPB, I calculated available energy in LPB based on autumn 2009 and spring 2010 sampling.

I used data from standardized, aerial waterfowl surveys that were conducted once every two weeks, autumn and spring 1990-2006 (Long Point Waterfowl, unpublished data) to estimate waterfowl usage of LPB. I determined Duck Use Days (DUD) for each species by adding abundances on days of counts to estimates of abundance between surveys. Duck abundances between surveys were estimated by averaging abundances from two consecutive surveys and multiplying by the number of non-survey days between aerial surveys (Korschgen et al. 1985). I calculated the energy needs of each waterfowl species that commonly eat SAV using species-specific daily energy requirements (DER; Table 3). DER incorporates the energetic costs of feeding and non-feeding behaviours and excludes the demands related to reproduction, molt, and migration in waterfowl (Baldassarre and Bolen 2006). Because SAV is a portion of total diet in waterfowl, I adjusted species-specific DER using data on waterfowl diets (Petrie 1998), and the equation (see also Table 3):

$$\text{Adjusted DER} = \text{DER} \times \%\ \text{stems/leaves in diet}$$

To calculate energy needs of waterfowl derived from SAV in each season and year at LPB, I multiplied adjusted DER by total seasonal DUDs for each species for autumn and spring and summed energy requirements across species within seasons and years.

I considered autumn migration 15 September – 15 December (100 days) and spring migration 1 March – 14 May (75 days). Autumn and spring migrations are separated by a 75 day wintering period when LPB is typically ice covered (Long Point Waterfowl, unpublished data; Bellrose 1980, Assel 2003). However, climate change scenarios and recent trends suggest an increasing number of ice-free days at LPB (Assel 2003). To determine the energetic capacity of

SAV in LPB to feed waterfowl into winter I calculated surplus energy by subtracting spring energy needs of waterfowl using LPB 1990 - 2006 from estimates of energy available during spring 2010. By subtracting the energy requirement in spring from energy available I determined the surplus (or deficit) of energy estimated to be available for overwintering waterfowl. I divided surplus energy by DER from stems and leaves (163.5 kcal/day; average of grazing and diving ducks adjusted for stems/leaves only; Table 3) to determine available DUDs for each wintering period between 1990-2006.

3.0 Results

3.1 Long-term Changes

3.1.1 Overall Changes

I detected an influence of sampling year on abundance of Dreissenid mussels in LPB ($F_{2,960}$=25.72, P<0.001) (Figure 2). Post-hoc comparisons indicated a 2110% increase in Dreissenid mussel abundance between 1991 (mean number per site; 20.6) and 1992 (mean number per site; 456.8), and a 96% decrease between 1992 and 2009 (mean number per site; 18.9) (P < 0.001), with no difference between 1991 and 2009 (P = 0.999). There also was an overall influence of sampling year on the percent cover of the six most abundant SAV species in LPB between 1976 and 2009 (MANOVA: Wilks' λ = 0.90, $F_{3, 316}$ = 11.76, P < 0.001) (Figures 3-9).

3.1.2 Species-specific Changes

Muskgrass

I detected an influence of sampling year on percent cover of muskgrass ($F_{3,918}$=17.76, P < 0.001) (Figure 4). Percent cover of muskgrass did not change between

1976 and 1991, increased between 1991 and 1992 ($P < 0.001$), and decreased between 1992 and 2009 ($P < 0.001$). Likelihood of detecting muskgrass was greater in 1992 than 1991 and 2009 ($P < 0.001$) (Table 1, Figure 7), but did not differ between 1991 and 2009 ($P = 0.320$) (Figure 7). Muskgrass occurrence decreased with increasing depth as a quadratic function among all substrate and sampling years (depth × depth) (Table 1, Figure 7). Detection probability also was greater on sandy loam substrate than mud and sand ($P \leq 0.006$), whereas I did not detect a difference in occurrence of muskgrass between mud and sand ($P = 0.465$).

Wild celery

I detected an influence of sampling year on percent cover of wild celery ($F_{3,916}=39.00$, $P < 0.001$) (Figure 3). Percent cover of wild celery increased between 1976 and 1991 ($P < 0.001$), did not change between 1991 and 1992, and decreased between 1992 and 2009 ($P = 0.016$) (Figure 8). Likelihood of detecting wild celery decreased with increasing water depth as a quadratic function across all substrate types (Table 1, Figure 9). Likelihood of detecting wild celery did not differ on mud or sand substrate among sampling years ($P \geq 0.510$), but was less in 2009 than 1991 and 1992 on sandy loam substrate ($P \leq 0.070$) (Table 1; Figure 8). In 2009, occurrence of wild celery was greater on sand than sandy loam substrate ($P = 0.003$) (Figure 8).

Eurasian milfoil

I detected an influence of sampling year on percent cover of Eurasian milfoil ($F_{3,919}=49.20$, $P < 0.001$). Percent cover of Eurasian milfoil increased between 1976 and 1991 ($P < 0.001$), did not change between 1991 and 1992, and decreased between 1992 and 2009 ($P < 0.001$). Likelihood of detecting Eurasian milfoil was greater in 1992 and

1991 than in 2009 ($P < 0.001$) (Table 1), but did not differ between 1991 and 1992 ($P = 0.531$) (Figure 7). Eurasian milfoil occurrence varied positively with depth as a quadratic function among all substrate and sampling years ($P < 0.001$) (Table 1, Figure 9). Detection probability also was greater on sand and mud substrate than sandy loam ($P < 0.001$), whereas I did not detect a difference in occurrence of Eurasian milfoil between sand and mud ($P = 0.820$) (Figure 7).

Naiad spp.

I detected an influence of sampling year on percent cover of naiad species ($F_{3,916}$=80.06, $P < 0.001$). Percent cover of naiad species increased between 1976 and 1991 ($P < 0.001$), increased between 1991 and 1992 ($P = 0.028$), and decreased between 1992 and 2009 ($P < 0.001$). Likelihood of detecting naiad was greater in 1991 and 1992 than in 2009 ($P < 0.001$) (Table 1), but did not differ between 1991 and 1992 ($P = 0.531$) (Figure 8). Naiad occurrence was similar among water depths ($P = 0.641$) (Table 1, Figure 9). Detection probability also was greater on sand and sandy loam substrate than mud in 1992 and 2009 ($P < 0.001$), whereas I did not detect a difference in occurrence of naiad between sand and sandy loam ($P = 0.997$). In 1991, detection probability was greater on sand and sandy loam substrate ($P < 0.001$) than mud substrate, whereas I did not detect a difference in occurrence of naiad between sand and sandy loam ($P = 0.993$) (Figure 8).

Slender pondweed

I detected an influence of sampling year on percent cover of slender pondweed ($F_{3,1214}$=25.52, $P < 0.001$). Percent cover of slender pondweed did not change between 1976 and 1991, increased between 1991 and 1992 ($P = 0.049$), and increased between

1992 and 2009 ($P < 0.001$). Likelihood of detecting slender pondweed increased linearly with water depth ($P = 0.054$) (Table 1, Figure 9). Detection probability also was greater on mud substrate than sand or sandy loam ($P = 0.018$), whereas I did not detect a difference in occurrence of slender pondweed between sand and sandy loam ($P = 0.643$) (Figure 7).

Richardson's pondweed

I detected an influence of sampling year on percent cover of Richardson's pondweed ($F_{3, 1214}=25.58$, $P < 0.001$). Percent cover of Richardson's pondweed increased between 1976 and 1991 ($P < 0.001$), did not change between 1991 and 1992, and decreased between 1992 and 2009 ($P < 0.001$). Likelihood of detecting Richardson's pondweed increased linearly with depth ($P = 0.002$) (Table 1, Figure 9). Detection probability in 1991 also was greater on mud and sandy loam substrate than mud ($P <$ 0.019), whereas I did not detect a difference in occurrence of Richardson's pondweed between mud and sandy loam ($P = 0.999$) (Figure 8).

3.2 Seasonal Changes in Energetic Carrying Capacity

Muskgrass and wild celery provide the majority of biomass of SAV within LPB during both autumn and spring (Table 4, Figure 1 and 10). Mean biomass ($g/m^2 \pm SE$) of Musk Grass during autumn was 60.55 ± 11.61, and spring mean biomass was 41.18 ± 3.35. Wild celery had a mean biomass of 3.20 ± 0.49 and 0.61 ± 0.49, during autumn and spring, respectively.

Based on the annual required energy to feed migrating diving and grazing ducks using LPB during migration, a surplus of available energy from SAV existed during autumn and spring when using SAV data 2009-2010 (Table 5 and Figures 12-15). I estimated the mean adjusted energy needs of diving and grazing ducks migrating through LPB in autumn was 3.48×10^8

kcals, 1990 - 2005. I calculated that there were 3.46×10^9 kcals available in LPB in autumn 2009, leaving a surplus of 3.11×10^9 kcals available in LPB. However, because muskgrass is not consumed in abundance by waterfowl in LPB (Petrie 1998), I removed it from the analysis to better estimate available energy from SAV. My adjusted available energy estimate (muskgrass excluded) in autumn was 7.63×10^8 kcals, which represented a surplus of 4.16×10^8 kcals. In spring, required energy, adjusted for stems/leaves only, was 1.62×10^8 kcals. The available energy (muskgrass excluded) was 3.46×10^8 kcals, with a surplus of 1.84×10^8 kcals.

I also estimated required and available DUDs if LPB remained ice-free throughout winter, exposing SAV to an additional 75 days of foraging. Excluding 1998 in which I estimated a substantial deficit of energy (-6×10^7 kcals), between 1990-2006, using the surplus energy estimate from spring 2010, the estimated ducks that LPB could feed each day for a 75 day wintering period ranged from 3,466 (2.6×10^5 DUDs) in 2000 to 24,000 (1.8×10^6 DUDs) in 1994 with an average of 16,000 (1.2×10^6 DUDs).

4.0 Discussion

4.1 Long-term Changes

SAV is an important food source for migrating waterfowl. The distribution and abundance of SAV, and consequently their availability to waterfowl is a function of several environmental factors including light quantity, interspecific competition, nutrient availability, herbivory, ice and storm damage, fluctuating water levels, temperature, and pH (Knapton and Petrie 1999, Petrie and Knapton 1999). However, Knapton and Petrie (1999) determined that the introduction of Dreissenid mussels to the Inner Bay in the early 1990s had been the most pronounced recent influence on SAV in LPB. We initiated this study, in part, to assess the abundance and distribution of Dreissenid mussels and SAV in LPB to make comparisons to prior studies. Although the distribution of Dreissenid mussels in LPB has not changed, the total abundance of these mussels has decreased considerably since 1992 (Figure 2). The rapid increase in Dreissenid mussel abundance in the early-1990s resulted in increased water transparency through the substantial filtering capacities of Dreissenid mussels causing a decline in all phytoplankton taxa and chlorophyll concentrations in Lake Erie (Holland 1993). The decline in particulate matter within the water column has likely contributed to the overall decline in Dreissenid mussels since 1992 because they use phytoplankton as food. Furthermore, predation by both fish and waterfowl likely had an influence on this overall decline in abundance of Dreissenid mussels (Mitchell 1995, Petrie and Knapton 1999). The resulting shift in water clarity in LPB also may have influenced the SAV community within LPB.

With the exception of slender pondweed, the 5 most abundant SAV species in LPB have experienced declines in abundance since 1992 (Figure 6). Though this was predicted for the charophyte species in LPB (muskgrass), it contradicted the predicted increase in angiosperm SAV species abundance expected with more eutrophic conditions. Carter and Rybicki (1986) determined that the resurgence of SAV within the tidal Potomac River could not be conclusively attributed to either nutrient loading or water clarity. Because nutrient enrichment and light availability are interrelated, it is possible that a synergistic effect could better explain SAV growth within LPB. Though angiosperm SAV species' are known to proliferate in eutrophic water (Smith 1979) it is possible that there is a point at which there is not enough light available to stimulate growth, regardless of nutrient availability. Inputs of nitrogen and phosphorus from fertilizer applications can result in declines of SAV and enhancement of phytoplankton growth (Twilley et al. 1985). Increased abundance of suspended particles in the water column decrease light availability for SAV and reductions in growth are often observed. As such, the decline in filter-feeding Dreissenid mussels in LPB and an associated increase in phytoplankton growth may have reduced light availability for SAV below a threshold that retards growth of these plants. My results suggest that SAV abundance is related to Dreissenid mussel densities within LPB with increased SAV and mussels in the 1990s and subsequent decreases in SAV with a 96% decrease in mussels detected between the mid-1990s and 2009.

Further monitoring of SAV and Dreissenid mussels within LPB is important given the importance of SAV to migrating waterfowl, specifically diving ducks and dabbling ducks that graze on the leaves and stems of SAV require an abundance of these plants to fuel migration (Petrie 1998, Baldassarree and Bolen 2006). Additionally, it would be beneficial for future studies to assess nutrient inputs and levels in LPB as they influence SAV growth and were not analyzed as part of this study. Nutrient inputs are also important when considering substrate types in LPB. Big Creek flows into northwest LPB, an area that is covered with dense, diverse stands of SAV. The Big Creek delta contains the only section of mud substrate in LPB, and this study shows the importance of this substrate type to a variety of plants (Figures 7 and 8). Because sediment from Big Creek watershed deposited in LPB as mud substrate and likely contributes substantially to turbidity, light attenuation, and nutrient loading in LPB, further research on landscape change and these inputs into LPB is necessary to increase our capacity to predict future changes to SAV in LPB.

4.2 Energetic Carrying Capacity

Availability of food from SAV for waterfowl using LPB, particularly diving ducks, is at a maximum in the end of summer prior to autumn migration. In August, SAV typically reaches maximum above-ground biomass and begins shifting resources to propagules by late-September

(Rybicki and Landwehr 2007). Above-ground biomass senesces throughout the autumn, and is further depleted through foraging by waterfowl and fish. Remaining biomass is available to spring migrating waterfowl after ice break-up, and was predicted to be potentially limiting to foraging carrying capacity of LPB for waterfowl during the spring migration period.

Food availability and thus energetic carrying capacity in LPB currently meets and exceeds the requirements of migrating waterfowl in both the autumn and spring seasons (Figure 5). Considering all species of SAV, there is a 10-fold surplus of energy in LPB. However, previous studies suggest that some species of SAV are avoided relative to their abundance. In a study of waterfowl shot at LPB, it was found that only Redhead and American wigeon consume muskgrass consistently (Petrie 1998), whereas it was found only in trace amounts among other species. I determined that muskgrass was > 80% of the plant community (dry weight) in autumn and spring, providing of the majority of potential available energy. When I excluded muskgrass from my analysis, energy available and surplus were greatly reduced (Figures 12-15). Habitat managers should assess the utility of muskgrass for the suite fish and wildlife that use LPB and, if justified, consider methods to reduce the abundance of muskgrass in LPB while concurrently increasing availability of other species of SAV to increase diversity and forage quality of the plant community for waterfowl.

Over the past 30-years, percentage of ice cover has decreased and length of periods with open water conditions on bays has increased at the Great Lakes during winter (Assel 2003). Further, it is predicted that a greater frequency of no-ice condition will continue to increase with increased warming during winter (Lofgren et al. 2002). I estimated potential increased foraging pressure if LPB was ice-free throughout winter using a 75-day winter period that traditionally excluded all waterfowl from LPB. Decreased numbers of days with ice cover in LPB and the related additional foraging pressure on SAV by waterfowl has the potential to decrease availability of these resources for spring migrating waterfowl. My estimates suggested a wide range of available winter DUDs using energy needs of waterfowl from 1990-2006 waterfowl surveys. In some years I detected an energy deficit in LPB, but our 16-year mean suggests that LPB could support slightly over 1.2 x 10^6 ducks that consume SAV through the 75 day wintering period without influencing availability of these plant foods for spring migrating waterfowl. In winter 2011-2012, an estimated 30,000 redheads and canvasback spent 60 days on LPB in open water areas (M. Schummer, personal observation), suggesting that recent trends in decreased ice cover during winter may currently have energetic implications for spring migrating waterfowl in the Great Lakes basin. I was only able to compare the requirements for wintering waterfowl with one year of availability data because my seasonal estimates are the only on record. Thus, I suggest caution when interpreting estimates, because greater energy needs of ducks (i.e., deficit years, Figure 15 – 1998) relative to availability suggest greater availability of SAV or other foods eaten by waterfowl. Indeed, variation in abundance and distribution of SAV is only quantified during 4 autumn periods (1976 – 2009) and I suggest that variation among years and understanding mechanisms for these changes would greatly improve our understanding of energetic carrying capacity of SAV in LPB. Further, the implication of a greater number of ice-free days and associated foraging pressure could be more appropriately assessed. I also suggest that waterfowl may shift to forage on muskgrass in years of greater foraging pressure or decreased availability of SAV. If waterfowl shift to forage on muskgrass when other selected SAV plants decrease in abundance, there is substantially more food available in LPB than required by waterfowl that used LPB 1990–2006.

Further research should look to add to what is known about food availability in LPB. This study only observed one-year of SAV biomass and provides only a small snapshot of what occurs on a yearly basis. Adding additional years of biomass data to the set would enable more accurate comparisons of availability and requirements. Furthermore, assessing the seasonal diets and testing for diet shifts of migrating waterfowl would help determine if muskgrass is eaten to a greater degree when other types of SAV are less abundant. Knapton and Petrie (1999) only assessed waterfowl diets for one year, and it is possible that particular year was one of abundant food availability and thus waterfowl actively selected more nutritious food.   Concurrently studying SAV and Dreissenid mussel availability and with waterfowl diets would help refine my energetic carrying capacity estimates and our understanding of the influence of climate change on SAV and waterfowl in LPB.

Table 1. Results of the multiple logistic regression of the SAV distribution data (n=321). Specific SAV species' presence or absence was the response variable and the 11 site characteristics were the explanatory variables.

Species	**Effect**	**Estimate**	**Error**	**DF**	***P***	**X^2**
Wild Celery	Intercept	-1243.2	213.6	1	<0.001	33.884
	Substrate			2	0.034	6.788
	Mud	-0.319	0.251	1		
	Sandy Loam	-0.142	0.153	1		
	Depth	-0.018	0.007	1	0.011	6.521
	Year			2	0.067	5.489
	1991	0.179	0.157	1		
	1992	0.162	0.162	1		
	Depth × Depth	<0.001	<0.001	1	0.027	4.885
	Substrate × Year			4	0.035	10.354
Muskgrass	Intercept	1567.5	237.3	1	<0.001	43.636
	Substrate			2	<0.001	22.056
	Mud	-0.56	0.208	1	0.007	7.214
	Sandy Loam	0.671	0.144	1	<0.001	21.734
	Depth	0.013	0.007	1	0.047	3.941
	Year			2	<0.001	36.341
	1991	-0.6	0.134	1	<0.001	19.923
	1992	0.828	0.141	1	<0.001	34.592
	Depth × Depth	<-0.001	<0.001	1	<0.001	13.872
Eurasian Milfoil	Intercept	-927.3	299.2	1	<0.001	16.367
	Substrate			2	0.001	17.731
	Mud	0.419	0.213	1	0.049	3.854
	Sandy Loam	-0.649	0.152	1	<0.001	17.723
	Year			2	<0.001	90.513
	1991	0.874	0.141	1	<0.001	38.624
	1992	0.625	0.139	1	<0.001	20.301
	Depth × Depth	<0.001	<0.001	1	<0.001	11.556

Table 1. Cont

Species	Effect	Estimate	Error	DF	***P***	X^2
Naiad	Intercept	-220.3	196.6	1	0.262	1.256
	Substrate			2	<0.001	44.131
	Sandy Loam	0.603	0.135	1	<0.001	20.047
	Year			2	<0.001	104.433
	1991	0.357	0.117	1	0.002	9.262
	1992	0.859	0.123	1	<0.001	49.022
	Substrate × Year			4	<0.001	33.341
Richardson's pondweed	Intercept	-618.4	240.1	1	0.01	6.636
	Substrate					
	Mud	0.9420	0.734	1		
	Sandy Loam	0.1756	0.798	1		
	Depth	-0.020	0.007	1	0.002	9.325
	Year			2	<0.001	23.652
	1991	2.787	0.635	1		
	1992	2.115	0.647	1		
	Depth × Depth	<0.001	<0.001	1	0.002	9.853
	Substrate × Year			4	0.047	9.650
Slender pondweed	Intercept	-1243.2	213.6	1	<0.001	33.884
	Substrate			2	0.024	7.491
	Mud	1.245	0.755	1		
	Sandy Loam	-0.512	0.572	1		
	Depth	-0.018	0.007	1	0.054	3.710
	Year			2	<0.001	5.489
	1991	-13.720	153.7	1		
	1992	-2.056	0.483	1		

Table 2. True metabolizable energy (TME) values (kcal/g) used to calculate energetic carrying capacity for food items in Long Point Bay, Lake Erie during summer/fall 2009.

Food Item	TME (kcal/g)	Source
Ceratophyllum demersum	0.49	Brasher et al. 2007
Chara vulgaris	0.57	Boyd 1968
Myriophyllum spicatum	0.55	Boyd 1968
Najas spp.	0.82	Brasher et al. 2007
Potamogeton spp.	0.82	Brasher et al. 2007
Vallisneria americana		
aboveground	0.78	Donnermeyer 1982
belowground	0.88	Donnermeyer 1982

Table 3. Daily energetic requirements (DER) of species and guilds (bold) and the percentage of diet consisting of stems/leaves of waterfowl species using SAV habitat within Long Point Bay, Lake Erie (LPB). DER (guild) represents the mean of all species.

Species	**DER (kcal/day)**	**% of diet consisting of stems/leaves**
Grazers	**268***	
American wigeon *(Anas americana)*	255*	90.5†
Gadwall (*Anas strepera)*	280*	96.7†
Divers	**274***	
Bufflehead (*Bucephala albeola)*	213**	29.3†
Canvasback (*Aythya valisineria)*	347*	88†
Common goldeneye (*Bucephala clangula)*	249***	51.7†
Redhead (*Aythya americana)*	311*	72.8†
Ring-necked duck (*Aythya collaris*)	234*	24.7††
Scaup (*Aythya affinis* and *Aythya marila)*	280*	9.3†

* Straub 2008
**McKinney and McWilliams 2012
*** DER migration = 3xBMR and DER wintering = 3xBMR (King 1974)
† Petrie 1998
† † Mendall 1958

Table 4. Seasonal biomass (g/m^2; mean ± SE), given by species of SAV in Long Point Bay, Lake Erie, Ontario autumn 2009 and spring 2010.

Species	**Spring Mean Biomass (g/m^2 ± SE)**	**Autumn Mean Biomass (g/m^2 ± SE)**
Ceratophyllum demersum	0.48 ± 0.26	0.82 ± 0.21
Chara vulgaris	41.18 ± 8.35	60.55 ± 11.61
Myriophyllum spicatum	1.59 ± 0.76	3.20 ± 1.25
Najas spp.	1.17 ± 0.5	3.60 ± 1.05
Potamogeton richardsonii	0.07 ± 0.08	0.53 ± 0.24
Potamogeton pusillus	1.36 ± 1.43	1.54 ± 0.67
Vallisneria americana		
above-ground	0.61 ± 0.49	3.20 ± 0.49
below-ground	0.27 ± 0.07	0.04 ± 0.01

Table 5. Seasonal estimates of average required (1990-2006) and available energy (kcals; energetic carrying capacity) in LPB, Lake Erie 2009.

Season	Avg. Required†	Avg. Required††	Total Carrying Capacity	Carrying Capacity*
Autumn	937,739,965	347,873,962	3,455,303,332	763,413,993
Spring	410,099,844	162,824,152	2,177,911,921	346,950,470

† Total energy required
†† Total energy required after stems/leaves adjustment
* Muskgrass removed from available energy

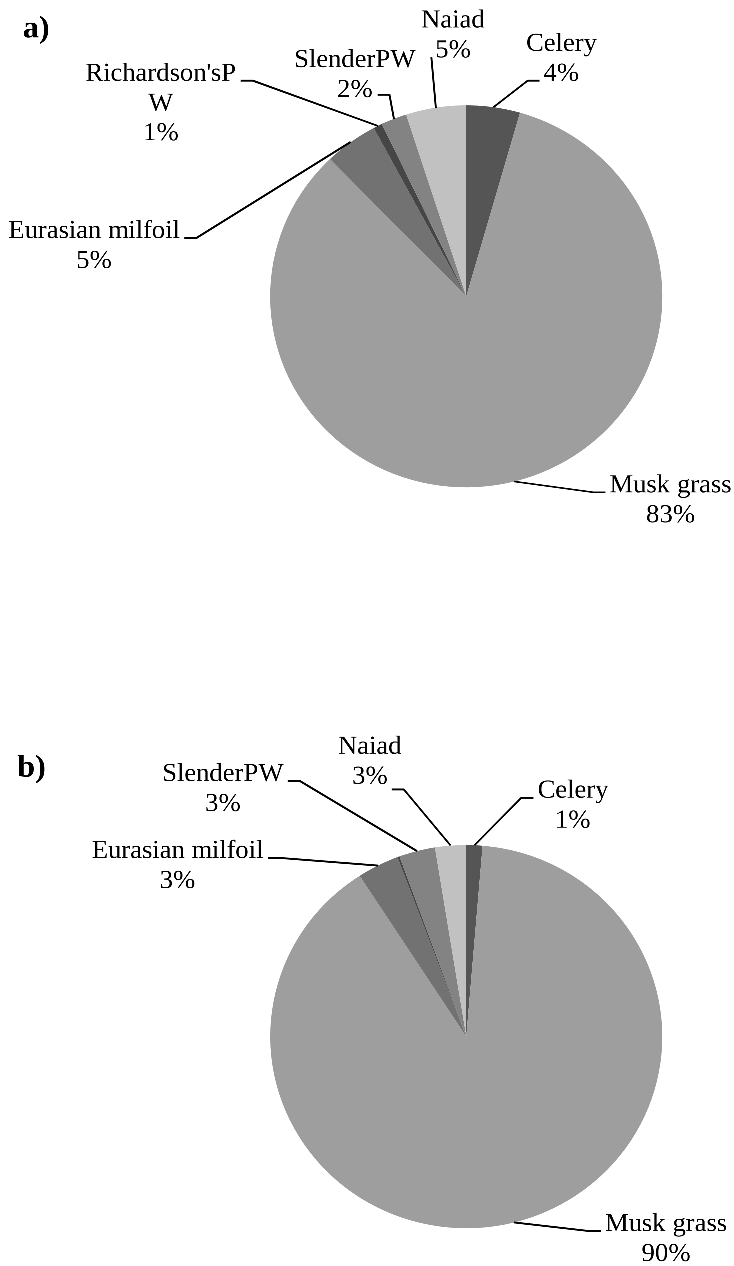


Figure 1. Percent composition of each SAV species' biomass (g/m^2) within LPB: a) Autumn and b) Spring.

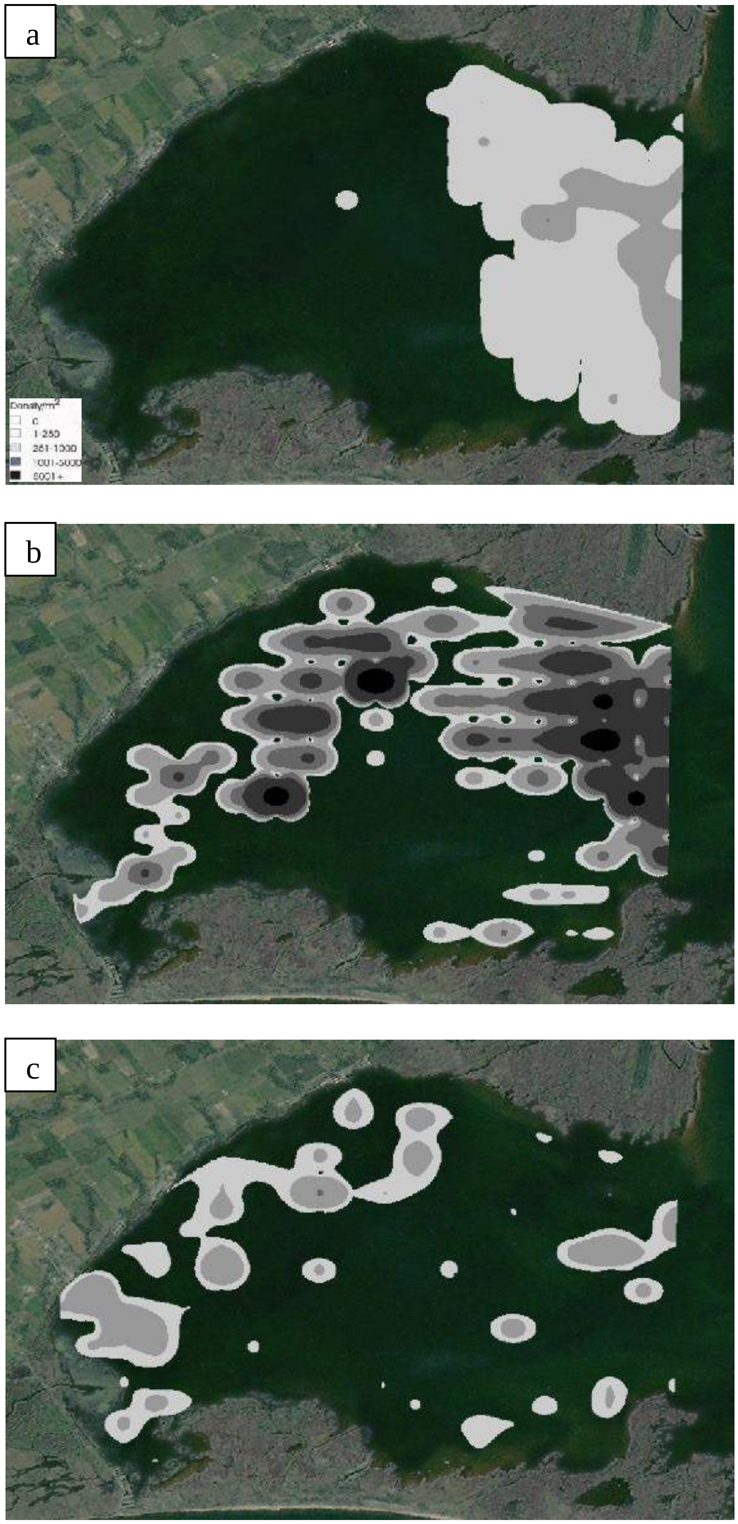


Figure 2. Distribution and abundance (mussels/m^2) of Dreissenid mussels in Long Point Bay – Lake Erie a) 1991 b) 1992 and c) 2009.

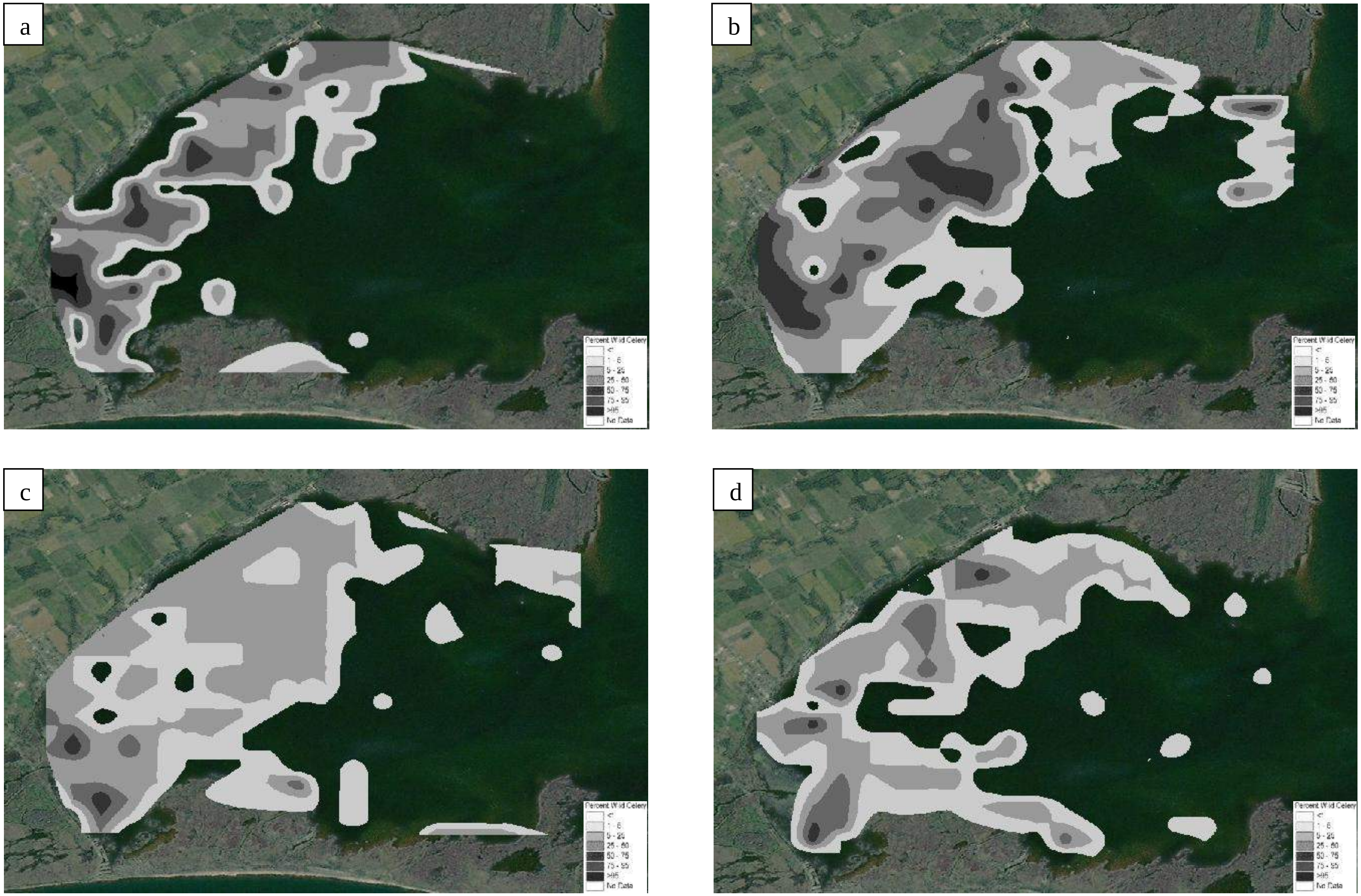


Figure 3. Distribution and abundance (percent cover) of wild celery (*Vallisneria americana*) in Long Point Bay – Lake Erie a) 1976 b) 1991 c) 1992 and d) 2009.

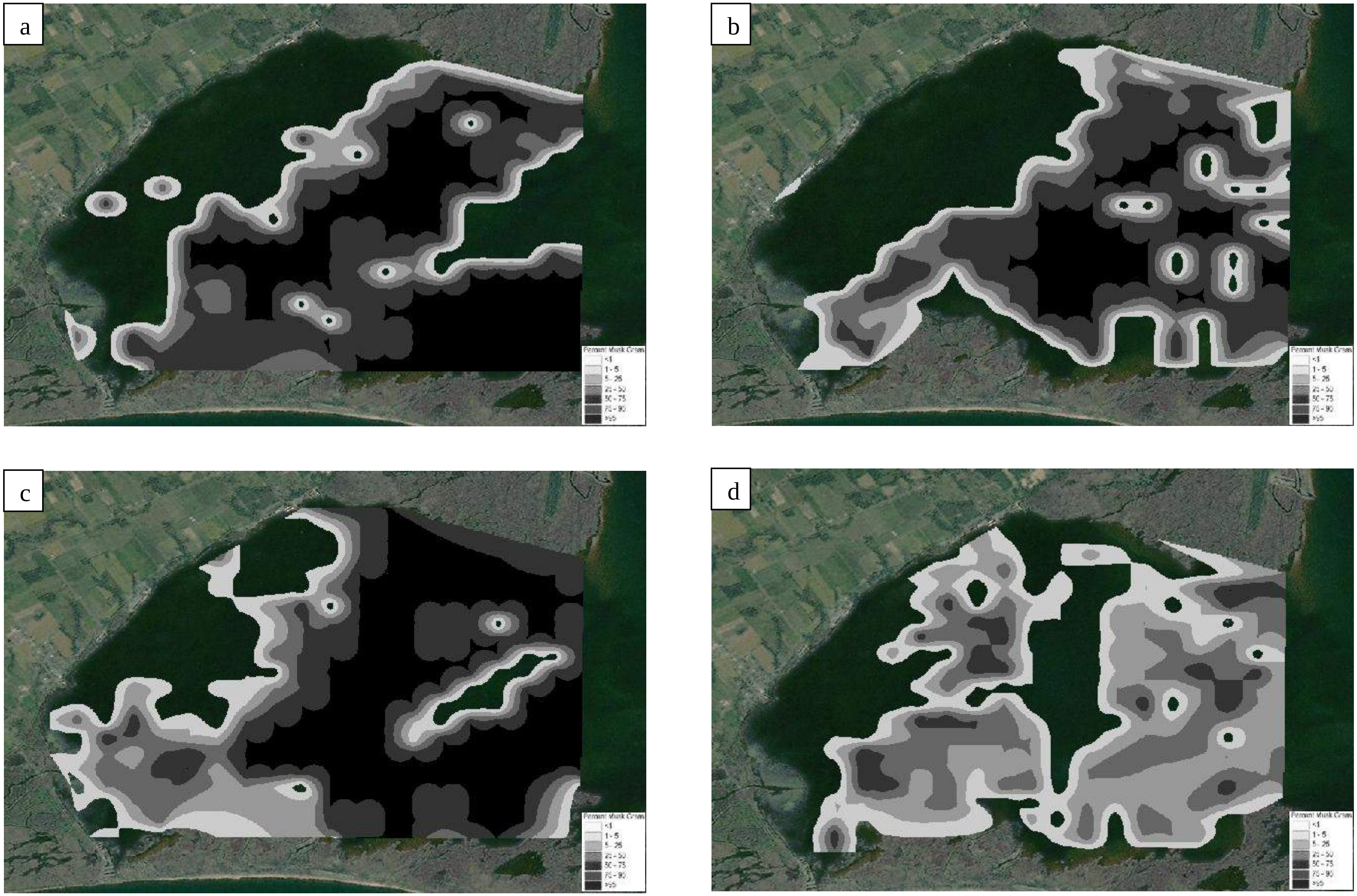


Figure 4. Distribution and abundance (percent cover) of muskgrass (*Chara vulgaris*) in Long Point Bay – Lake Erie a) 1976 b) 1991 c) 1992 and d) 2009.

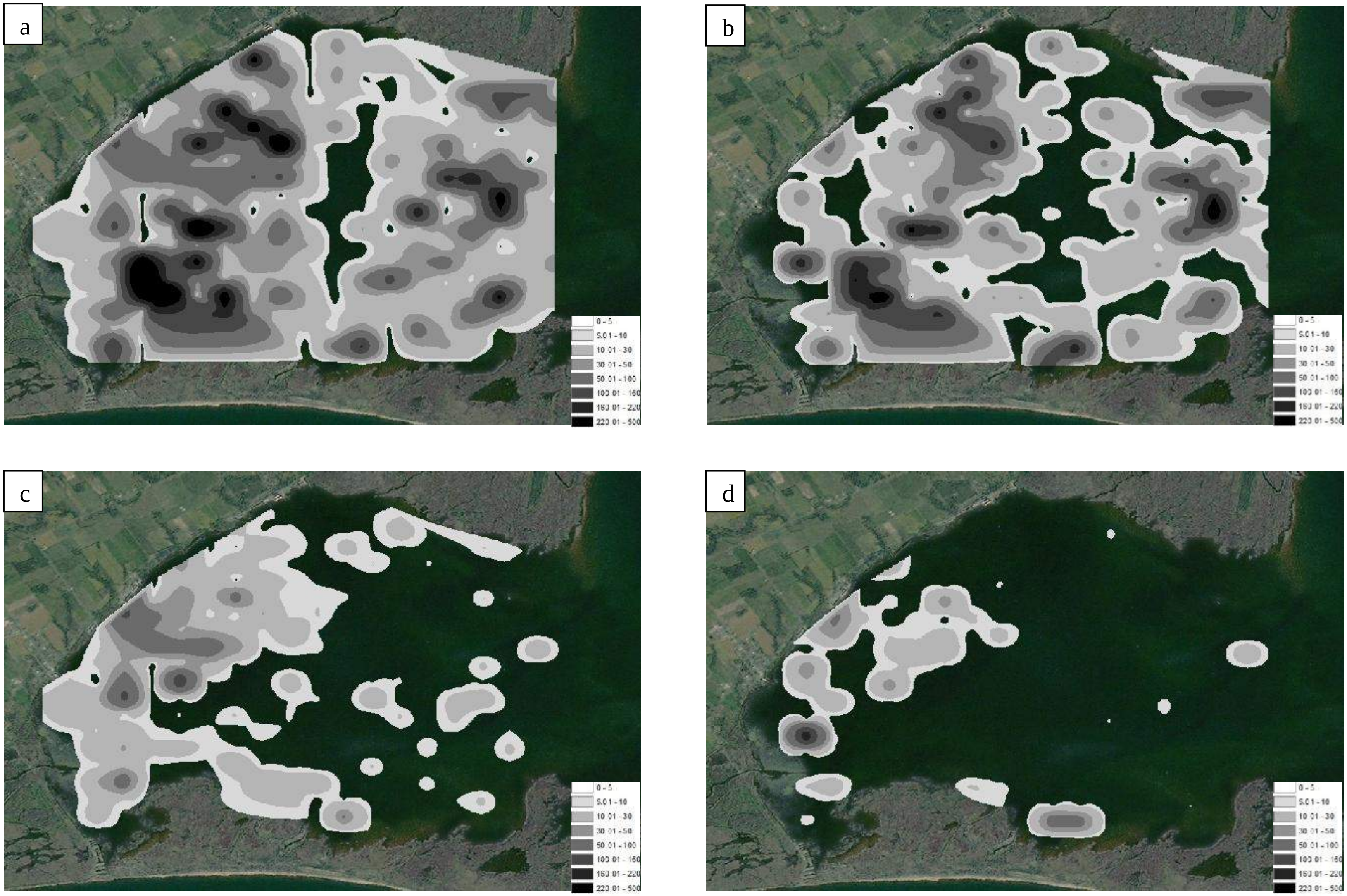


Figure 5. Total energy available (kcal/m^2) from submerged aquatic vegetation in autumn 2009 (a and c) and spring 2010 (b and d) both with (a and b) and without (c and d) muskgrass (*Chara vulgaris*) in Long Point Bay – Lake Erie.

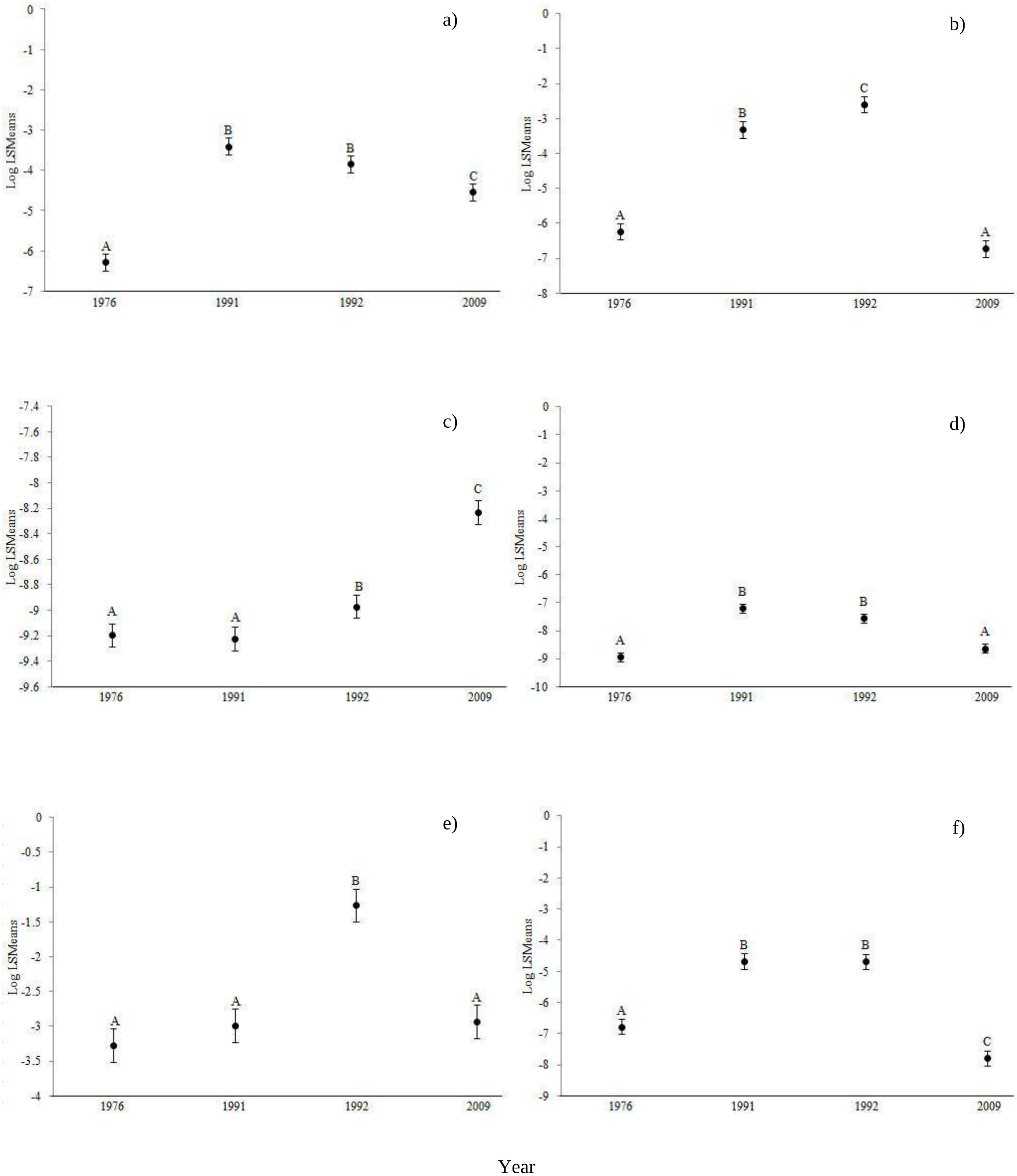


Figure 6. Least-squared means (log transformed) of percent abundance (± SE) for the most abundant species of SAV in LPB: a) Wild celery b) Naiad spp. c) Slender pondweed d) Richardson's pondweed e) Muskgrass and f) Eurasian milfoil.. Years with similar letters are not significantly different (P > 0.10).

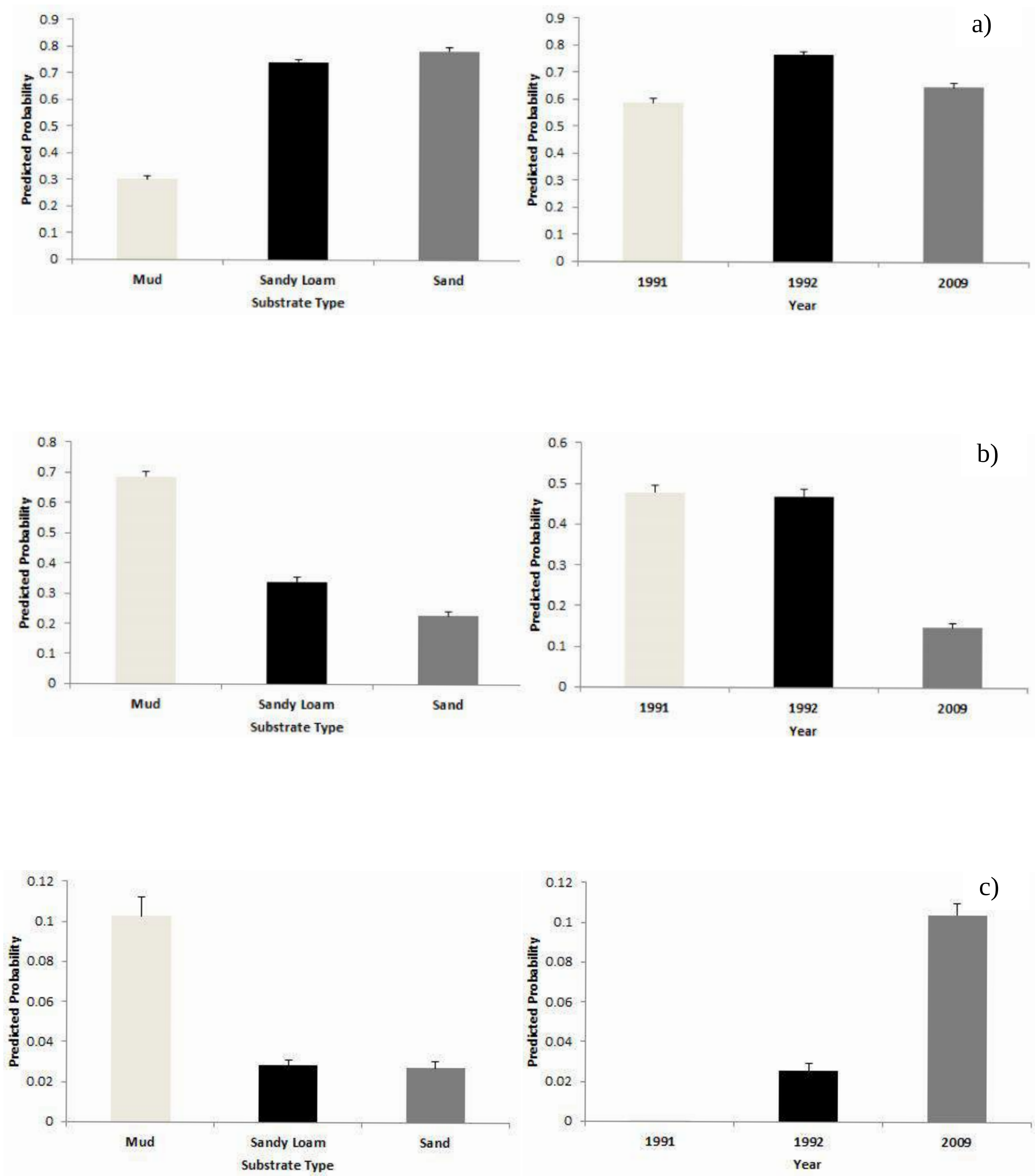


Figure 7. Relationship between the predicted probability of SAV presence (a) muskgrass b) Eurasian milfoil c) slender pondweed) and the effects of substrate and year in Long Point Bay – Lake Erie in 1991, 1992, and 2009.

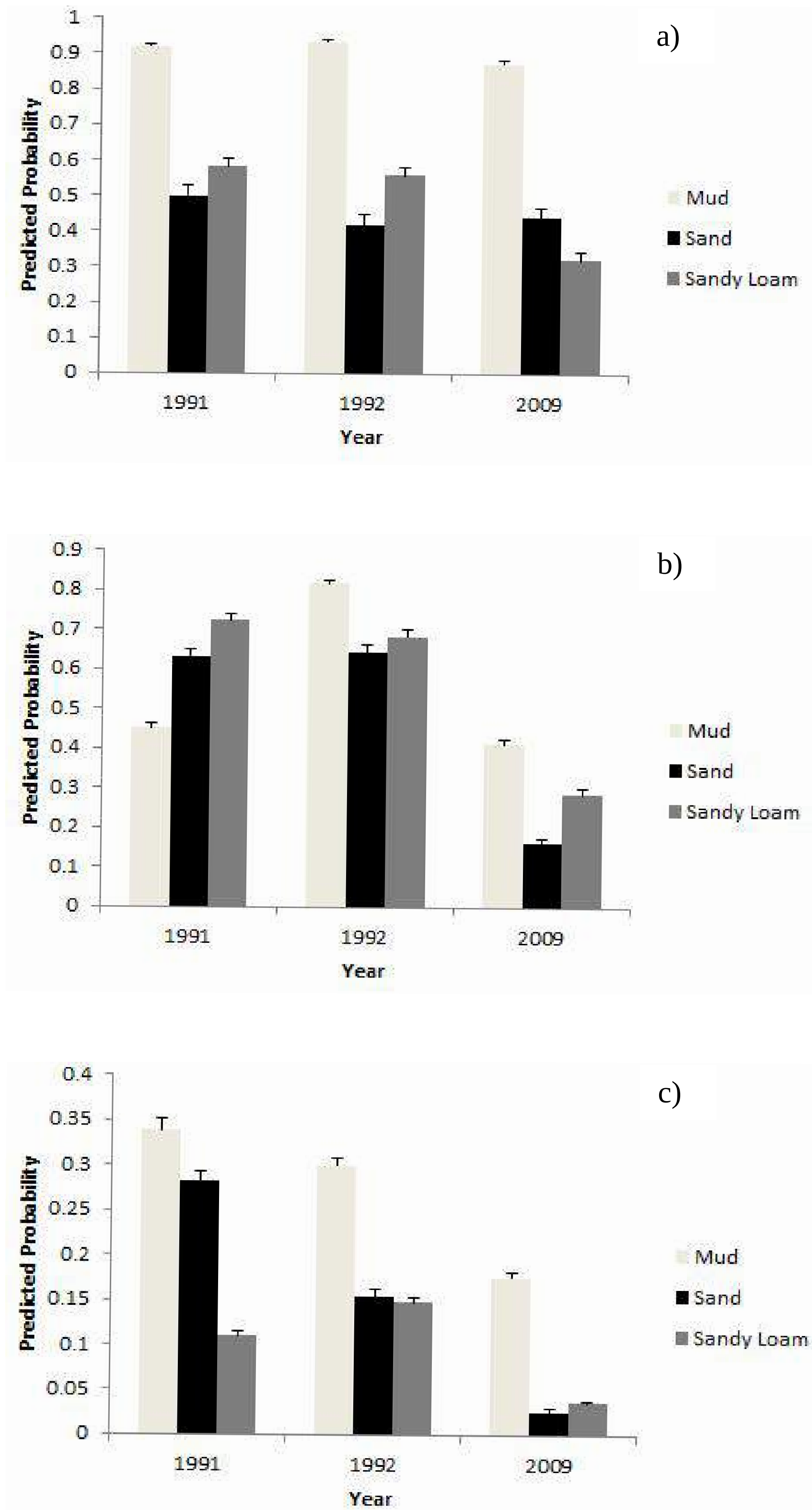
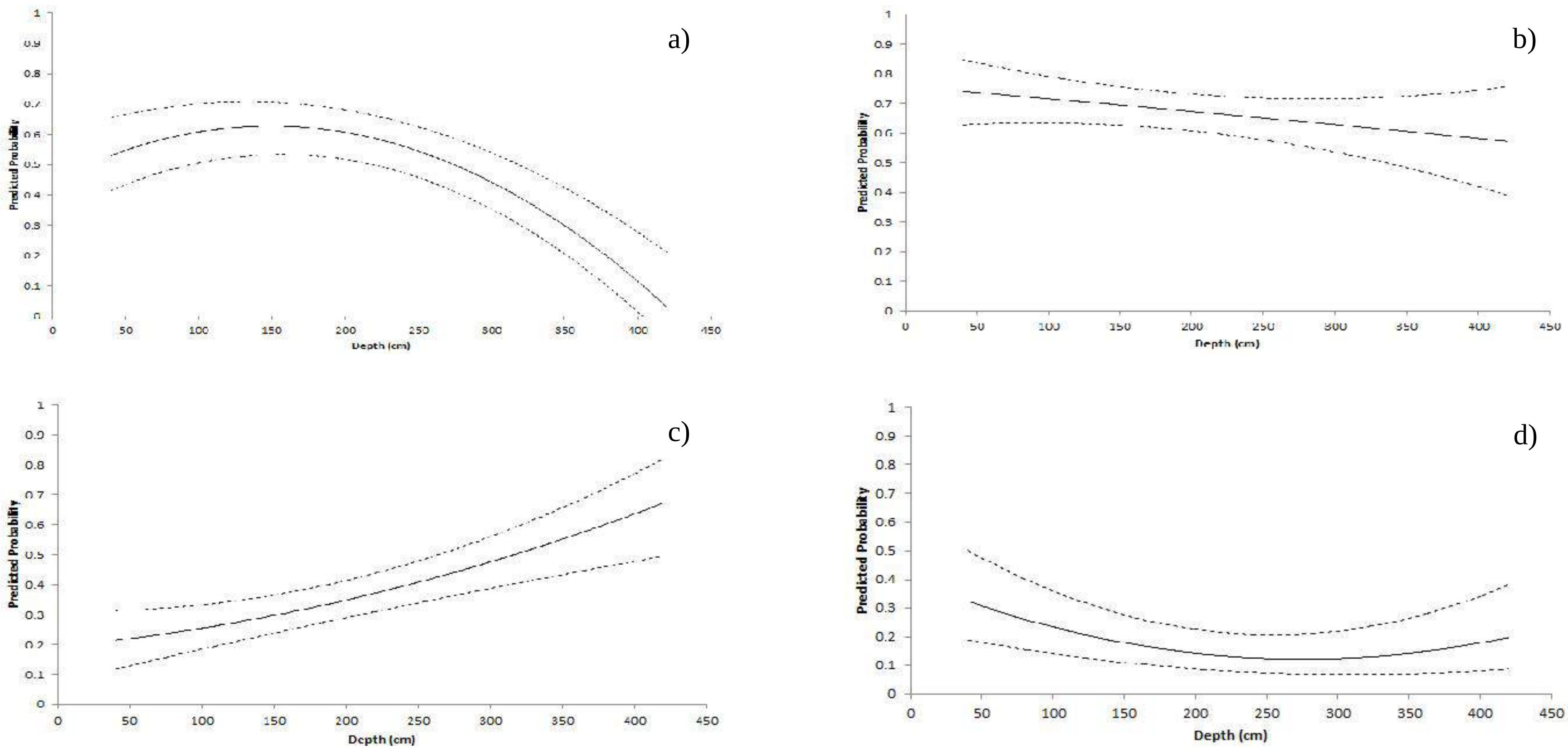


Figure 8. Relationship between the predicted probability of SAV presence (a) wild celery b) naiad spp. c) Richardson's pondweed) and the interactive effects of substrate and year in Long Point Bay – Lake Erie in 1991, 1992, and 2009.



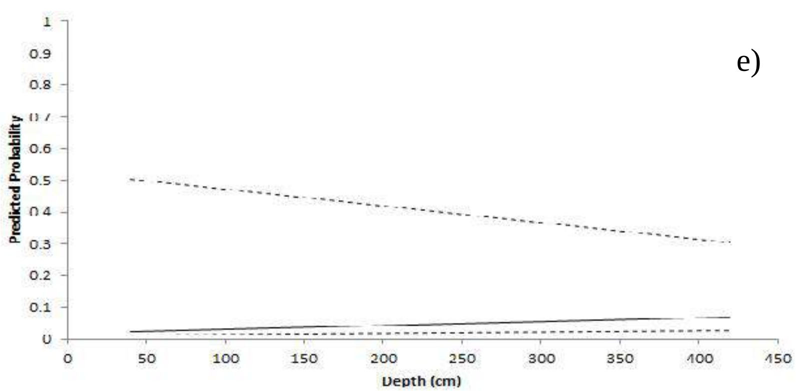


Figure 9. Relationship between the predicted probability of SAV presence (a) wild celery b) muskgrass c) Eurasian milfoil d) Richardson's pondweed e) slender pondweed) and water depth (± 90% confidence intervals) in Long Point Bay – Lake Erie in 1991, 1992, and 2009.

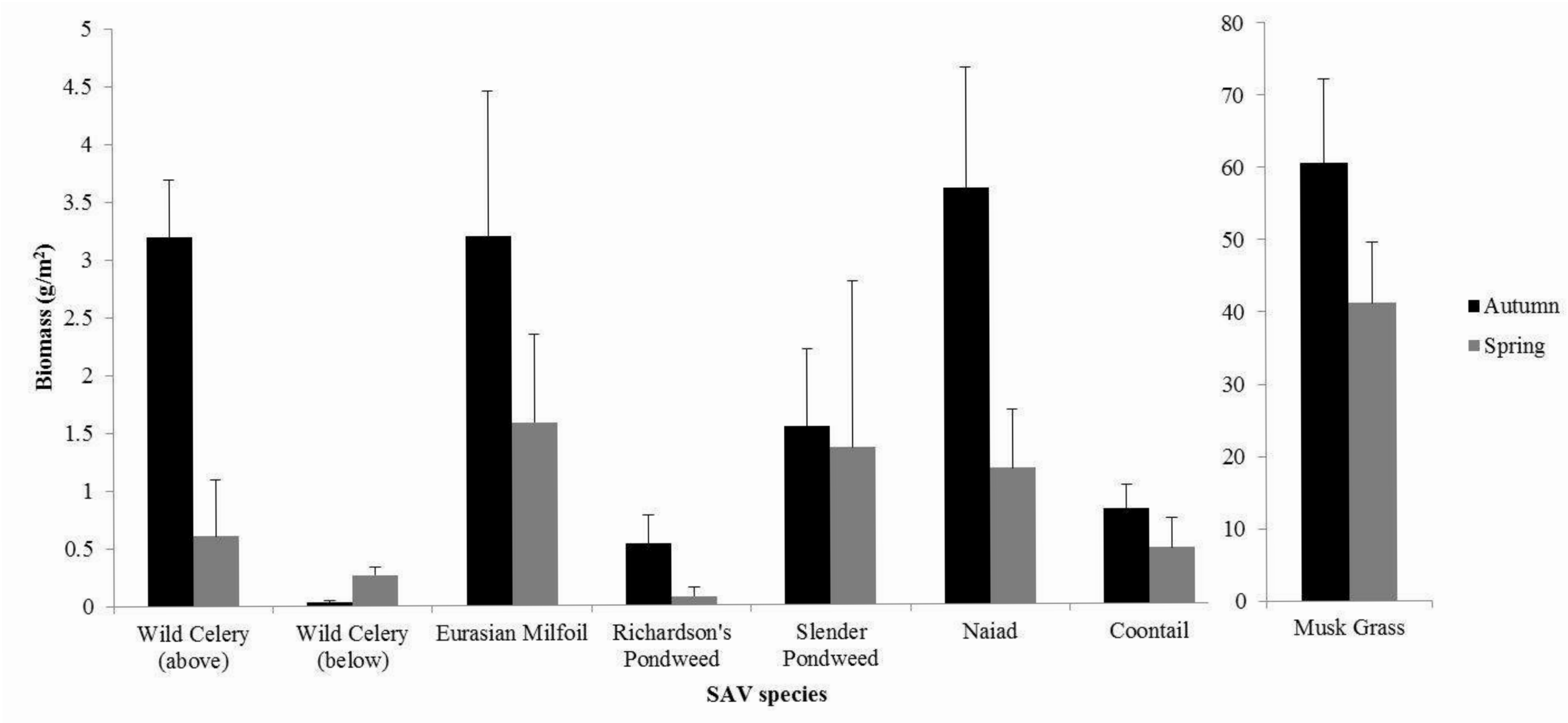


Figure 10. Seasonal biomass (g/m^2; mean ± 90% CI), given by species of SAV in Long Point Bay, Lake Erie, Ontario autumn 2009 and spring 2010.

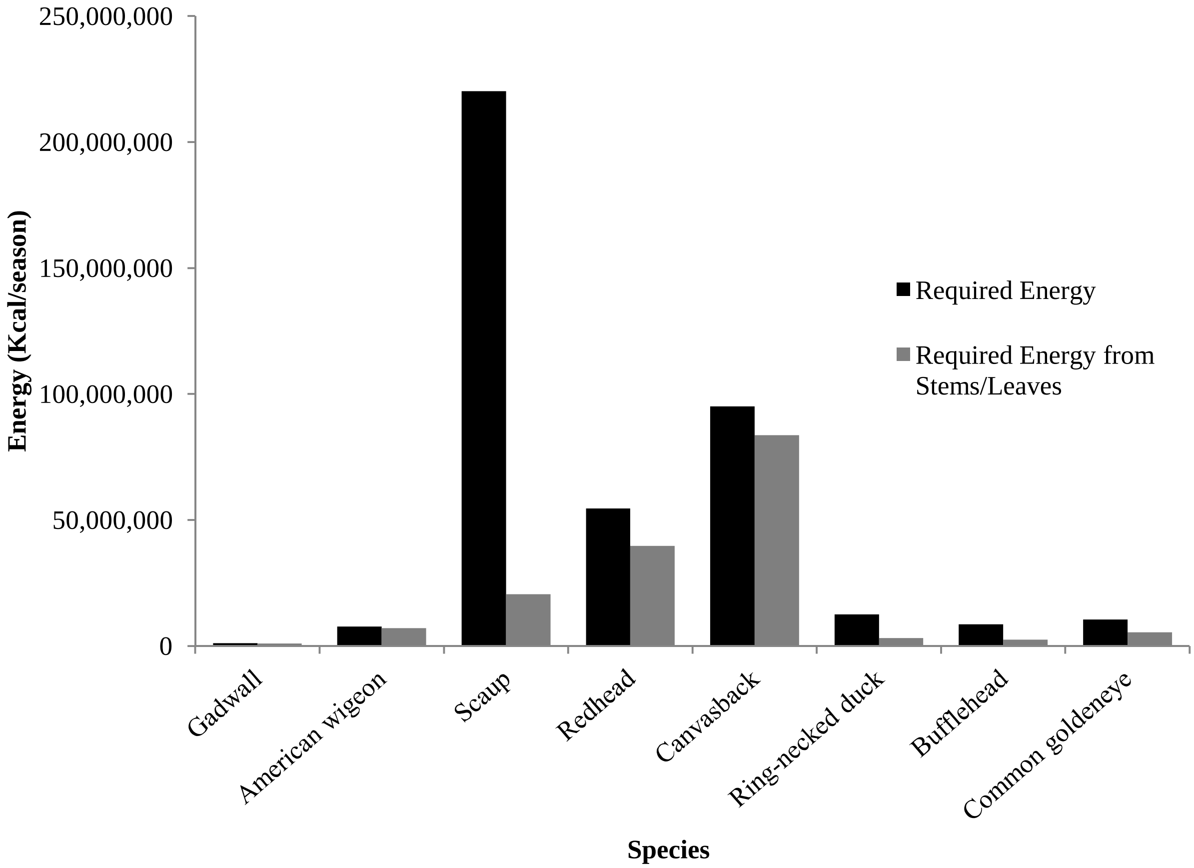


Figure 11. Total required energy and the total required energy from stems/leaves for SAV consuming waterfowl species within LPB

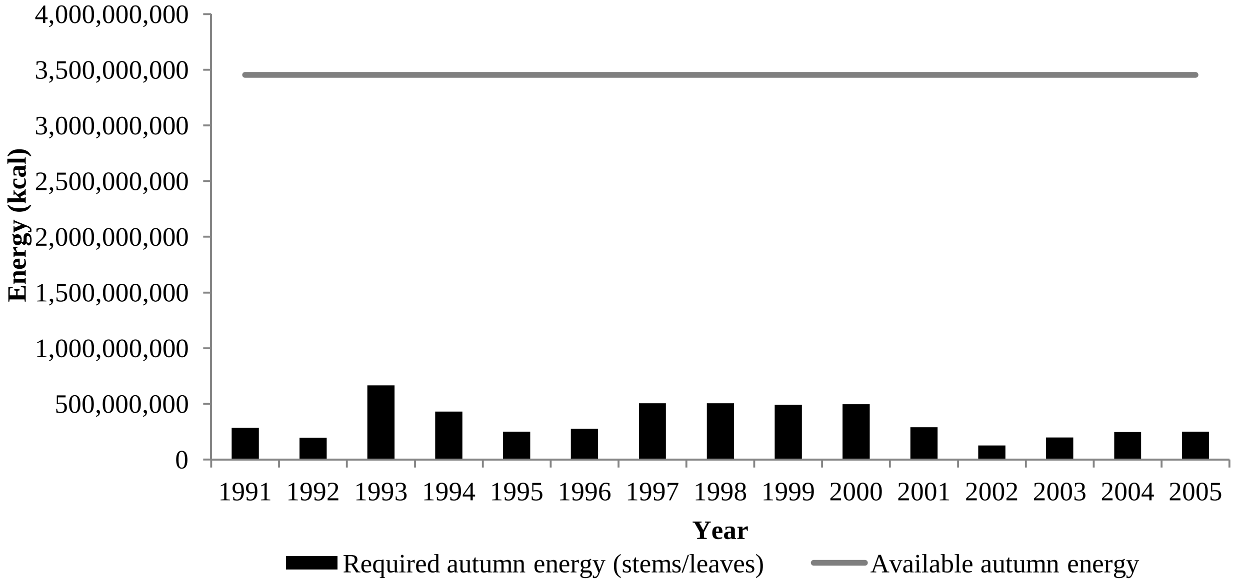


Figure 12. Available autumn energy and the required energy from the stems/leaves of SAV within LPB (with Muskgrass).

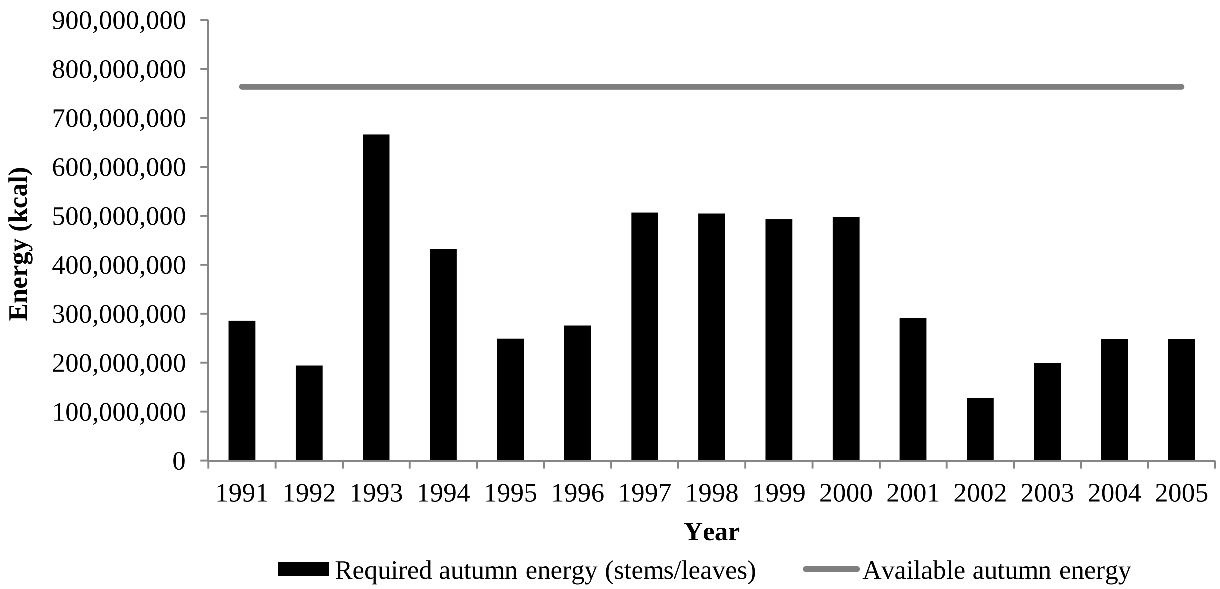


Figure 13. Available autumn energy and the required energy from the stems/leaves of SAV within LPB (without Muskgrass).

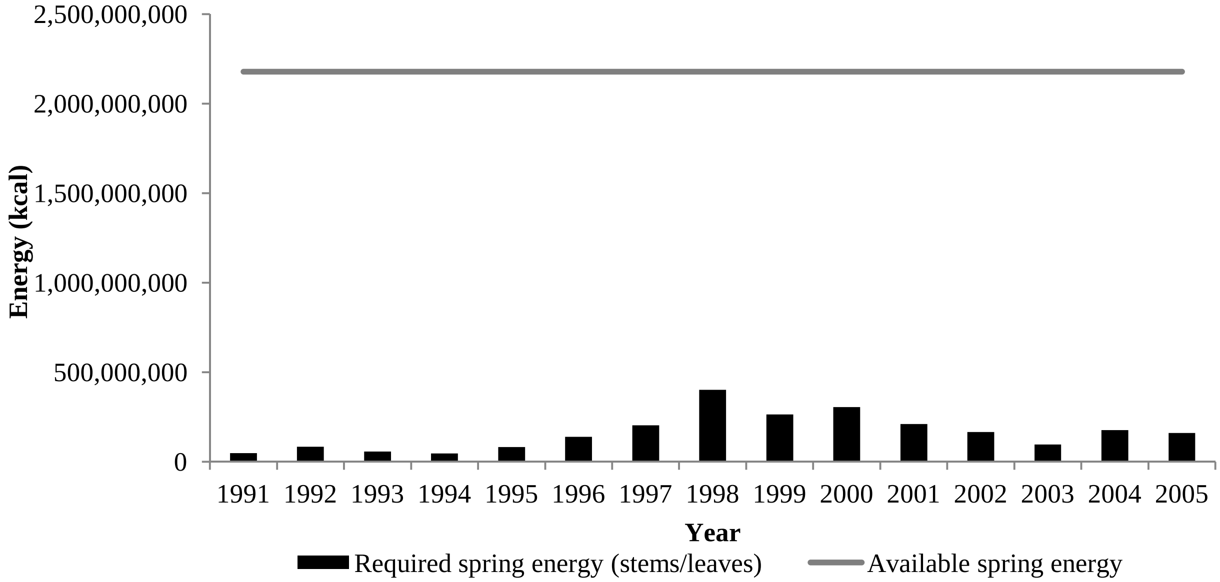


Figure 14. Available spring energy and the required energy from the stems/leaves of SAV within LPB (with Muskgrass).

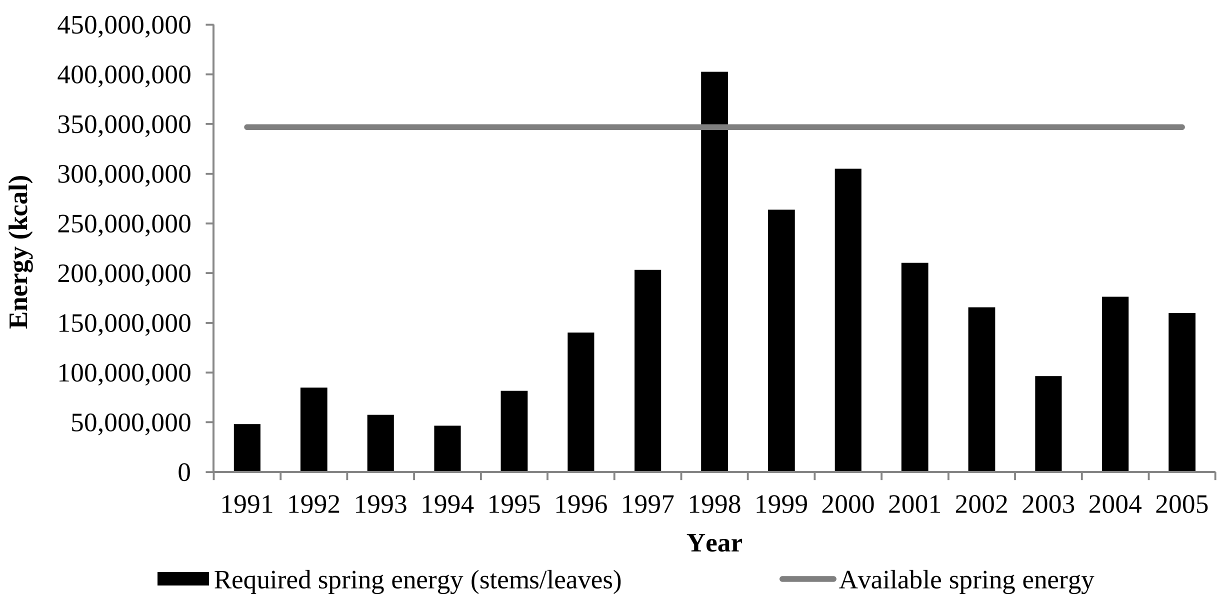


Figure 15. Available spring energy and the required energy from the stems/leaves of SAV within LPB (without Muskgrass).

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Monitoring and Assessing Bird and Anuran Populations at Long Point Inner Bay Marshes

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INTRODUCTION

Marsh-dependent bird and amphibian communities are known to be sensitive to disturbances within and surrounding wetlands (Price et al. 2007, Kerby et al. 2010, DeLuca et al. 2004, Howe et al. 2007). Marsh bird and amphibian species population declines over the past several years may be due to loss and degradation of wetlands across the Great Lakes (Gibbs et al. 1992, Conway 1995, Melvin and Gibbs 1996). Marsh bird and amphibian communities can be used as indicators of marsh ecological integrity (DeLuca et al. 2004, Crewe and Timmermans 2005, Hanowski et al. 2007, Price et al. 2007). Therefore, monitoring and evaluating relative population status and community structure of marsh birds and amphibians within the Great Lakes basin is important to understand how well marshes across the basin are functioning to maintain ecological integrity.

The Great Lakes Marsh Monitoring Program (MMP) is a binational marsh bird and anuran population monitoring program that has successfully engaged volunteer naturalists since 1995 to measure the status and trends of wetland-dependent birds and anurans (herein referred to as amphibians), and has provided valuable information about the health and ecological integrity of Great Lakes coastal lacustrine and inland palustrine wetlands. Since the program's inception, one of its primary objectives has been to contribute to the assessment and long-term monitoring of priority wetland sites throughout the Great Lakes basin. The primary objectives of the Great Lakes MMP are to:

1. Monitor marsh bird abundance and amphibian occurrence over time at a variety of spatial scales bi-nationally across the Great Lakes basin.
2. Investigate habitat associations of marsh birds and amphibians.
3. Inform wetland conservation, restoration, and management planning, such as for Great Lakes Areas of Concern, through assessments of marsh bird and amphibian communities.
4. Increase awareness of marsh bird, amphibian, and wetland conservation issues through volunteer participation and communication to the public, scientists, and resource managers.

In 2008 and 2009, BSC, in partnership with the Ontario Ministry of Natural Resources (OMNR) – Lake Erie Management Unit, conducted marsh bird and amphibian surveys in Long Point-area marshes using MMP protocols. Surveys were completed by volunteers, and contract staff. This work was part of a larger three-year OMNR project to assess the ecological health of, and threats to, Long Point Bay, and to identify remedial actions needed to protect and rehabilitate this important Lake Erie ecosystem. Measures of marsh health, based on marsh bird and amphibian community condition, will be integrated with several other biotic and abiotic components to provide a comprehensive assessment of Long Point Bay ecological integrity.

This report summarizes the results of two years of extensive marsh-based bird and amphibian surveys throughout Long Point Bay marshes and lower tributaries. The primary objectives of this project were to:

1) Summarize marsh bird and amphibian species occurrence and relative abundance among survey visits and overall for surveyed marsh habitats;

2) Summarize proportional coverage of major habitat features and emergent marsh vegetation among surveyed marsh habitats;
3) Relate collected bird and amphibian data to site-level disturbance data to evaluate and rank coastal marsh relative health, through use of Indices of Biotic Integrity, in relation to other Lake Erie coastal marshes;
4) Assess marsh bird and amphibian species richness in surveyed Long Point Bay marshes, relative to values calculated for other Lake Erie coastal marshes;
5) Assess changes in marsh bird and amphibian species occurrence and relative abundance across years at selected marsh sites; and,
6) Compare marsh bird and amphibian species occurrence and relative abundance between "more degraded" and "less degraded" marsh sites among Long Point Bay and Rondeau wetland complexes.

METHODS

Route selection and characteristics of MMP routes and stations

Upon registering with the MMP, volunteers received training kits that included detailed protocol instructions, field and summary data forms, instructional CDs with examples of songs and calls of common marsh birds and amphibians, and a CD used to elicit calls from secretive marsh bird species. Survey routes were established in marsh sites that are at least 1 ha in size. Each route consisted of one to eight monitoring stations depending on factors such as available time and marsh habitat size. Each marsh bird survey station was separated by at least 250 m to minimize duplicate counts of individuals. For amphibians, this distance was extended to 500 m because observers record all amphibians heard both inside and beyond the 100 m station boundary (i.e., within hearing distance).

An MMP station was defined as a 100-m radius semi-circle with marsh habitat covering greater than 50% of the semi-circular area. Marsh habitat was defined as habitat regularly or periodically wet or flooded to a depth of up to two metres where cattail, bulrush, burreed and other non-woody vegetation predominated. Counts were conducted from a focal point at each station – the surveyor stood at the midpoint of the 200 m semi-circular base and faced the arc of the station perimeter. Each focal point was permanently marked with a stake and metal tag to facilitate relocation within and between years.

Bird Survey Protocol

Survey visits for birds were conducted twice between 20 May and 5 July, with at least 10 days occurring between visits. Visits began either between sunrise and no later than four hours after sunrise, or between four hours before sunset and the onset of darkness. Once a route was established as either a morning or evening route, it remained as such permanently. Bird surveys were conducted under appropriate survey conditions (i.e., warm, dry weather and little wind). The 15-minute survey consisted of a five-minute passive listening period, followed by a five-minute call broadcast period, and a final five-minute passive listening period. The broadcast CD contained calls of the normally secretive Least Bittern, Sora, Virginia Rail, Common Moorhen, American Coot and Pied-billed Grebe and was used to elicit call responses from those species.

During the count period, observations (seen or heard) of species listed among a defined list of "focal" (marsh obligate indicator) species were recorded on the survey form in one-minute intervals during the first ten minutes of the survey. Focal species individuals were tracked separately, and were observed within the semi-circular sample area at unlimited distance. All other observed bird species were recorded onto a survey station map if they occurred within 100-m semi-circular station boundary. Aerial foragers were also counted and were defined as those species foraging within the station area to a height of 100 m. Non-focal bird species flying through or detected outside the station were tallied separately.

Amphibian Survey Protocol

Amphibians surveyed by MMP volunteer participants were calling frogs and toads that typically depend on marsh habitat during spring and summer breeding periods. MMP routes were surveyed for calling amphibians during three separate nights each year, between early April and mid-June, with at least 15 days occurring between visits. Because peak amphibian calling periods are more strongly associated with temperature and precipitation than with date, visits were scheduled to occur during three separate evenings according to minimum night air temperatures of 5°C (41°F), 10°C, (50°F), and 17°C (63°F), respectively.

Amphibian surveys began one-half hour after sunset and ended before or at midnight. Visits were conducted during evenings with little wind, preferably in moist conditions with one of the above corresponding temperatures. During three-minute survey visits, observers assigned a Call Level Code to each species detected; for two of these levels, estimated numbers of individuals were also recorded. Call Level Code 1 was assigned if calls did not overlap and calling individuals could be discretely counted. Call Level Code 2 was assigned if calls of individuals sometimes overlapped, but numbers of individuals could still reasonably be estimated. Call Level Code 3 was assigned if so many individuals of a species were calling that overlap among calls seemed continuous (i.e., full chorus); a count estimate is impossible for Call Level Code 3 and thus is not required by the protocol.

MMP participants were asked to use their best judgment to distinguish whether each species detected was calling from inside the station boundary only, from outside the station boundary only, or from both inside and outside the station boundary.

Habitat Description Protocol

MMP surveyors estimated proportional coverage of habitat characteristics for each MMP station. These descriptions were completed once annually during mid- to late June, when plants were readily identified. Observers provided information about coverage of five general habitat types: herbaceous emergent plants; open water; exposed mud, rock or sand; trees; and shrubs. Percent coverage of the four most dominant types of emergent plants was also recorded, providing a more detailed assessment of this important component of wetland habitat. Observers recorded coverage of floating plants and estimated wetland size and permanency, and adjacent land use.

Data Analysis

Indices of Biotic Integrity

<u>Marsh Bird Index of Biotic Integrity</u>

The Great Lakes coastal wetland marsh bird community-based Index of Biotic Integrity (IBI) (Crewe and Timmermans 2005) was used to assess marsh quality based on the bird communities observed at each site. The marsh bird IBI used bird species richness and abundance values, collected by MMP surveyors, to give a score to each wetland. Three metrics identified in Grabas et al. (2008) were used to calculate the IBI:

- Mean relative abundance of non-aerial foragers at a marsh
- Mean relative abundance of marsh-nesting obligates at a marsh
- Mean species richness of area-sensitive marsh-nesting obligates at a marsh

After the metrics were standardized (see below), an IBI score ranging from 0 to 100 was calculated for each wetland.

Amphibian Index of Biotic Integrity

The Great Lakes coastal wetland amphibian community-based Index of Biotic Integrity (IBI) (Crewe and Timmermans 2005) was used to assess marsh quality based on the amphibian communities observed at each site. The amphibian IBI used presence and species richness values, collected by MMP surveyors, to give a score to each wetland. Three metrics identified in Timmermans et al. (2008) were used to calculate the IBI:

- Mean total species richness across survey stations in a marsh
- Mean species richness of woodland-associated species across survey stations at a marsh
- Probability of detection of woodland-associated species across survey stations at a marsh

After the metrics were standardized (see below), an IBI score ranging from 0 to 100 was calculated for each wetland.

IBI Calculation and Standardization

Metrics for both IBIs were summarized by calculating the mean metric value for each wetland across twelve years of data (1998-2009) corresponding to years of relatively low Great Lakes water levels. Metrics were then transformed into a measure of biological integrity according to the method of Minns et al. (1994) and Hughes et al. (1998), which standardizes metrics from 0 to 10 using the equation:

$$M_S = A + BM_R$$

where $M_S = M_{min}$ if $M_S < M_{min}$, $M_S = M_{max}$ if $M_S > M_{max}$, B = slope between standardized metric (M_S) and the raw metric (M_R), and A= intercept. For metrics that decrease with increasing disturbance, a lower limit (M_{min}) of zero was used, and the upper limit (M_{max}) was based on the percentile. For metrics that increased with increasing disturbance, the slope of this relationship was negative, and a value of $M_S = 0$ was assigned to those wetlands with $M_R \geq 97.5$ percentile, while a value of $M_S = 10$ was assigned when $M_R = 0$.

After metrics were standardized, an IBI score of 0-100 was calculated for each wetland by adding the standardized values of each metric, multiplying those values by 10, and dividing by the total number of metrics. Thus, wetlands with a high marsh bird or amphibian IBI were in better biological condition than wetlands with a low IBI score. Selected metrics had been significantly correlated with a Great Lakes coastal wetland site disturbance gradient based on land cover/land use variables surrounding each site at different buffer distances (500 m, 20 km, 20 km), to validate their use in the IBI, during development of these IBIs (Crewe and Timmermans 2005).

The standard deviation of each wetland's marsh bird or amphibian IBI was calculated by bootstrapping raw metric values according to the methods of Environment Canada (2004;

R 2.9.2 2009). The applied method randomly chose three stations from wetlands with at least five (marsh bird) or four (amphibian) survey stations, and recalculated the mean and standard deviation of each IBI through 1,000 iterations.

Site Grouping Comparisons by Disturbance Class

Monitored marsh sites within the Long Point and Rondeau wetland complexes (including the west shore of Rondeau Bay) were grouped into two categories based on their suspected exposure to anthropogenic disturbance: relatively more-disturbed and relatively less-disturbed. Expert opinion of OMNR – Lake Erie Management Unit and BSC staff, with first-hand knowledge of these marsh habitats, was used to qualitatively group marsh sites into one of these two categories. Previous assessments of Long Point wetland habitat disturbance, whereby individual sites were ranked according to various qualitatively- and quantitatively-based criteria (Timmermans and Craigie 2003), were used to help categorize Long Point sites. Disturbance factors that were considered included: suspected impacts of surrounding land use; proximity to urban or residential areas; proximity to, and relative amount of, nearby roads; proximity to and intensity of known human recreational activities (e.g., boating); and known presence of habitat control structures (e.g., dykes, channels, culverts). Table 3 lists the categorical grouping of sites as relatively less-disturbed versus relatively more-disturbed.

Table 3. Classification of Long Point and Rondeau wetland complex marsh sites as relatively less-disturbed and more-disturbed.

Marsh Name	Marsh Code	Marsh Name	Marsh Code
Less Disturbed		More Disturbed	
Rondeau Provincial Park	ON026	Big Creek NWA – Managed Cells	ON034
Long Point NWA – Breakwater, Squires Ridge	ON037	Long Point Bay South Shore Marshes – Crown Marsh, Coletta Bay, Provincial Park, Rice Bay, Thoroughfare	ON039
Long Point NWA – Bluff Marsh	ON038	BSC Starling Property Pond	ON345a
Turkey Point Marsh	ON266	BSC Starling Property Inner Bay	ON345b
		Rondeau Bay West Shore	ON479
		Big Creek NWA – Unmanaged; Lower Big Creek	ON512
		Upper Big Creek NWA	ON523
		Long Point Bay North Shore Marshes	ON525
		Bayou Club Wet Meadow Complex	ON806

SURVEY SITES

A total of 20 MMP monitoring routes were monitored in marshes along Long Point Inner Bay and the surrounding Long Point area between 2008 and 2009 (see Figures 1 to 7). Eleven routes were monitored for both birds and amphibians, while five were monitored for birds only and four were monitored for amphibians only (Table 1). These routes were collectively monitored by MMP volunteer participants, Bird Studies Canada (BSC) staff, and temporary contract staff. Staff and contractor-surveyed routes were chosen to representatively sample marsh sites in the Long Point area in terms of geographic distribution and estimated levels of anthropogenic disturbance (Timmermans and Craigie 2003). Volunteers selected their own monitoring routes in conjunction with program staff, who suggested available marsh sites that were considered priority for monitoring. Volunteers also selected their routes considering proximity to their home and ease of access to the marsh.

To summarize data, stations were grouped within pre-designated Long Point marsh complex categories. This allowed for comparison at the marsh complex scale. Table 2 lists these marsh complexes and the number of bird and amphibian stations within each.

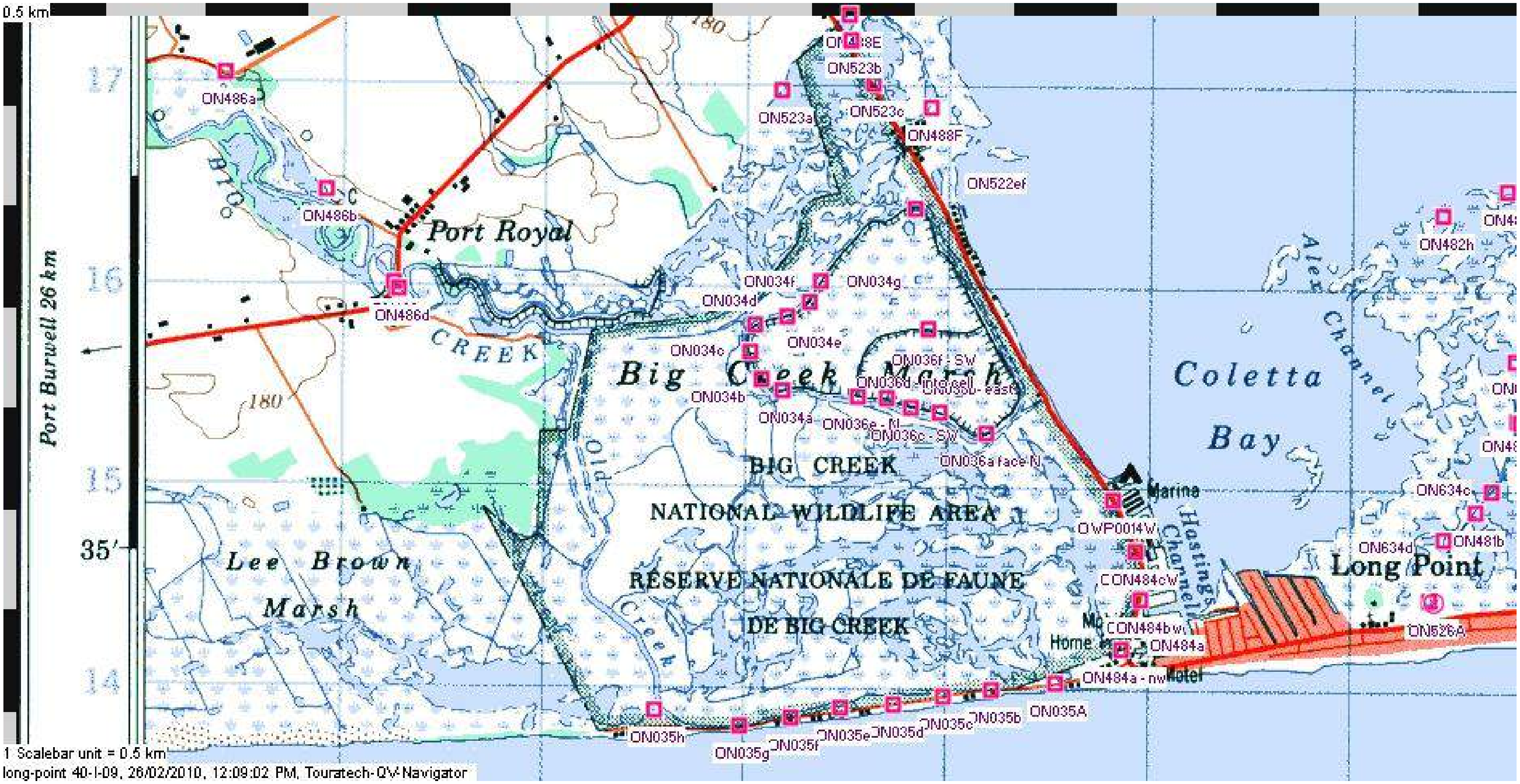

Figure 1. MMP station locations within the Big Creek National Wildlife Area (managed and unmanaged) and lower Big Creek marsh sites across the 2008 and 2009 survey years.

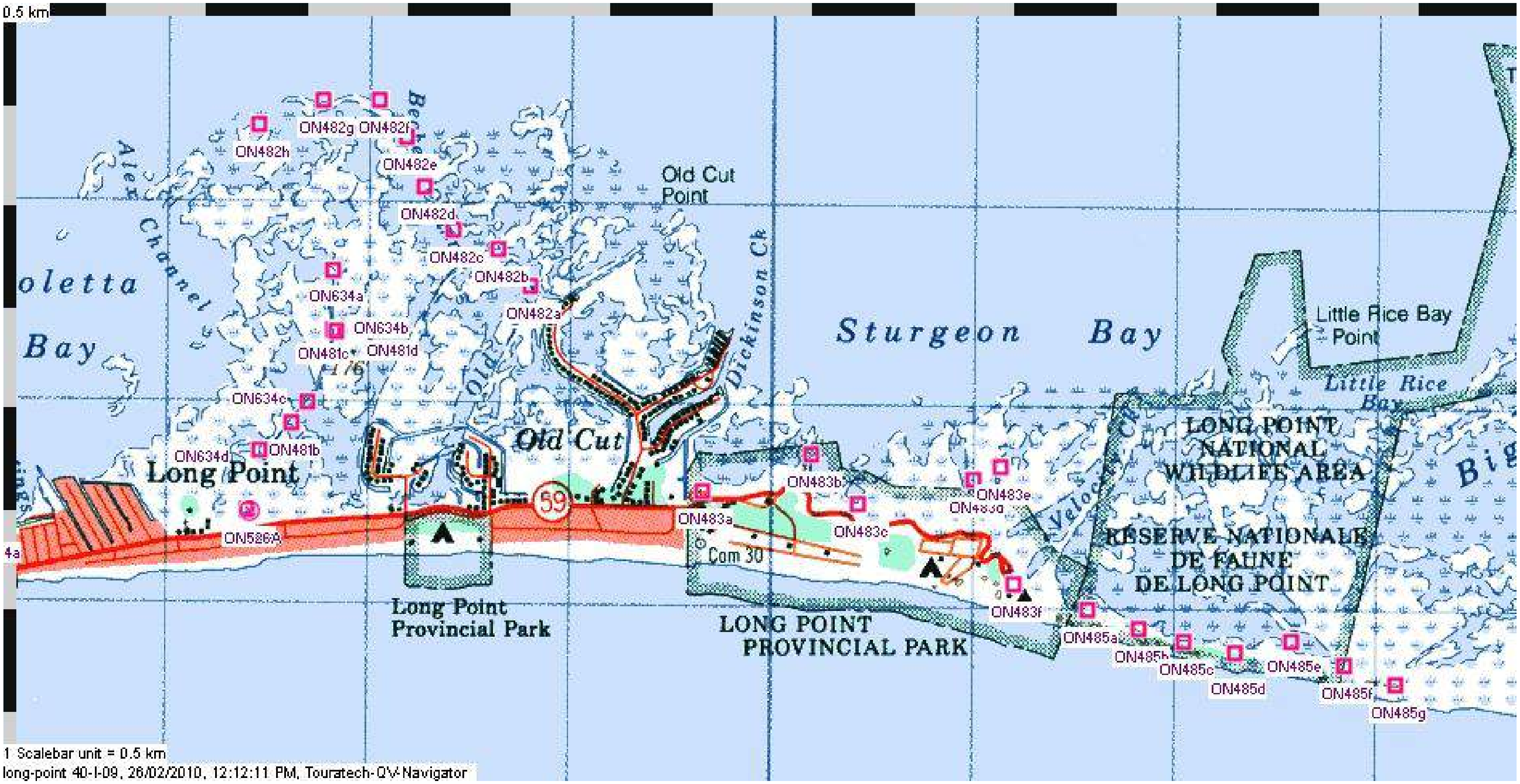

Figure 2. MMP station locations within the Long Point Bay South Shore Marsh complex (including Crown Marsh, Long Point Provincial Park and Long Point National Wildlife Area-Thoroughfare Unit) across the 2008 and 2009 survey years.

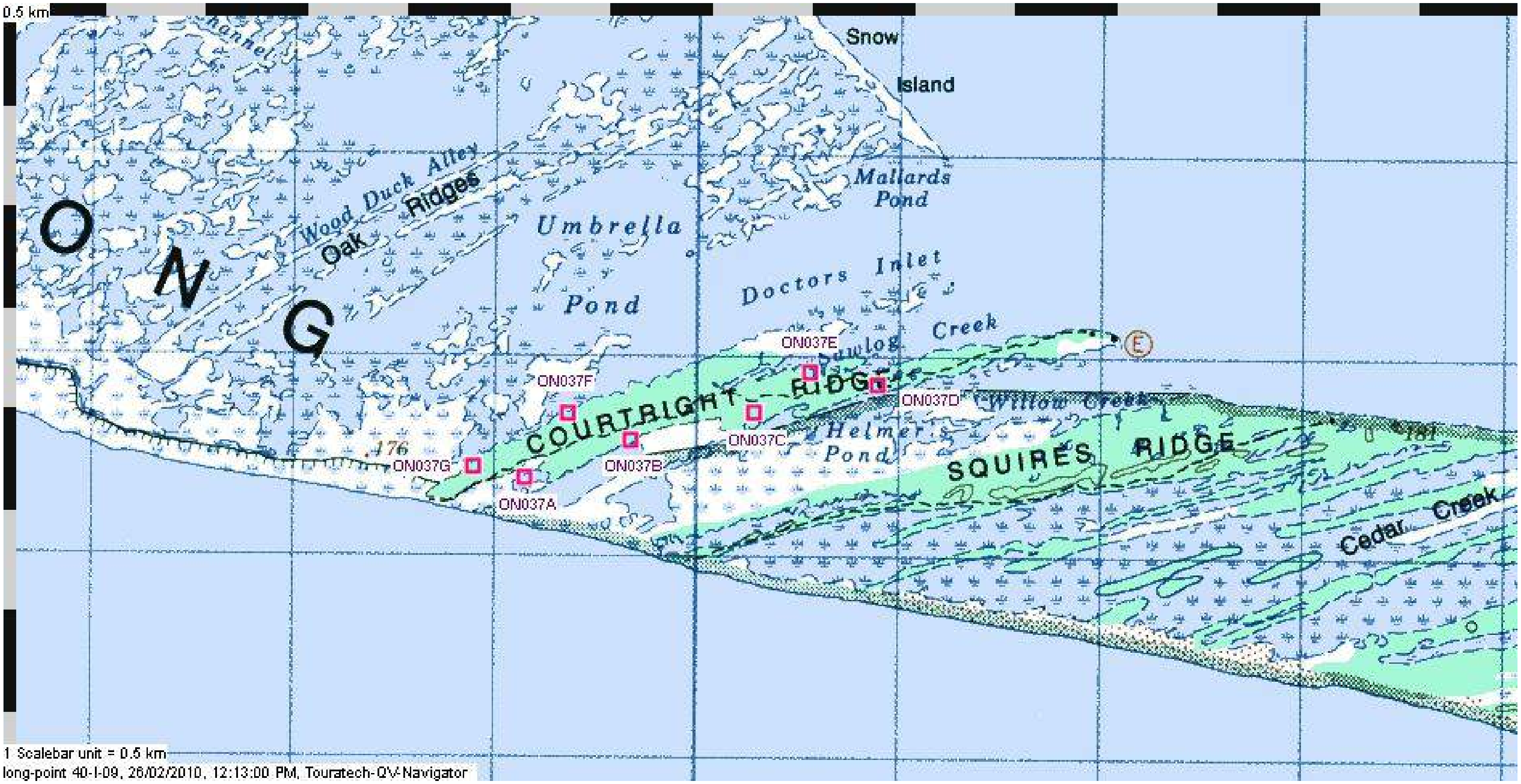

Figure 3. MMP station locations within the Breakwater marsh site across the 2008 and 2009 survey years.

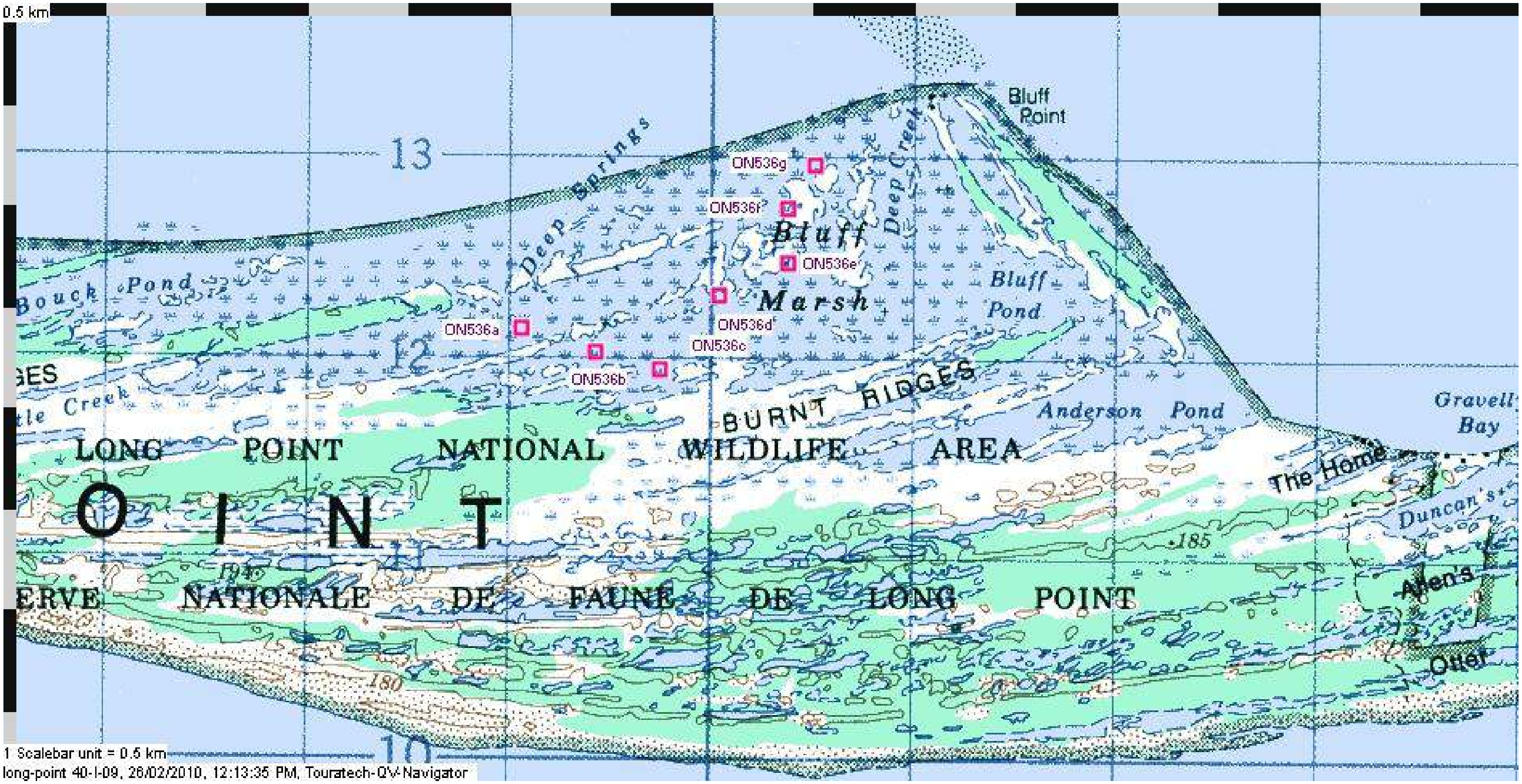

Figure 4. MMP station locations within the Bluff Marsh site across the 2008 and 2009 survey years.

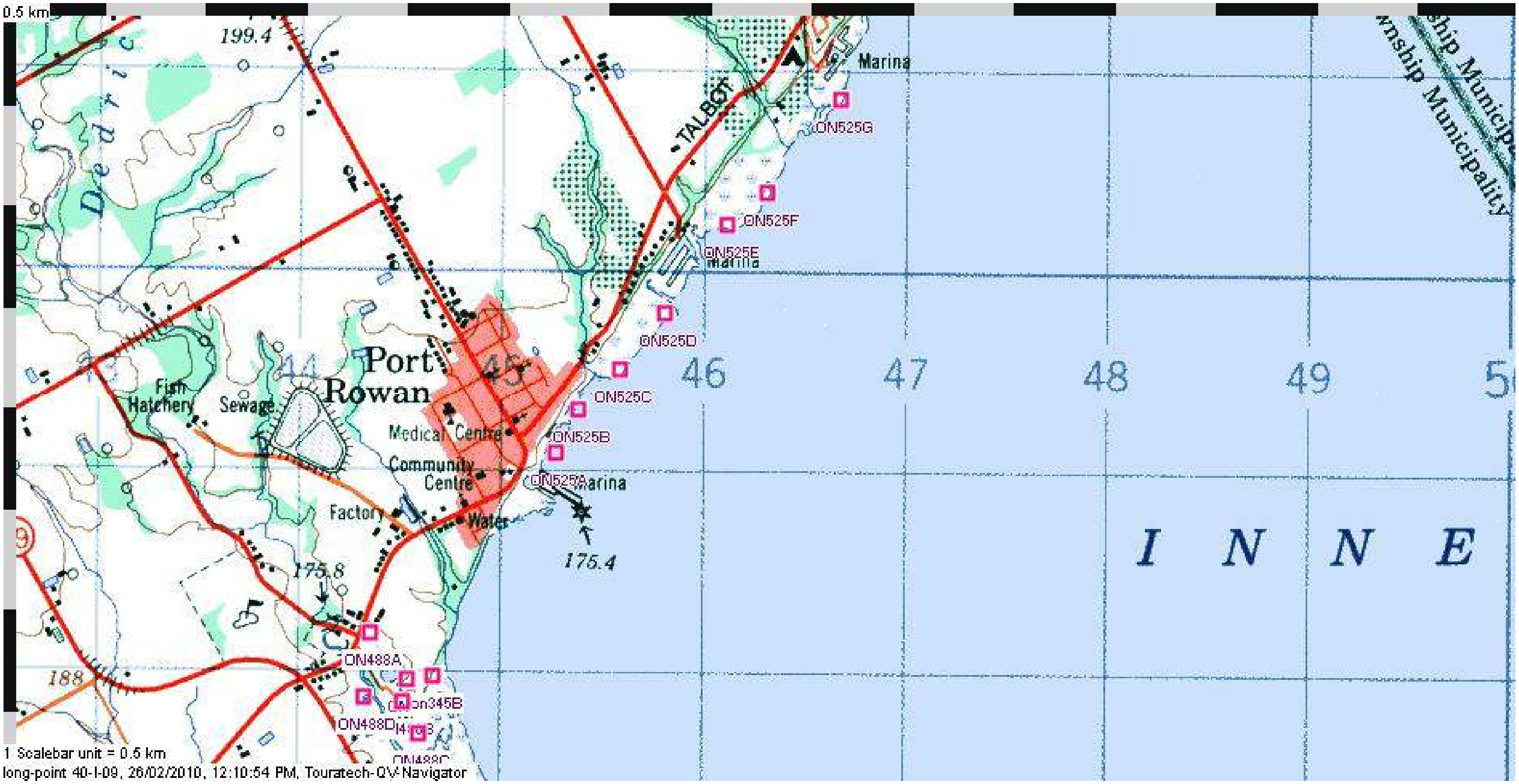

Figure 5. MMP station locations within the Bird Studies Canada property pond and Inner Bay sites and the Long Point Inner Bay North Shore marshes across the 2008 and 2009 survey years.

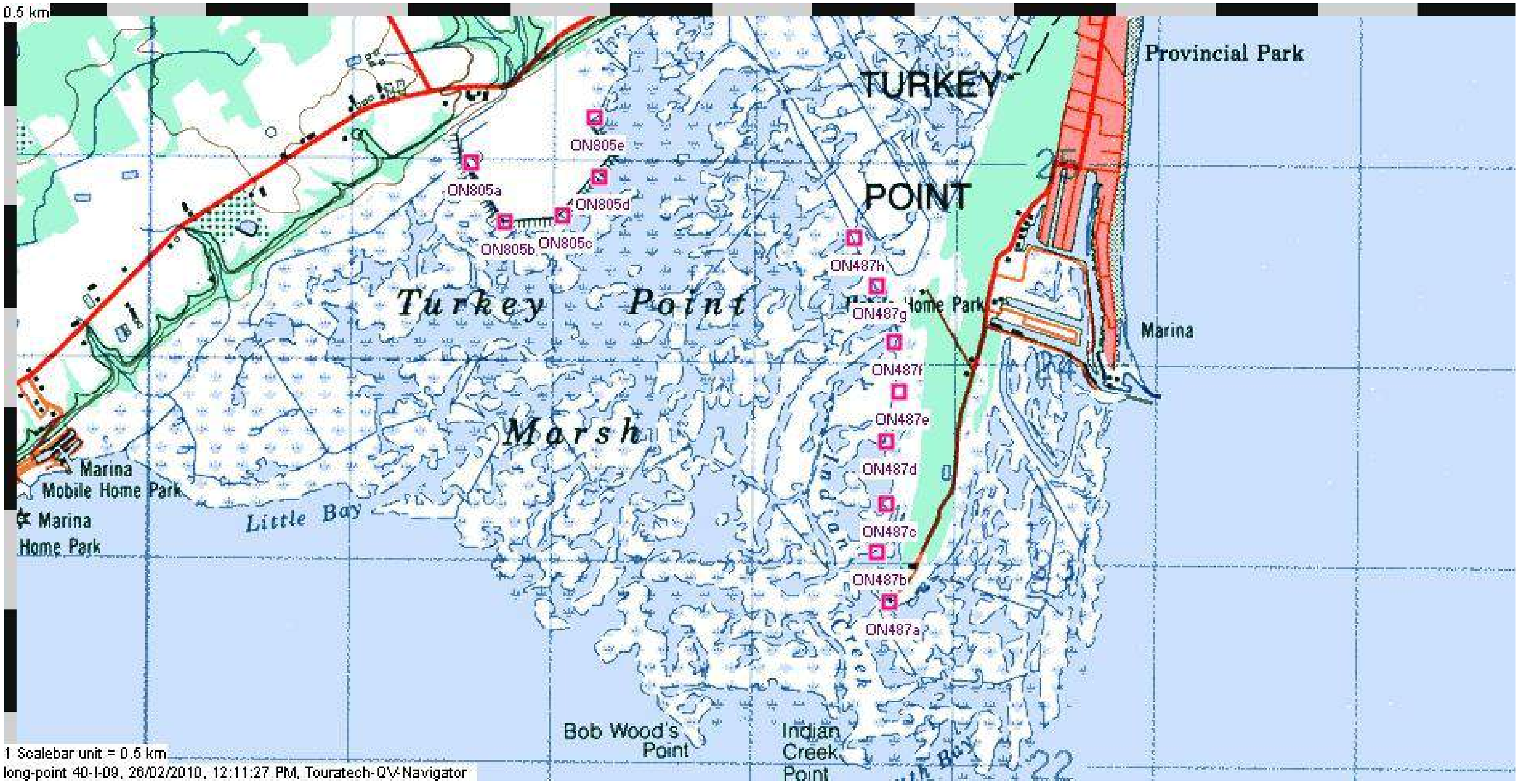

Figure 6. MMP station locations within Turkey Point Marsh across the 2008 and 2009 survey years.

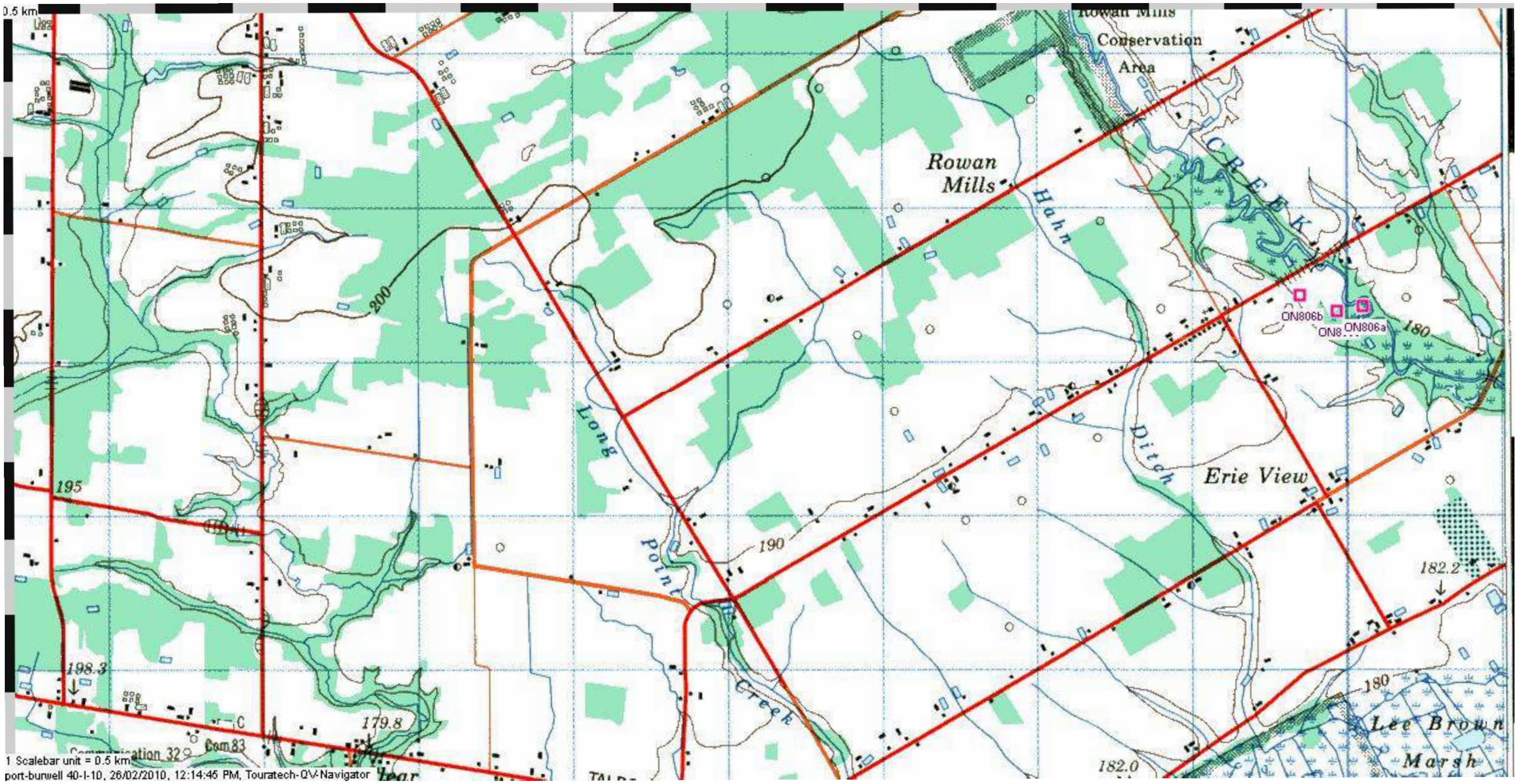

Figure 7. 2009 MMP station locations within the Bayou Club Wet Meadow Complex on lower Big Creek.

Table 1. Route name, type of survey and surveyor type for Long Point MMP routes monitored during 2008 and 2009. Wetland complex code within which each route/station occurred is provided.

Route ID	Route Name	Survey Type	Surveyor	Wetland Complex Code	Project Years Surveyed
ON034	Big Creek NWA North	Amphibians/Birds	BSC staff in-kind	ON034 – Stations A,C,G,H ON512 – Stations B,D,E,F	2008, 2009
ON035	Big Creek Hastings Drive	Amphibians/Birds	Volunteer	ON512	2008
ON036	Big Creek NWA South	Amphibians/Birds	BSC staff in-kind	ON034 – Stations A,B,C,D,F ON512 – Station E	2008, 2009
ON037	Long Point NWA – Breakwater	Birds	BSC staff in-kind	ON037	2009
ON345	BSC Starling Property Pond and Inner Bay	Birds	BSC staff in-kind	ON345a – Station A ON345b – Station B	2008, 2009
ON481	Crown Marsh Dyke Amphibians	Amphibians	Contractor	ON039	2008, 2009
ON482	Old Cut – Crown Marsh	Amphibians/Birds	Contractor	ON039	2008, 2009
ON483	Long Point Provincial Park	Amphibians/Birds	Contractor	ON039	2008, 2009
ON484	Causeway	Amphibians/Birds	Contractor	ON512	2008, 2009
ON485	Long Point NWA – Thoroughfare Unit	Amphibians/Birds	Volunteer	ON039	2008, 2009
ON486	Port Royal Marsh	Amphibians/Birds	Contractor	ON512	2008, 2009
ON487	Turkey Point Marsh	Birds	Contractor	ON266	2008, 2009
ON488	North Causeway and BSC HQ	Amphibians	Volunteer	ON345b – Stations A,B,D,E,F ON345a – Station C	2008, 2009
ON522	Big Creek NWA East	Amphibians	Contractor	ON512 – Station E ON034 – Station F	2009
ON523	Upper Big Creek Marsh	Birds	Volunteer	ON512	2009
ON525	Port Rowan Lakeshore	Amphibians/Birds	Contractor	ON525	2008, 2009
ON536	Bluff Bar	Amphibians	Volunteer	ON037	2008, 2009
ON634	Crown Marsh Dyke Birds	Birds	Contractor	ON039	2008, 2009
ON805	Turkey Point Marsh – Onion Farm Dyke	Amphibians/Birds	BSC staff in-kind/ Volunteer	ON266	2009
ON806	Bayou Club Wet Meadow Complex	Amphibians/Birds	BSC staff in-kind	ON806	2009

Table 2. Long Point marsh sites with number of amphibian bird stations monitored in each during 2008 and 2009.

Marsh Code	Marsh Name	Amphibian Stations		Bird Stations	
		2008	2009	2008	2009
ON034	Big Creek NWA-Managed Cells	6	6	7	7
ON037	Long Point NWA-Breakwater	0	0	0	7
ON038	Long Point NWA-Bluff Marsh	7	7		
ON039	Long Point Bay South Shore Marshes (Crown Marsh, Coletta Bay, Provincial Park, Rice Bay, Thoroughfare)	17	18	25	25
ON266	Turkey Point Marsh	0	3	8	11
ON345a	BSC Starling Property Pond	2	1	1	1
ON345b	BSC Starling Property Inner Bay	4	4	7	4
ON512	Big Creek NWA-Unmanaged	18	12	28	11
ON525	Long Point Bay North Shore Marshes	3	3	7	7
ON806	Bayou Club Wet Meadow Complex	0	1	0	2

RESULTS

Amphibian Species Occurrence, Relative Abundance and Community Integrity

A total of nine amphibian species were detected across all sites (comprising 67 stations) between both survey years (Table 4). Most species were detected during their expected breeding period (e.g., early season, late season). However, detection of the relatively late-season breeding Green Frog during Visit 1 (18/04/09; BSC Starling Property Inner Bay site) is unusual although not unknown at Long Point marshes. Additionally, detection of the typically early- to mid-season breeding Spring Peeper during Visit 3 (06/06/09; Bayou Club Wet Meadow site) may be attributed to lower-than-average temperatures and a preponderance of woody vegetation surrounding that site.

Table 4. Occurrence of amphibian species within Long Point wetlands during each survey visit across 2008 and 2009 survey years.

Species	Occurrence		
	Visit 1	Visit 2	Visit 3
American Toad	✓	✓	✓
Bullfrog		✓	✓
Western Chorus Frog	✓	✓	
Fowler's Toad		✓	
Gray Treefrog		✓	✓
Green Frog	✓	✓	✓
Northern Leopard Frog	✓	✓	✓
Spring Peeper	✓	✓	✓
Wood Frog	✓		

Most species were recorded at a maximum calling code of 3, with the exception of Wood Frog (maximum calling code = 2) and Fowler's Toad (maximum calling code = 1) (Table 5). Western Chorus Frog was predominantly recorded at calling code 1, while Spring Peeper was most often recorded at full chorus. Among marsh sites, the Long Point Bay

South Shore Marshes and Big Creek National Wildlife Area (NWA)-Unmanaged each yielded the highest number of species detected with eight. Seven species were detected at each of Big Creek NWA-Managed and Long Point Bay North Shore Marshes. Only four species were detected at each of Bluff Marsh and Turkey Point Marsh; however, Bluff Marsh was only surveyed once per year (corresponding to the late-season breeding period), while amphibian surveys in Turkey Point Marsh were restricted to the northern border of the marsh.

Green Frog was the only species detected at all nine wetland sites, although Bluff Marsh was not surveyed during the early and mid-season breeding periods. Bullfrog, Northern Leopard Frog, and Spring Peeper were each detected at eight sites (Table 5). Fowler's Toad was the most uncommon species detected, only recorded at the Long Point Bay South Shore Marsh complex. Wood Frog was only detected at two sites; this may be in part due to the difficulty of properly timing surveys to coincide with the brief, explosive Wood Frog breeding period.

Green Frog was detected at 81% of all stations surveyed across both survey years, followed by Bullfrog (73%) and Northern Leopard Frog (64%) (Table 6). Fowler's Toad was only detected at a single station during 2008. Three stations within Long Point Provincial Park and two stations within Long Point NWA-Thoroughfare Unit MMP routes did not yield any amphibian observations in 2008 (Table 7).

Cross-Year Comparisons

Amphibian species occurrence, maximum calling code, and proportion of stations occupied were compared across survey years (1995 to 2009), and were compared separately for Big Creek NWA-Managed and Big Creek NWA-Unmanaged marsh sites. These sites were chosen because they have been monitored for the most years of all Long Point-area marshes.

American Toad, Bullfrog, Green Frog, Northern Leopard Frog, and Spring Peeper were detected during most survey years at Big Creek NWA-Managed, while Western Chorus Frog, Fowler's Toad, Gray Treefrog, and Wood Frog were infrequently detected among years (Table 8). No apparent temporal patterns in maximum calling code or station occupancy were identified for American Toad or Green Frog. Bullfrog station occupancy was lower during 2008 and 2009 relative to previous years, while Northern Leopard Frog data may show an apparent increase in calling intensity over this same period relative to earlier years. Spring Peeper was recorded at calling code 1 from 1995-1997, but has been recorded at higher calling codes (2 or 3) and at a greater proportion of stations since then.

Table 5. Maximum calling code detected during each survey visit for each species, within each marsh complex, across 2008 and 2009. Number of stations surveyed and total number of species detected per marsh are provided.

Marsh Complex	Visit Number	Maximum Calling Code: American Toad	Bullfrog	Western Chorus Frog	Fowler's Toad	Green Frog	Gray Treefrog	Northern Leopard Frog	Spring Peeper	Wood Frog	Number of Stations Surveyed	Number of Species Detected
Big Creek NWA – Managed Cells	1	1		1				3	3	2	8	
	2	3	1			1		1	3		9	7
	3		2			3					9	
Long Point NWA – Bluff Marsh	3		3			2	3				7	4
Long Point Bay South Shore Marshes	1	1		3				3	2		14	
	2	3	2	1	1	2		2	2		20	8
	3		3			3	2				20	
Turkey Point Marsh	1							2	3		3	
	2	1				1	3		3		3	4
	3					2					1	
BSC Starling Property Pond	1	1						1	3		2	
	2								1		2	5
	3	1	1			2					2	
BSC Starling Property Inner Bay	1	3				1		2	3		4	
	2	1				1		1	1		4	5
	3	1	1			2		1			4	
Big Creek NWA – Unmanaged	1	2		1				3	3	1	19	
	2	3	1	1		1	1	1	3		18	8
	3		3			3	1				14	
Long Point Bay North Shore Marshes	2	3		1		1	1	1	1		3	7
	3		3			2					3	
Bayou Club Wet Meadow Complex	1			3				2	3		1	
	2		1			1			1		1	6
	3		1			1	1		1		1	
Long Point Marshes Across Visits	3	3	3	3	1	3	3	3	3	2	67	9

Table 6. Number of stations across both survey years at which each species was detected and percent occurrence among stations across 2008 and 2009 survey years.

Species Name	Number of Stations with Species Detected	Percent Occurrence Among All Stations
American Toad	31	46%
Bullfrog	49	73%
Western Chorus Frog	21	31%
Fowler's Toad	1	1%
Gray Treefrog	7	10%
Green Frog	54	81%
Northern Leopard Frog	43	64%
Spring Peeper	39	58%
Wood Frog	4	6%

Table 7. Stations that had no amphibians detected during the 2008 or 2009 monitoring seasons.

Route ID	Station	Year
ON483	D	2008
ON483	E	2008
ON483	F	2008
ON485	C	2008
ON485	G	2008

Table 8. Maximum calling code and percent of stations within which each amphibian species was detected across surveyed years within Big Creek NWA-Managed Cells. “N.D.” stands for “not detected”.

Species		Year															
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Across Years
American Toad	Max. Calling Code	3	1	3		N.D.			2					3	2	N.D.	3
	% Stations Present	50	25	100		N.D.			60					100	50	N.D.	75
Bullfrog	Max. Calling Code	2	3	2		3			2					N.D.	2	2	3
	% Stations Present	100	100	100		100			100					N.D.	50	86	100
Western Chorus Frog	Max. Calling Code	N.D.	N.D.	N.D.		N.D.			2					N.D.	N.D.	N.D.	2
	% Stations Present	N.D.	N.D.	N.D.		N.D.			20					N.D.	N.D.	N.D.	13
Fowler’s Toad	Max. Calling Code	N.D.	N.D.	N.D.		N.D.			1					N.D.	N.D.	N.D.	1
	% Stations Present	N.D.	N.D.	N.D.		N.D.			40					N.D.	N.D.	N.D.	25
Green Frog	Max. Calling Code	2	1	2		1			3					1	2	3	3
	% Stations Present	75	50	75		100			60					50	50	86	88

Table 8 (cont.)

Species		Year 1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Across Years
Gray Treefrog	Max. Calling Code	N.D.	1	N.D.		N.D.			N.D.					N.D.	N.D.	N.D.	1
	% Stations Present	N.D.	25	N.D.		N.D.			N.D.					N.D.	N.D.	N.D.	13
Northern Leopard Frog	Max. Calling Code	3	2	2		N.D.			2					1	3	3	3
	% Stations Present	100	100	100		N.D.			100					100	83	100	100
Spring Peeper	Max. Calling Code	1	1	1		N.D.			3					2	3	2	3
	% Stations Present	25	50	25		N.D.			100					100	67	86	100
Wood Frog	Max. Calling Code	N.D.	N.D.	N.D.		N.D.			N.D.					N.D.	2	N.D.	2
	% Stations Present	N.D.	N.D.	N.D.		N.D.			N.D.					N.D.	50	N.D.	38
No. Species Detected		5	6	5		2			7					4	6	4	9
No. Stations Surveyed		3	4	4		4			5					2	6	7	8

American Toad, Bullfrog, Western Chorus Frog, Fowler's Toad, Green Frog, Northern Leopard Frog, and Spring Peeper were detected in over half of all survey years at Big Creek NWA-Unmanaged (Table 9). Gray Treefrog and Wood Frog were less common. For most species there were no apparent differences in calling intensity or station occupancy among years, although some exceptions occurred. Spring Peeper has been consistently recorded at calling code 3 annually since 2002 following more varied calling intensities during previous years. Green Frog data may show apparent increases in calling intensity since 2007 relative to earlier years. Fowler's Toad has not been detected at this site since 2005.

Site Disturbance Class Comparisons

Maximum calling codes for most species were similar at disturbed vs. unsiturbed sites (Table 10). Five species (Western Chorus Frog, Gray Treefrog, Northern Leopard Frog, Spring Peeper, Wood Frog) occurred at a greater proportion of stations within relatively less disturbed marshes, while four species (American Toad, Bullfrog, Fowler's Toad, Green Frog) occurred at a greater proportion of stations within relatively more disturbed marshes. Spring Peeper and Green Frog showed the biggest differential in station occupancies between disturbance classes among species.

Index of Biotic Integrity

Figure 8 shows mean amphibian IBI scores of Lake Erie coastal wetlands monitored between 1998 and 2009. Site-based IBI scores presented here are similar to those presented in Crewe and Timmermans (2005) for Great Lakes coastal wetland amphibian community condition.

Table 9. Maximum calling code and percent of stations within which each amphibian species was detected across surveyed years within the Big Creek NWA-Unmanaged wetland complex. “N.D.” stands for “not detected”.

Species		Year															
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Across Years
American Toad	Max. Calling Code	3	1	3	1	1	3	2	2	1	2	1		3	3	1	3
	% Stations Present	33	57	100	25	29	75	50	61	100	100	25		89	78	50	69
Bullfrog	Max. Calling Code	1	3	1	1	1	N.D.	2	1	N.D.	N.D.	1		3	1	3	3
	% Stations Present	67	71	33	100	71	N.D.	50	52	N.D.	N.D.	50		44	39	50	66
Western Chorus Frog	Max. Calling Code	N.D.	N.D.	N.D.	N.D.	3	2	1	1	1	N.D.	3		N.D.	1	1	3
	% Stations Present	N.D.	N.D.	N.D.	N.D.	14	50	25	15	25	N.D.	25		N.D.	50	25	32
Fowler’s Toad	Max. Calling Code	N.D.	2	N.D.	1	1	1	2	3	N.D.	1	1		N.D.	N.D.	N.D.	3
	% Stations Present	N.D.	29	N.D.	100	14	25	75	33	N.D.	25	25		N.D.	N.D.	N.D.	24
Green Frog	Max. Calling Code	1	1	1	1	2	1	1	3	1	1	1		2	3	3	3
	% Stations Present	67	71	100	100	57	50	50	59	50	75	75		78	44	50	68

Table 9 (cont.)

Species		Year															
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Across Years
Gray Treefrog	Max. Calling Code	N.D.	1	N.D.	N.D.	N.D.	N.D.	N.D.	3	1	N.D.	N.D.		1	1	1	3
	% Stations Present	N.D.	29	N.D.	N.D.	N.D.	N.D.	N.D.	59	25	N.D.	N.D.		11	6	8	23
Northern Leopard Frog	Max. Calling Code	1	3	1	2	1	1	N.D.	2	1	2	3		2	1	3	3
	% Stations Present	100	71	33	100	43	75	N.D.	63	50	75	100		78	39	75	71
Spring Peeper	Max. Calling Code	3	1	2	2	3	2	2	3	3	3	3		3	3	3	3
	% Stations Present	67	29	67	75	71	50	100	85	50	100	100		89	67	83	89
Wood Frog	Max. Calling Code	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	1	N.D.		N.D.	N.D.	1	1
	% Stations Present	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	25	N.D.		N.D.	N.D.	8	3
No. Species Detected		5	7	5	6	7	6	6	8	6	6	7		6	7	8	9
No. Stations Surveyed		3	7	3	4	7	4	4	46	4	4	4		9	18	12	62

Table 10. Maximum calling code and percent stations occupied of amphibian species detected within relatively less-disturbed and more-disturbed wetland sites among the Long Point and Rondeau wetland complexes, 1995-2009 inclusive.

Species	Disturbance Category					
	Less Disturbed		More Disturbed		Overall	
	Max. Calling Code	% Stations Occupied	Max. Calling Code	% Stations Occupied	Max. Calling Code	% Stations Occupied
American Toad	3	19.3	3	24.8	3	22.4
Bullfrog	3	25.9	3	28.2	3	27.2
Western Chorus Frog	3	7.3	3	6.4	3	6.8
Fowler's Toad	2	3.6	3	7.6	3	5.9
Green Frog	3	17.8	3	32.3	3	26.1
Gray Treefrog	3	11.6	3	2.7	3	6.5
Northern Leopard Frog	3	37.2	3	31.3	3	33.7
Spring Peeper	3	41.5	3	25.7	3	32.3
Wood Frog	2	1.0	2	0.8	2	0.9
No Anurans Detected	-	5.3	-	4.0	-	4.5
No. of Station-Visits	589		802		1,391	
No. of Stations Surveyed	70		158		228	

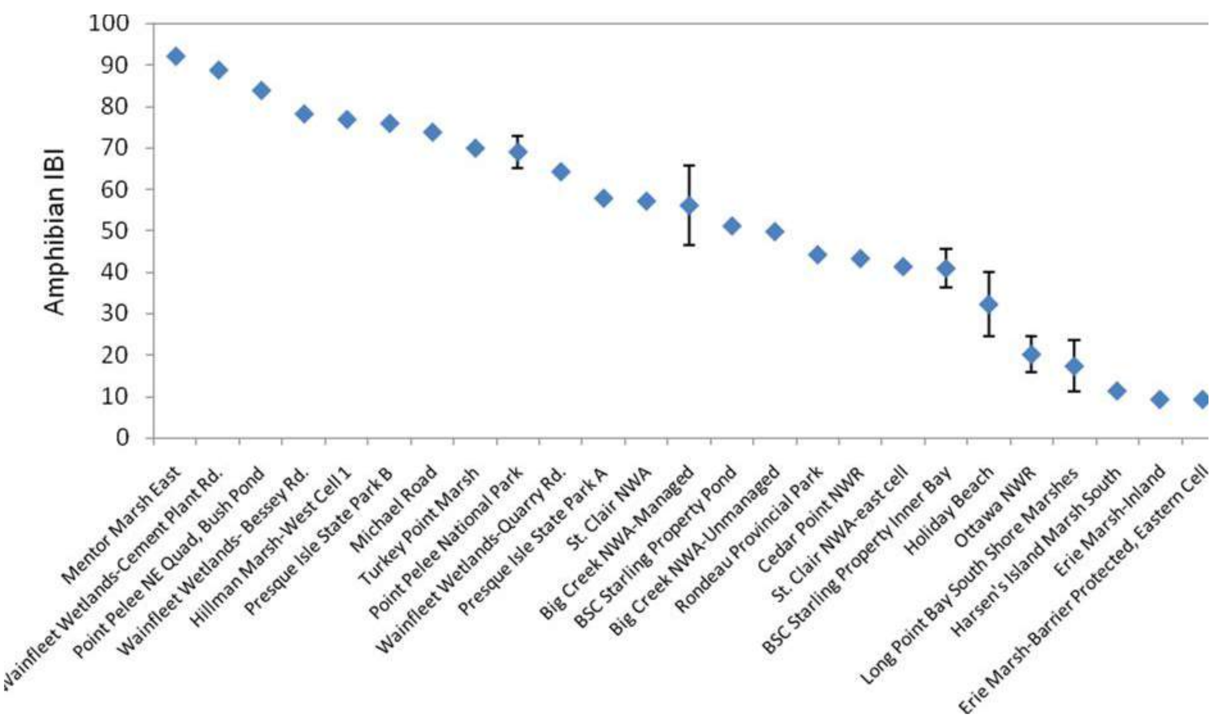

Figure 8. Amphibian IBI scores, derived from MMP data collected from 1998-2009, inclusive, for Long Point-area marshes in relation to other monitored Lake Erie coastal marshes.

Most Long Point sites scored within the mid-range of all monitored Lake Erie coastal wetland sites. Among Long Point sites, Turkey Point Marsh scored highest (mean IBI=69.95) followed by Big Creek NWA-Managed (mean IBI = 56.13) (Figure 8). Long

Point Bay South Shore Marshes scored lowest among Long Point sites, with a mean IBI of 17.34.

Species Richness

Relative to other monitored Lake Erie coastal marshes, Big Creek NWA-Managed Cells and the Long Point Bay South Shore Marshes ranked among the highest in terms of species richness across guilds (Table 11). Other Long Point sites ranked moderately high in relation to other coastal wetland sites, although variation among sites within a guild was minimal given the small number of potential amphibian species. See Table A1 for amphibian species classifications across reported guilds.

Table 11. Maximum species richness across five amphibian guilds among monitored Lake Erie coastal marshes for the years 1998-2009, inclusive. Long Point sites are bolded.

Marsh Name	Guild				
	Woodland	Disturbance Tolerant	Disturbance Intolerant	Great Lakes Basin-wide Distribution	Total Anuran Species
Ottawa NWR	2	4	3	4	7
Cedar Point NWR	3	4	2	4	6
Big Creek NWA – Managed Cells	**2**	**3**	**3**	**5**	**6**
Long Point Bay South Shore Marshes	**2**	**4**	**2**	**4**	**6**
Holiday Beach	2	3	3	5	6
Hillman Marsh - West Cell	2	4	2	4	6
Wainfleet Wetlands CA-Cement Plant Rd.	2	4	2	4	6
Presque Isle State Park A	2	3	2	3	6
Mentor Marsh East	3	3	2	3	5
Rondeau Provincial Park	2	3	2	3	5
St. Clair NWA East Cell	1	3	2	3	5
Point Pelee National Park	2	4	2	4	5
Turkey Point Marsh	**1**	**3**	**2**	**4**	**5**
BSC Starling Property Pond	**1**	**3**	**2**	**4**	**5**
BSC Starling Property Inner Bay	**1**	**3**	**2**	**4**	**5**
Point Pelee NE Quad, Bush Pond	2	4	1	4	5
Wainfleet Wetlands CA-Quarry Rd.	1	3	2	4	5
Big Creek NWA-Unmanaged	**2**	**3**	**2**	**4**	**5**
Wainfleet Wetlands CA-Bessey Rd.	2	3	1	2	4
Erie Marsh - Barrier Protected, Eastern Cell	0	2	1	2	3
Michael Road	3	2	1	2	3
Presque Isle State Park B	2	3	1	3	3
Harsen's Island Marsh South	0	1	1	2	2
Erie Marsh – Inland	0	1	1	1	2
St. Clair NWA	1	2	0	1	2

Bird Species Occurrence, Relative Abundance, and Community Integrity

A total of 90 bird species, including all 11 indicator species, were recorded across all sites (comprising 148 stations) between both survey years (Table 12). Marsh Wren and Swamp Sparrow were the most frequently detected indicator species among marshes, present at eight sites, followed by Pied-billed Grebe (seven) and American Bittern, Least Bittern, and Virginia Rail (six). American Coot was only detected at one site (Long Point Bay South Marshes), while undifferentiated Common Moorhen/American Coot was recorded at one site. Red-winged Blackbird, Tree Swallow, Marsh Wren, Barn Swallow, and Northern Rough-winged Swallow were the five most abundant bird species across all sites during first survey visits, while Barn Swallow, Tree Swallow, Red-winged Blackbird, Northern Rough-winged Swallow, and Marsh Wren were the five most abundant bird species during the second survey visits. Among focal species, Sora and American Coot were present at the lowest abundances across all marsh sites (Table 13).

The Long Point South Shore Marshes contained all ten indicator species (excluding undifferentiated Common Moorhen/American Coot), followed by Big Creek NWA-Managed with nine species, and Long Point NWA-Breakwater and Turkey Point Marsh, each with eight species (Table 13). Only one indicator species (Marsh Wren) was detected at Bayou Club Wet Meadow.

Cross-Year Comparisons

Bird species occurrence and relative abundance were qualitatively compared across surveyed years, 1995 to 2009 inclusive, separately for Big Creek NWA-Managed and Big Creek NWA-Unmanaged marsh sites.

Eight indicator species (American Bittern, American Coot, Black Tern, Common Moorhen, Least Bittern, Marsh Wren, Swamp Sparrow, and Virginia Rail) were detected during at least six surveyed years at Big Creek NWA-Managed (Table 14), while Pied-billed Grebe and Sora were detected less frequently detected. Undifferentiated Common Moorhen/American Coot was only recorded in two years.

There were few apparent patterns in relative abundance across years (Table 14). However, Marsh Wren and Common Yellowthroat appeared to increase in abundance across all years and Swamp Sparrow appears to have increased in the last three years. Black Tern appears to have decreased since 2002 while Sora has not been detected at this site since 1997.

Table 12. Occurrence of wetland bird species in Long Point wetlands during each survey visit, across 2008 and 2009 survey years.

Species	Species Code	Occurrence Visit 1	Occurrence Visit 2
Alder Flycatcher	ALFL	✓	✓
American Bittern	AMBI	✓	✓
American Coot	AMCO	✓	✓
American Crow	AMCR	✓	✓
American Goldfinch	AMGO	✓	✓
American Robin	AMRO	✓	✓
American Wigeon	AMWI		✓
American Woodcock	AMWO		✓
Bald Eagle	BAEA	✓	✓
Baltimore Oriole	BAOR	✓	✓
Bank Swallow	BASW	✓	✓
Barn Swallow	BARS	✓	✓
Belted Kingfisher	BEKI	✓	✓
Black Tern	BLTE	✓	✓
Black-billed Cuckoo	BBCU		✓
Black-capped Chickadee	BCCH	✓	✓
Black-crowned Night Heron	BCNH	✓	✓
Blue Jay	BLJA	✓	
Blue-winged Teal	BWTE		✓
Brown Thrasher	BRTH	✓	✓
Brown-headed Cowbird	BHCO	✓	
Canada Goose	CAGO	✓	✓
Carolina Wren	CAWR	✓	
Caspian Tern	CATE	✓	✓
Cedar Waxwing	CEWA	✓	✓
Chestnut-sided Warbler	CSWA		✓
Chimney Swift	CHSW	✓	✓
Chipping Sparrow	CHSP	✓	✓
Common Grackle	COGR	✓	✓
Common Moorhen	COMO	✓	✓
Common Nighthawk	CONI		✓
Common Tern	COTE	✓	✓
Common Yellowthroat	COYE	✓	✓
Double-crested Cormorant	DCCO	✓	✓
Downy Woodpecker	DOWO	✓	✓
Eastern Kingbird	EAKI	✓	✓
Eastern Phoebe	EAPH	✓	
Eastern Wood-Pewee	EAWP		✓
European Starling	EUST	✓	✓
Field Sparrow	FISP	✓	
Forster's Tern	FOTE	✓	✓
Gray Catbird	GRCA	✓	✓
Great Blue Heron	GBHE	✓	✓
Great Crested Flycatcher	GCFL	✓	✓
Great Egret	GREG		✓
Green Heron	GRHE	✓	✓
Hairy Woodpecker	HAWO		✓
Herring Gull	HEGU		✓
Hooded Merganser	HOME		✓
House Sparrow	HOSP	✓	✓
House Wren	HOWR	✓	✓
Indigo Bunting	INBU		✓
Killdeer	KILL	✓	✓
Least Bittern	LEBI	✓	✓
Least Flycatcher	LEFL	✓	
Mallard	MALL	✓	✓
Marsh Wren	MAWR	✓	✓
Mourning Dove	MODO	✓	✓
Mute Swan	MUSW	✓	
Northern Cardinal	NOCA	✓	✓
Northern Flicker	NOFL		✓
Northern Harrier	NOHA	✓	✓
Northern Pintail	NOPI	✓	
Northern Rough-winged Swallow	NRWS	✓	✓
Pied-billed Grebe	PBGR	✓	✓
Purple Martin	PUMA	✓	✓
Red-bellied Woodpecker	RBWO		✓
Red-eyed Vireo	REVI	✓	
Red-winged Blackbird	RWBL	✓	✓
Ring-billed Gull	RBGU	✓	✓
Rose-breasted Grosbeak	RBGR	✓	
Ruby-throated Hummingbird	RTHU	✓	✓
Sandhill Crane	SACR	✓	✓
Savannah Sparrow	SASP	✓	
Sedge Wren	SEWR	✓	
Song Sparrow	SOSP	✓	✓
Sora	SORA	✓	✓
Spotted Sandpiper	SPSA	✓	
Swamp Sparrow	SWSP	✓	✓
Tree Swallow	TRES	✓	✓
Turkey Vulture	TUVU	✓	✓
Undifferentiated Moorhen/Coot	MOOT	✓	
Virginia Rail	VIRA	✓	✓
Warbling Vireo	WAVI	✓	✓
White-breasted Nuthatch	WBNU		✓
Willow Flycatcher	WIFL	✓	✓
Wilson's Snipe	WISN	✓	
Wood Duck	WODU	✓	✓
Yellow Warbler	YEWA	✓	✓
Yellow-billed Cuckoo	YBCU	✓	✓

Table 13. Maximum abundance per 10 stations for bird species detected during each survey visit, within each marsh complex, across 2008 and 2009 survey years. Indicator species are identified by bold and italicized font.

Species Code	Marsh Code																			
	ON034		ON037		ON039		ON266		ON345a		ON345b		ON512		ON525		ON806		Across Sites	
Survey Period	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
ALFL			0.3	0.6									0.3	0.6					0.1	0.1
AMBI	***P***	***0.6***	***2.9***		***2.8***	***0.4***	***1.6***					***P***	***0.3***	***0.3***					***1.3***	***0.3***
AMCO					***0.2***	***0.6***													***0.1***	***0.2***
AMCR							P							P			P			
AMGO		P			P	0.6		1.1		5.0			0.3	0.3					0.1	0.5
AMRO	0.6	P			0.4	0.6	0.5	P	5.0	10.0	5.0	P	1.4	0.8	P	1.4	10.0	P	0.9	0.6
AMWI		P																		
AMWO						0.2														0.1
BAEA	P		P	P				P												
BAOR					0.8								0.6	0.3					0.4	0.1
BANS	0.6	4.7				2.2								2.2				5.0	0.1	1.9
BARS	16.5	30.0			9.6	25.9	18.4	83.7		15.0		10.0	28.6	53.6	118.6	415.7			20.1	56.2
BEKI				P	P	0.2	0.5	P						0.6	P	P			0.1	0.2
BLTE	***3.5***	***1.8***			***1.4***	***P***	***10.0***	***8.9***					***3.3***	***1.7***	***P***				***3.0***	***1.8***
BBCU						0.4								0.8						0.3
BCCH												10.0	1.4						0.3	0.1
BCNH					P		P													
BLJA					0.2														0.1	
BWTE														0.3						0.1
BRTH					0.4	0.4													0.1	0.1
BHCO					P															
CAGO	P		P		P		4.7				P		0.8		P		10.0		0.9	
CAWR													0.3						0.1	
CATE		1.2					P													0.1
CEWA		P											0.6						0.1	
CSWA						0.4														0.1
CHSW			4.3	2.9															0.2	0.1
CHSP											5.0	10.0							0.1	0.1
COGR	P	P			1.6	0.4	2.1	0.5	30.0		10.0	5.0	12.5	0.6	P	2.9	5.0	15.0	4.5	0.7
COMO	***1.8***			***P***	***1.6***	***1.0***	***P***	***P***								***10.0***			***0.7***	***0.8***
CONI																		P		
COTE		P		P	P	P							1.4	0.6	P	P			0.3	0.1
COYE	9.4	20.6	11.4	11.4	12.4	16.1	17.9	24.7		5.0	10.0	10.0	16.9	26.4	28.6	52.9	10.0	25.0	13.9	21.0

Table 13 (cont.)

Species Code	Marsh Code																			
	ON034		ON037		ON039		ON266		ON345a		ON345b		ON512		ON525		ON806		Across Sites	
Survey Period	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
DCCO						P	0.5	P					1.4						0.4	
DOWO														0.8						0.2
EAKI		0.6			2.4	1.8	2.1	4.2	5.0	15.0			1.7	3.3		10.0			1.6	2.7
EAPH									5.0										0.1	
EAWP						0.4		0.5												0.2
EUST	P	P			P	0.2	0.5	P	10.0		5.0		P	P		P	20.0	P	0.5	0.1
FISP					0.4														0.1	
FOTE	P	P	5.7		P	P							0.3			P			0.3	
GRCA					3.6	3.3	0.5	1.1			5.0		1.4	1.4	2.9	2.9		P	1.8	1.7
GBHE	P	0.6		P	P	P	0.5	0.5					P	P	1.4	P			0.1	0.1
GCFL							0.5	0.5							1.4				0.1	0.1
GREG														P						
GRHE		P	P	1.4	P	P			10.0	5.0		5.0	P	0.6			15.0		0.3	0.3
HAWO						0.2														0.1
HEGU						P				P		P								
HOME											5.0									0.1
HOSP					0.2				10.0										0.2	
HOWR					0.2	0.8							0.8	1.7		4.3			0.3	0.9
INBU		P																		
KILL		P		P	P	P			15.0	10.0					P	P	5.0		0.3	0.1
LEBI	***0.6***	***1.2***		***P***	***1.4***	***0.6***		***1.6***				***P***	***0.3***						***0.6***	***0.5***
LEFL													0.6						0.1	
MALL	P	P	P	P	0.2	0.4	1.1									P			0.2	0.1
MAWR	***40.0***	***31.8***	***17.1***	***10.0***	***28.4***	***35.1***	***17.9***	***28.4***		***15.0***			***13.1***	***16.1***	***65.7***	***85.7***	***15.0***	***20.0***	***23.8***	***28.0***
MODO	P	P			0.6	0.2	1.1	P	P	P	P	P	1.4	0.3	P	P			0.7	0.1
MOOT	***1.8***																		***0.2***	
MUSW					0.2														0.1	
NOCA				0.9	0.4	0.2	1.1	1.6					1.1	0.7	7.1	4.3		P	0.9	0.7
NOFL						0.2														0.1
NOHA					P	P														
NOPI									5.0										0.1	
NRWS					25.2	67.3		23.2					23.9	12.2	30.0	12.9			15.7	29.0
PBGR	***1.2***		***P***	***2.9***	***2.2***	***2.0***	***P***		***P***	***5.0***		***5.0***			***18.6***	***28.6***			***1.8***	***2.3***

Table 13 (cont.)

Species Code	**Marsh Code**																			
	ON034		**ON037**		**ON039**		**ON266**		**ON345a**		**ON345b**		**ON512**		**ON525**		**ON806**		**Across Sites**	
Survey Period	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**
PUMA	21.2	20.6			7.6	3.7	1.6	11.0	5.0			5.0	10.0	11.4	64.3	24.3			10.9	9.0
RBWO														0.3						0.1
REVI					0.2														0.1	
RWBL	38.2	32.3	51.4	38.6	44.4	44.1	48.4	38.4	65.0	10.0	5.0	40.0	60.0	36.9	88.6	104.3	55.0	40.0	48.5	40.7
RBGU		P	P	P	P	P	1.1	P						P	P	P			0.1	
RBGR															1.4				0.1	
RTHU							0.5							0.3					0.1	0.1
SACR	0.6	P		P	P	P	0.5						1.4	0.3					0.5	0.1
SASP			0.3										0.3						0.1	
SEWR							4.7												0.6	
SOSP	5.3	7.1		1.4	6.4	7.3	3.7	2.6			15.0		8.6	6.1	8.6	30.0	5.0		6.0	6.6
SORA			***1.4***	***1.4***	***0.2***														***0.1***	***0.1***
SPSA							0.5												0.1	
SWSP	***9.4***	***17.6***	***11.4***	***15.7***	***9.6***	***13.9***	***17.4***	***18.9***		***5.0***	***5.0***	***10.0***	***7.2***	***18.9***	***12.9***	***7.1***			***9.5***	***15.0***
TRES	18.2	58.2	54.3	40.0	12.0	43.1	35.3	61.6	10.0	60.0	10.0	20.0		39.2	104.3	140.0	15.0	15.0	27.4	48.5
TUVU			P		P											P				
VIRA	***0.6***	***1.8***	***1.4***	***5.7***	***0.2***	***0.2***	***1.6***	***1.6***				***10.0***				***2.9***			***0.4***	***1.0***
WAVI					0.2	0.2							0.8	0.3					0.3	0.1
WBNU												5.0								0.1
WIFL					1.2	0.4					5.0	15.0							0.5	0.3
WISN			0.6										0.6						0.1	
WODU	1.2	P	P		1.4	P	4.2	4.2	5.0	25.0		P	P	P	1.4	1.4	10.0	10.0	1.4	1.1
YEWA					7.0	7.3	7.9	3.7	15.0	5.0	25.0	20.0	8.6	5.0	15.7	5.7	10.0	25.0	6.9	5.1
YBCU													0.6	0.3					0.1	0.1
No. Stations Surveyed	15	15	7	7	50	49	19	19	2	2	2	2	36	36	7	7	2	2	148	147

Table 14. Abundance per 10 stations of marsh bird indicator species and selected marsh-nesting generalist species across surveyed years within the Big Creek NWA-Managed Cells marsh complex. “N.D.” stands for “not detected”.

Species	Year															
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Across Years
AMBI	P	P	P	P	N.D.		0.6	P		N.D.			P	P	P	0.45
AMCO	0.6	N.D.	P	0.6	P		N.D.	P		N.D.			N.D.	0.6	N.D.	1.36
BLTE	9.4	8.8	22.5	4.4	P		17.5	3.9		P			4.3	1.9	1.4	53.6
COMO	8.8	6.3	1.3	0.6	N.D.		3.1	1.7		N.D.			P	N.D.	2.1	17.3
COYE	7.5	4.4	7.5	6.9	10.8		3.8	8.3		4.0			8.6	10.0	16.4	58.6
LEBI	1.3	0.6	0.6	N.D.	N.D.		1.3	0.6		N.D.			2.9	1.3	0.7	6.4
MAWR	18.1	19.4	15.0	9.4	23.3		27.5	12.8		20.0			20.7	33.1	36.4	153.2
MOOT	N.A.	N.A.	0.6	N.A.	N.A.		2.5	N.A.		N.A.			N.A.	N.A.	2.1	3.6
PBGR	P	N.D.	N.D.	P	N.D.		N.D.	P		N.D.			N.D.	P	1.4	0.9
RWBL	50.0	43.1	41.9	28.1	29.2		18.8	28.9		26.0			35.7	38.8	39.3	253.6
SORA	N.D.	0.6	0.6	N.D.	N.D.		N.D.	N.D.		N.D.			N.D.	N.D.	N.D.	0.9
SWSP	12.5	16.3	15.0	5.6	12.5		8.1	16.1		8.0			14.3	15.0	17.1	94.6
VIRA	2.5	N.D.	1.3	1.9	5.0		1.3	3.3		N.D.			1.4	1.9	N.D.	12.7
YEWA	N.D.	N.D.	N.D.	N.D.	N.D.		N.D.	0.6		N.D.			N.D.	N.D.	N.D.	0.5
No. Indicator Species	7	6	8	6	3		8	6		2			5	6	7	11
Total No. Species	34	28	29	32	22		24	31		12			26	32	28	58
No. Stations Surveyed	8	8	8	8	6		8	9		5			7	7	7	10

Six indicator species (American Bittern, Black Tern, Common Moorhen, Least Bittern, Marsh Wren, and Swamp Sparrow) were detected during at least seven of 14 survey years at Big Creek NWA-Unmanaged, while American Coot, undifferentiated Common Moorhen/American Coot, Pied-billed Grebe, Sora, and Virginia Rail were detected less frequently (Table 15).

There were few apparent patterns in relative abundance across years (Table 15). Apparent increases in relative abundance were observed for Common Yellowthroat across years; however, much variation across years occurred for this species, which may account for some of these differences. Common Moorhen has been detected during only two of the past six surveyed years, while Sora has not been recorded at this site since 2002.

Site Disturbance Class Comparisons

Among indicator species, only two (American Bittern and Sora) were more abundant in relatively less disturbed marshes (Table 16). Two of three selected generalist species (Red-winged Blackbird and Common Yellowthroat) were more abundant in more disturbed marshes, while Yellow Warbler was more abundant within relatively less disturbed marshes. Most species, however, showed little differences between site disturbance classes. Statistical analyses of the effects of disturbance are required.

Index of Biotic Integrity

Figure 9 shows mean bird IBI scores of Lake Erie coastal wetlands monitored between 1998 and 2009. Among Long Point sites, Turkey Point Marsh scored highest with a mean IBI of 54.70, followed by Big Creek NWA-Managed, with a mean IBI of 44.17. These sites were two of the top four-scoring Lake Erie coastal wetland sites. Most other Long Point sites scored within the mid-range of all monitored sites. Long Point Bay North Shore Marshes scored lowest among Long Point sites, with a mean IBI of 18.91.

Species Richness

The Long Point Bay South Shore Marsh complex had the highest maximum species richness in terms of total bird species and marsh-nesting obligates among Lake Erie coastal marshes during 1998-2009 (Table 17). Among Long Point Bay marshes, Turkey Point Marsh and Big Creek NWA-Unmanaged also had relatively high species richness for these marsh bird guilds. Maximum species richness values at these sites were comparable to those recorded at Rondeau Provincial Park, another major sand spit-based wetland complex on Lake Erie, but were greater than that recorded at Point Pelee. Other Long Point Bay marshes had moderate levels of species richness among these guilds relative to other Lake Erie coastal marshes. See Table A2 for marsh bird species classifications across reported guilds.

Table 15. Abundance (mean/ 10 stations) of marsh bird indicator species and selected marsh-nesting generalist species across surveyed years within the Big Creek NWA-Unmanaged marsh complex. "N.D." stands for "not detected".

Species	Year														
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Across Years
AMBI	P	P	1.3	P	0.8	N.D.	P	0.2	N.D.	1.3	0.7		P	0.4	0.3	1.0
AMCO	N.D.	N.D.	P	1.0	N.D.	N.D.	N.D.	0.2	N.D.	N.D.	N.D.		N.D.	N.D.	N.D.	0.2
BLTE	8.0	4.0	3.1	2.0	2.5	P	4.6	1.6	5.0	1.3	0.7		4.3	2.2	3.7	6.0
COMO	2.0	P	1.9	P	N.D.	N.D.	0.4	0.2	N.D.	N.D.	N.D.		P	N.D.	P	0.6
COYE	12.0	15.0	10.0	7.0	8.3	9.3	10.4	12.3	14.3	16.7	13.6		8.6	23.0	21.0	34.6
LEBI	N.D.	P	0.6	1.0	0.8	N.D.	1.7	0.2	N.D.	N.D.	N.D.		2.9	P	0.3	0.9
MAWR	27.0	24.0	32.5	47.0	15.9	2.9	3.8	7.4	0.7	4.7	5.7		20.7	12.4	22.0	29.6
MOOT	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	P	P	N.A.	N.A.	N.A.		N.A.	N.A.	N.A.	N.A.
PBGR	1.0	N.D.	N.D.	N.D.	N.D.	N.D.	P	P	N.D.	0.7	N.D.		N.D.	P	P	0.1
RWBL	51.0	44.0	39.4	29.0	40.0	64.3	30.8	30.3	56.4	44.7	54.3		35.7	44.6	67.3	102.0
SORA	N.D.	N.D.	0.6	N.D.	N.D.	N.D.	N.D.	0.1	N.D.	N.D.	N.D.		N.D.	N.D.	N.D.	0.1
SWSP	35.0	39.0	31.9	20.0	16.7	19.3	11.3	23.7	24.3	20.0	15.7		14.3	10.4	17.0	48.9
VIRA	N.D.	N.D.	N.D.	N.D.	0.8	N.D.	N.D.	0.4	N.D.	N.D.	N.D.		1.4	0.4	N.D.	0.5
YEWA	N.D.	N.D.	3.8	N.D.	2.5	10.0	0.8	7.5	1.4	0.7	2.1		N.D.	6.0	8.3	12.1
No. Indicator Species	5	3	7	5	6	2	5	9	3	5	4		5	5	5	10
No. Total Species	27	27	32	36	33	37	38	65	32	32	33		26	49	50	93
No. Stations Surveyed	5	5	11	5	6	7	12	53	7	8	7		7	24	15	68

Table 16. Abundance per 10 stations of marsh bird indicator species and selected marsh-nesting generalist species detected within relatively less-disturbed and more-disturbed wetland sites among the Long Point and Rondeau wetland complexes, 1995-2009 inclusive.

Species	Disturbance Category		
	Less Disturbed	More Disturbed	Overall
American Bittern	0.6	0.5	0.5
American Coot	0.2	0.3	0.2
Black Tern	2.1	4.6	3.3
Common Moorhen	0.1	1.3	0.7
Common Yellowthroat	11.1	14.3	12.7
Least Bittern	0.5	0.9	0.7
Marsh Wren	10.7	27.5	18.7
Undifferentiated Moorhen/Coot	0.1	0.2	0.1
Pied-billed Grebe	0.1	0.7	0.4
Red-winged Blackbird	46.2	50.7	48.4
Sora	0.8	0.1	0.4
Swamp Sparrow	9.4	20.6	14.7
Virginia Rail	0.8	0.9	0.8
Yellow Warbler	13.6	4.6	9.3
No. Indicator Species	14	14	14
No. Total Species	133	116	138
No. of Stations Surveyed	39	58	97

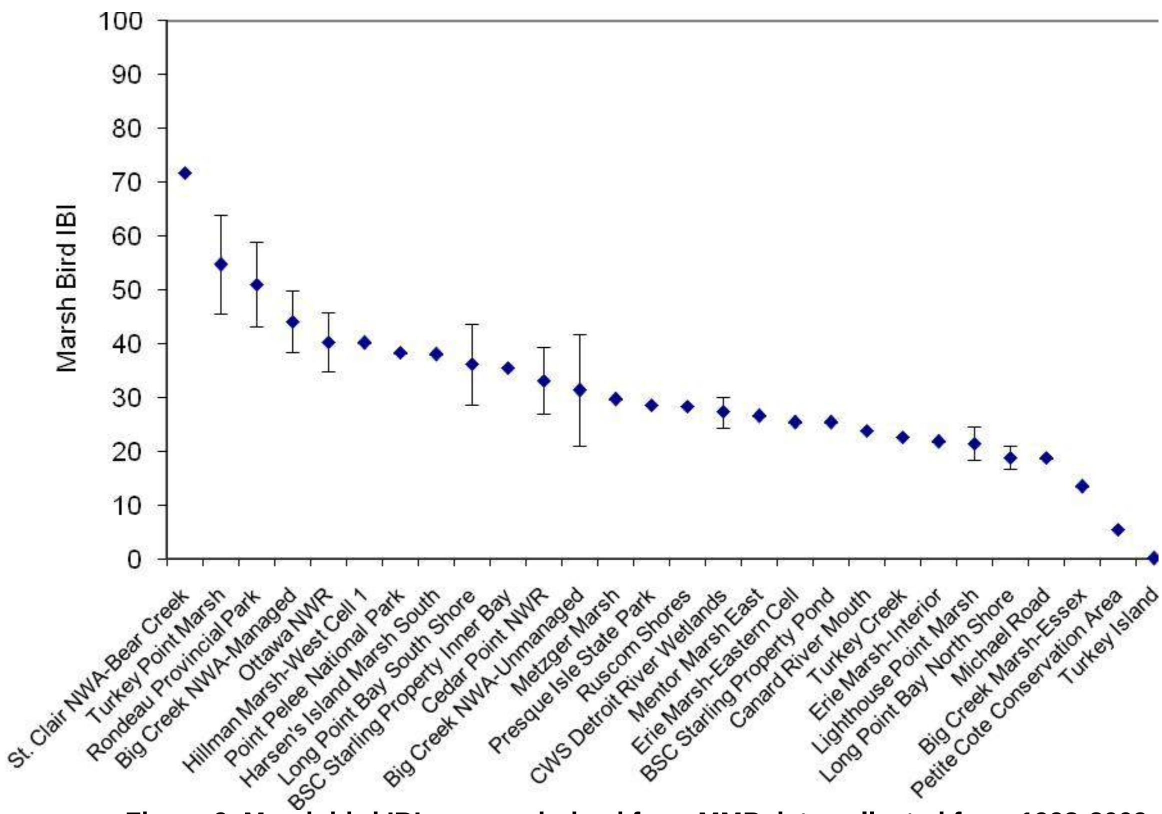

Figure 9. Marsh bird IBI scores, derived from MMP data collected from 1998-2009, inclusive, for Long Point-area marshes in relation to other monitored Lake Erie coastal marshes.

Table 17. Maximum species richness across three marsh bird guilds among monitored Lake Erie coastal marshes for the years 1998-2009, inclusive.

Marsh Name	Guild		
	Marsh-nesting Generalists	Marsh-nesting Obligates	Total Bird Species
Long Point Bay South Shore Marshes	2	9	40
Cedar Point NWR	4	8	35
Ottawa NWR	3	7	34
Turkey Point Marsh	3	7	29
CWS Detroit River Wetlands	3	2	27
Rondeau Provincial Park	2	6	25
Big Creek NWA-Unmanaged	3	5	25
Canard River Mouth	2	3	20
Erie Marsh - Barrier Protected, Eastern Cell	2	5	18
Long Point Bay North Shore Marshes	2	5	18
Turkey Creek Riparian Wetland	2	1	18
Lighthouse Point Marsh	1	2	17
Mentor Marsh East	2	1	16
Big Creek NWA-Managed Cells	2	7	16
BSC Starling Property Pond	2	2	16
BSC Starling Property Inner Bay	2	3	15
Point Pelee National Park	2	2	14
St. Clair NWA - Bear Creek	2	7	13
Erie Marsh - Inland	3	3	12
Presque Isle State Park	2	3	12
Hillman Marsh - West Cell	2	5	10
Turkey Island	1	0	9
Metzger Marsh NWA	2	1	6
Big Creek Marsh-Essex	2	0	6
Ruscom Shores	2	1	6
Petite Cote Conservation Area	3	0	6
Harsen's Island Marsh South	2	2	5
Michael Road	1	0	5

Within-station Habitat Characteristics

All marsh sites were dominated by emergent herbaceous vegetation (Table 18). Amount of open water ranged widely among sites, from a low of 11.9% at the Long Point Bay South Shore Marshes to 40.7% at Bayou Club Wet Meadow. The highest proportion of woody vegetation occurred at BSC Starling Property Inner Bay, with 17.0% and 10.3% of shrub- and tree-coverage, respectively.

With the exception of Bayou Club Wet Meadow, cattails were the dominant emergent vegetation type at all sites, while “reeds” (common reed and reed canary grass) were the second most dominant emergent vegetation type (Table 18). Bayou Club Wet Meadow, as its name suggests, had a different emergent vegetation mosaic than the other marsh-type wetlands; sedges and grasses represented 80.0% of all emergent vegetation within stations, while cattails only accounted for 6.7%. Long Point Bay South Shore Marshes, Turkey Point Marsh, and Long Point Bay North Shore Marshes had the highest number of emergent vegetation types as described in MMP habitat surveys, with ten, nine, and nine, respectively.

Table 18. Percent cover of habitat and emergent vegetation composition for each Long Point marsh complex monitored in 2008 and 2009.

Habitat Characteristic	Marsh Code								
	ON034	ON039	ON266	ON345a	ON345b	ON512	ON525	ON806	Across Sites
Habitat Composition (Percent Cover)									
Emergent Vegetation	78.3	78.4	71.0	50.6	54.2	68.2	74.3	47.7	71.4
Open Water	21.1	11.9	25.8	31.6	18.0	18.1	17.9	40.7	17.9
Exposed Mud, Sand, Rock	0.0	0.5	0.1	2.0	0.5	1.3	0.4	1.7	0.7
Trees	0.0	1.5	1.2	3.4	10.3	6.9	6.4	3.3	3.8
Shrubs	0.6	7.7	2.4	12.4	17.0	5.6	1.1	6.7	6.3
Emergent Vegetation Composition (Percent Cover)									
Cattail (*Typha* spp.)	56.3	34.3	53.4	77.8	79.5	61.9	48.6	6.7	49.1
Reeds (*Phragmites australis, Phalaris* spp.)	3.8	28.7	10.9	1.4	11.1	10.3	6.8	1.7	15.7
Grasses and Sedges	6.3	10.5	7.4	9.0	5.5	5.5	3.9	80.0	9.0
Rushes and Bulrushes (*Juncus* spp., *Scirpus* spp.)	0.0	1.9	4.7	0.2	0.0	1.1	2.5	0.0	1.7
Water Willow (*Decodon verticillatus*)	15.6	0.3	0.6	0.0	0.0	0.3	0.0	0.0	1.1
Pickerelweed (*Pontederia cordata*)	0.0	0.9	2.7	0.0	0.0	0.9	4.6	0.0	1.3
Arrowhead (*Sagittaria* spp.)	0.0	0.2	2.7	0.0	0.0	0.0	12.1	0.0	1.6
Smartweed (*Polygonum* spp.)	0.0	0.1	0.4	0.0	0.0	0.0	0.7	0.0	0.1
Burreed (*Sparganium* spp.)	0.0	0.1	0.4	0.0	0.0	0.0	0.7	0.0	0.2
Other	8.8	5.7	0.0	3.4	0.0	5.4	3.6	0.0	4.2
Number of Stations Surveyed	9	51	17	5	10	32	14	3	141

Cross-Year Comparisons

Within-station habitat and emergent vegetation characteristics were qualitatively compared across surveyed years, 2003 to 2009 inclusive, for Big Creek NWA-Managed and Big Creek NWA-Unmanaged combined. However, because station location within each marsh varied across years, a reliable estimate of change in habitat and emergent vegetation coverage could not be estimated for these marshes. Future studies may use Geographic Information Systems (GIS) for more accurate assessments of habitat changes within Long Point marshes.

Site Disturbance Class Comparisons

Relatively less-disturbed sites had slightly higher proportions of emergent vegetation (80.5% versus 75.8%) while more-disturbed sites tended to contain higher proportions of woody vegetation (shrubs and trees) (Table 19). Sites within both disturbance classes averaged 16.3% open water. Among emergent vegetation types, cattails dominated sites within both disturbance classes to an almost equal degree (51.6% within less-disturbed sites, 49.3% within more-disturbed sites). Grasses and sedges represented the next most dominant emergent vegetation type in each. All other emergent vegetation types occurred in small proportions, but were generally slightly higher within more-disturbed sites (e.g., pickerelweed, arrowhead, smartweed). Burreed, rushes and bulrushes, and wild rice occurred in slightly higher proportions within less-disturbed sites, while purple loosestrife did not occur within this site disturbance class.

Table 19. Percent cover of habitat and emergent vegetation composition within relatively less-disturbed and more-disturbed wetland sites among the Long Point and Rondeau wetland complexes, 1995-2009 inclusive.

Habitat Characteristic	Disturbance Category		
	Less Disturbed	More Disturbed	Overall
Habitat Composition (Percent Cover)			
Emergent Vegetation	80.5	75.8	78.8
Open Water	16.3	16.3	16.3
Exposed Mud, Sand, Rock	0.5	1.1	0.7
Trees	0.6	2.3	1.2
Shrubs	1.6	4.3	2.6
Emergent Vegetation Composition (Percent Cover)			
Cattail (*Typha* spp.)	51.6	49.3	50.8
Reeds (*Phragmites australis, Phalaris* spp.)	1.4	0.3	1.1
Grasses and Sedges	23.4	28.7	25.3
Rushes and Bulrushes (*Juncus* spp., *Scirpus* spp.)	3.8	2.9	3.5
Water Willow (*Decodon verticillatus*)	0.2	2.5	1.0
Pickerelweed (*Pontederia cordata*)	0.2	1.2	0.5
Arrowhead (*Sagittaria* spp.)	0.3	1.4	0.7
Smartweed (*Polygonum* spp.)	0.1	1.6	0.5
Burreed (*Sparganium* spp.)	1.4	0.3	1.1
Purple Loosestrife (*Lythrum salicaria*)	0.0	0.1	0.0
Wild Rice (*Zizania palustris*)	3.1	0.1	2.2
Other	1.1	2.3	1.5
Number of Station-Visits	502	286	788
Number of Stations Surveyed	107	97	204

DISCUSSION

Marsh bird and amphibian species richness in Long Point-area marshes ranked high to moderate, compared to other Lake Erie coastal marshes. Within these, the Long Point Bay South Shore Marsh complex, Turkey Point Marsh, and the Big Creek NWA managed cells stand out as having habitat that could support a relatively high number of marsh-dependent bird species. These sites also had relatively high amphibian species richness values, and supported most disturbance-intolerant species. Marsh bird and amphibian species richness values at these sites are generally comparable to those for Rondeau Provincial Park, but tended to be higher than values for Point Pelee National Park.

Long Point marsh ecological integrity as inferred from marsh bird IBI results was much more variable in relation to all other monitored Lake Erie coastal marshes, although Turkey Point Marsh, the Long Point Bay South Shore Marsh complex, and the Big Creek NWA managed cells still ranked among the highest scores. In contrast, Long Point-area marshes tended to rank low to moderate among Lake Erie coastal marshes in terms of amphibian IBI scores. For instance, the Long Point Bay South Shore Marsh complex was the fourth lowest ranked among sites. These results, which appear to contradict the species richness summaries, may be due to the fact that the amphibian IBI, as well as the marsh bird IBI, was not correlated against a disturbance gradient. These IBIs and their constituent metrics were originally correlated against a coastal marsh site disturbance gradient based on values of land use/land cover surrounding each marsh at various buffer scales, during their development, in order to validate their use (Crewe and Timmermans 2005). However, over the five years since development of these IBIs, several additional Great Lakes coastal marshes have been monitored, including several around Long Point, and are thus included in these updated IBIs. It is therefore ideal to update the marsh site disturbance gradient against which IBI metrics are correlated to ensure their continued appropriate use. Because this wasn't accomplished as part of this project, these reported IBI results should be interpreted with some caution. However, despite this, the marsh bird IBI site rankings do appear to generally reflect expected biotic condition results among sites. Future IBI rankings would also benefit from power analyses to determine the minimum detectable difference between IBI scores, which enables classification of different categorical marsh conditions (e.g., poor, fair, good). This was not accomplished as part of this project due to lack of available time.

Amphibian species richness values ranged from four to eight out of a possible total of nine species among the Long Point-area sites during the 2008-09 project period. At least five species were detected at most sites, a relatively high level of species richness. Bullfrog and Green Frog was commonly detected at these sites, owing to the typically large, permanent, deep-water, cattail-dominated nature of these marshes. In contrast, woodland species were relatively under-represented given the low proportions of woody vegetation within and surrounding monitoring stations. For example, Spring Peeper only occurred on 58% of all stations during the project period. While Wood Frog occurrence values would be expected to be low at most of these sites, their presence was undoubtedly missed to an unknown extent because of the difficulty in timing surveys to coincide with their early, brief calling period.

The largest marsh complexes, such as Turkey Point Marsh, Big Creek NWA and the Long Point South Shore Marsh Complex, contained the greatest number of marsh bird indicator species (e.g., Black Tern, Virginia Rail, Common Moorhen, Pied-billed Grebe). However, American Coot and Sora were relatively uncommon at these sites. While Least Bittern was detected at most major marsh complexes, its occurrence and relative abundance may have been underestimated by these surveys. Tozer et al. (2007) demonstrated that the short call-broadcasts as used by the

MMP are not effective at detecting Least Bitterns due to their lack of territory defence and pair-bond maintenance calls and because they remain silent once pairs have formed. However, others (e.g., Gibbs and Melvin 1993) have reported increased detectability of Least Bitterns when using call-broadcasts over passive listening. Regardless, specialized Least Bittern surveys conducted by Long Point Waterfowl (M.Sc. candidate, Nick Bartok) in several Long Point Inner Bay marshes during 2008-09 can complement these data to provide a more thorough assessment of Least Bittern occurrence and relative abundance.

During the 2008-09 project period, there was little difference between Big Creek NWA managed and unmanaged marsh components in terms of amphibian species occurrence and calling intensity. Similarly, across all survey years, there was little difference between zones although Fowler's Toad and Western Chorus Frog were more frequently detected in the unmanaged zone while Bullfrog, American Toad and Northern Leopard Frog tended to be recorded at higher calling codes and at more stations within the managed cells. Conversely, during the project period species richness and relative abundance of marsh bird species tended to be higher within the managed cells. Between Big Creek NWA marsh components, Pied-billed Grebe, undifferentiated Common Moorhen/American Coot, Common Moorhen and Virginia Rail were only detected within the managed cells while relative abundances of American Bittern, Least Bittern, and Marsh Wren were generally higher within the cells. Additionally, across all years, most marsh bird indicator species were detected more often and at higher relative abundances within the managed cells. In contrast, wetland generalist species such as Red-winged Blackbird, Yellow Warbler and Common Yellowthroat were more common in the unmanaged zone. These results suggest that wetland management practices at Big Creek NWA may be benefiting several marsh bird indicator species and certain amphibian species.

Qualitative assessments of temporal change in amphibian and marsh bird species occurrence and calling intensity/relative abundance did not reveal apparent patterns or trends for most species at either of the assessed Big Creek NWA marsh sites. There were some exceptions though. For example, within the managed cells in recent years (e.g., since 2002) apparent declines in Black Tern abundance were recorded while there have been apparent increases in occurrence and relative abundance/calling code of Spring Peeper, Common Yellowthroat, Marsh Wren and Swamp Sparrow. Sora has not been detected in the managed cells since 1997. Within the unmanaged zone over the same period, an apparent general increase in Common Yellowthroat relative abundance has occurred. Sora and Fowler's Toad have not been detected in this marsh zone since 2002 and 2005, respectively. Apparent temporal changes in marsh bird and amphibian community structure and relative abundance within the managed cells may be responses to wetland management activities such as water level manipulation. Apparent changes within both marsh zones may also reflect other local or landscape-level causative factors. Future studies may investigate these potential relationships. We recommend that temporal data be analyzed statistically to determine whether or not real change has occurred.

There was no difference in the occurrence of amphibian and selected marsh bird species between pre-defined groupings of less-disturbed and more-disturbed marsh sites among the Long Point and Rondeau wetland complexes. Almost all amphibian species had equivalent maximum calling codes (usually 3) between both disturbance categories, and relative abundance of most marsh bird species were also similar between categories. Contrary to what we expected, certain marsh bird indicator species, such as Black Tern and Marsh Wren, were more abundant within the more-disturbed marsh sites. These results may be due to the much greater survey coverage and representation of relatively more-disturbed marshes, which include large protected sites such as Big Creek NWA and Crown Marsh. This qualitative assessment would also benefit from a more comprehensive and objective method to assign marshes to categorical disturbance classes, and to statistically assess differences in marsh bird and amphibian community composition among these.

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APPENDIX

Table A1. Amphibian species classification by guild.

Species	Guild			
	Woodland	Disturbance-Tolerant	Disturbance-Intolerant	Great Lakes Basin-wide
American Toad		X		X
Bullfrog			X	
Western Chorus Frog	X	X		
Fowler's Toad				
Green Frog		X		X
Gray Treefrog	X	X		
Northern Leopard Frog			X	X
Spring Peeper	X	X		X
Wood Frog	X		X	X

Table A2. Marsh bird species classification by guild.

Marsh-Nesting Generalists	Marsh-nesting Obligates
American Black Duck	American Bittern
Canada Goose	American Coot
Common Loon	Black Tern
Common Yellowthroat	Common Moorhen
Le Conte's Sparrow	Common Snipe
Lesser Scaup	Forster's Tern
Northern Harrier	Horned Grebe
Red-winged Blackbird	King Rail
Sedge Wren	Least Bittern
Wilson's Phalarope	Little Gull
	Marsh Wren
	Undifferentiated Common Moorhen/American Coot
	Pied-billed Grebe
	Redhead
	Ring-necked Duck
	Red-necked Grebe
	Sandhill Crane
	Sora
	Swamp Sparrow
	Trumpeter Swan
	Virginia Rail
	Yellow Rail
	Yellow-headed Blackbird

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An Assessment of the Nearshore Fish Community of Long Point Bay

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Abstract

A survey of the nearshore fish community in Long Point Bay, Lake Erie was conducted in 2007. A total of 32 sites dispersed geographically and by habitat characteristics around the bay were sampled by beach seining and electrofishing from June 21st to August 30th, 2007. The majority of the sites (24) were sampled three times in early, mid and late summer. Additional sites were added based on observed habitat characteristics, and sampled either once or twice. The majority of sites were seined, one site was seined and electrofished and two sites were only electrofished. Fish species were identified counted and measured (length and weight) in situ and released.
*A total of 52,807 fish were observed, representing 42 species in 15 families, 14 species of which described 97% of the entire survey. The most common species captured was brook silverside (*Labidesthes sicculus*), accounting for 22.77% of the total catch, blacknose shiner (*Notropis heterolepis*) represented 20.69% of the catch, and spottail shiner (*Notropis hudsonius*) 10.51%. Four federally designated at-risk listed species were observed in the survey: pugnose shiner (*Pimephales notatus *COSEWIC status Endangered) ,lake chubsucker (*Erimyzon sucetta*, Status: Threatened), grass pickerel (*Esox americanus vermiculatus*, Special Concern) and warmouth (*Lepomis gulosus*, Special Concern).*
Site specific biodiversity indices, calculated using Shannon-Wiener index, ranged from a low of H' = 0.258 to a high of H' = 2.522 with an overall H' = 2.411. A comparison of biodiversity indices from a coincident nearshore survey of Lake St. Clair and Lake Erie suggest that biodiversity of nearshore fish communities in the Long Point Bay area are potentially the highest in the St. Clair-Erie system in Canadian waters. Cluster analysis using Ward's method determined there were 9 clusters, which except for 2 of the clusters, were significantly different. Two clusters situated at the interface of large, protected coastal marsh systems with the bay proper, exhibited the highest biodiversity values. Vegetation species richness at a particular site significantly influenced fish species diversity, as expressed as effective number of species (R^2 = .063, p=0.0106). Canonical correspondence analysis (CCA), some species captured in this survey have association to specific aquatic vegetation communities.
The anthropogenic effects of shoreline and nearshore development, such as shore structures and urban land uses, are cumulative and are known to affect fish communities over larger spatial scales. Protection and management of the diversity of nearshore habitats, rather than solely the most productive, is therefore important. Management, planning and restoration strategies should incorporate and address both local and large scale, and immediate and cumulative impacts.

Introduction

Long Point and its associated wetlands are the largest undeveloped area remaining on the shores of the lower Great Lakes (Nelson et al. 1993). The approximately 40 km long sand spit delineates the western boundary of Lake Erie's eastern basin. Home to a UNESCO World Biosphere Reserve, the northern coast of the spit, and Inner Long Point Bay enclosed by the spit, has a variety of wetlands and habitats throughout. The spit, except for the extreme western end which has a cottage community, is mostly lightly or undeveloped, owing to private and government ownership. Canadian Wildlife Service, Ontario Ministry of Natural Resources and a private hunting club (the Long Point Company) control most of the land of the spit. Long Point Bay has a large recreational fishery and supports both a hoop and seine commercial fishery in the Inner Bay, and a gill and trawl net fishery in the Outer Bay (see Craig 2003 for detailed fishery history and information).

Long Point and the bay it forms creates a large nearshore area in the eastern basin of Lake Erie. This bay, on the leeward side of Long Pont from the prevailing westerly winds, is fringed with coastal marsh systems and sheltered habitat (see figure 1). These nearshore areas are important to fish populations, as they provide spawning, nursery, foraging and migratory habitats to the majority of all Great Lakes fish (Goforth and Carman 2005) and affect many other species as well as abiotic processes (Edsall and Charlton 1997; Hecky *et al*. 2004). Coastal wetlands in Lake Erie are utilized by over 80 species of fish, with more than 50 species dependent upon them (Jude and Pappas, 1992). Wei *et al* (2004) found Great Lakes fish communities utilize wetlands disproportionately to their availability and that distribution in coastal wetlands are influenced by the type of wetland (e.g. and embayment vs. open shore).

Long Point, because of its UNESCO status and the large amount of protected or undeveloped land, is the focus of much research. Despite this, nearshore fish community surveys of Long Point Bay are infrequent and sporadic, but are valuable in assessing the health of the ecosystem and providing a baseline that can be utilized to track ecosystem changes, expand knowledge of distribution and presence of species at risk or invasive species and guide resource management decisions. Fish communities are determined by many biotic and abiotic factors (Jackson et al 2001), and defining these factors can advise greatly on protection, restoration and management of communities and habitat. This survey was conducted for this purpose, to assess and evaluate the diversity and composition of nearshore fish communities, and as a component of the Long Point Bay Ecosystem Assessment project funded under the Canada Ontario Agreement. Findings from this survey will eventually integrate with other aquatic components to describe the health of the Long Point Bay ecosystem.

Methods

A total of 32 sites were sampled at various locations on Long Point Bay from June 21 to August 30, 2007 (figure 1). Sites were selected based on geographical location within the bay, plant species present, substrate and depth; chosen for wide spatial and habitat characteristics. The majority of sites (24) were selected during a tour of the bay by project staff in May 2007. Additional sites were added through the sampling season based on closer observation of habitat characteristics (One site was sampled twice and seven sites were sampled once).

Each of the original 24 sites were scheduled to be sampled on a rotational basis with sampling roughly falling into an early, mid and late summer visits. Sites added after sampling commenced would be revisited if there was an additional period available (e.g. a site added mid summer would be revisited in late summer). Upon arriving at each site for sampling, time of arrival and weather conditions were recorded. Air temperature (°C), wave height (m) wind direction and speed (kts), cloud cover and precipitation were recorded. Water quality parameters were measured 7.5m offshore of the starting point on the shore line in the approximate centre of the water column using a YSI 600 QS instrument, recording water temperature (°C), pH, specific conductivity (mS/cm), dissolved oxygen in % and mg/l, oxygen reduction potential (ORP). Depth (m) was noted and substrate was examined *in situ* for percent of sand, silt, clay and gravel. Vegetation was noted within the littoral and near shore zones. Most plants were identified to species level.

The primary sampling method was beach seining using a 15m long 6mm mesh bag seine. The seine was deployed perpendicular to shore from the shoreline. The seine was dragged parallel to the shore for 15m after which the offshore pole was brought inshore to purse the seine (total sampled area $225m^2$). The net was then pulled in slowly keeping the lead line on the bottom to reduce escapes. If fewer than 10 fishes were captured, the length of seining was increased by an additional 15m to a total of 30m.

All fish captured were placed in aerated tanks for processing. Each seining event tallied and identified all fish caught, with total and fork lengths of the first 20 individuals of each species recorded. Voucher specimens of fish not easily identified were preserved in ethanol for identification and archiving. Once processed, all fish were released live back into Long Point Bay and away from the seining site.

This procedure was replicated 3 times at each site visit, with the area seined spaced at close locations within the same habitat. Elapsed time of sampling and GPS waypoints were recorded for the start and end of each seine. Departure time and weather conditions were recorded upon completion of sampling.

Boat electrofishing was conducted once at 3 deeper water sites. Weather conditions, water quality, and vegetation identification were collected using the same protocols as with seining. Due to the depth of these sites, a substrate sample was not taken. The boat sampled a 45m² section for 500 seconds with two people holding dip nets at the front of the boat collecting stunned fishes. The fishes were placed into an aerated holding tank and identified when the sampling was finished using the same protocols as described with seining.

Species richness, catch per unit effort (CUE) and Shannon-Wiener Biodiversity indices were calculated for each visit, each site and the entire survey. Specimens were categorized using the Ontario Species Code List. This list has specific codes for generic as well as specific identification, as some specimens could only be identified to genera due to their condition and size.

Cluster analysis was performed using PAST v 1.42 software. Abundance in catch was standardized for effort, and electrofishing data were eliminated as effort comparison between gear types could not be achieved. There are a number of algorithms available for this analysis, and Ward's Method was chosen. Most ecological community data are relatively continuous and not separated by natural definable discontinuities, and Ward's method, by joining clusters to minimize within-group variance, would tend to divide up variations into equitable groups (Ward 1963; Bayne *et al*. 1980).

Substrate at each site was recorded, with the presence of sand, silt, mud or gravel denoted by a numeric scale of 0 – 4, with 0 being absent and 4 being 75-100%. Vegetation species was also ranked on a *DAFORA* scale (dominant, abundant, occasional, rare and absent) with a numerical value of 5 for dominant and 0 for absent. These values, as well as the physical parameters measured were used in a canonical correspondence analysis between fish species and environmental variables using Canoco v4.5 statistical software.

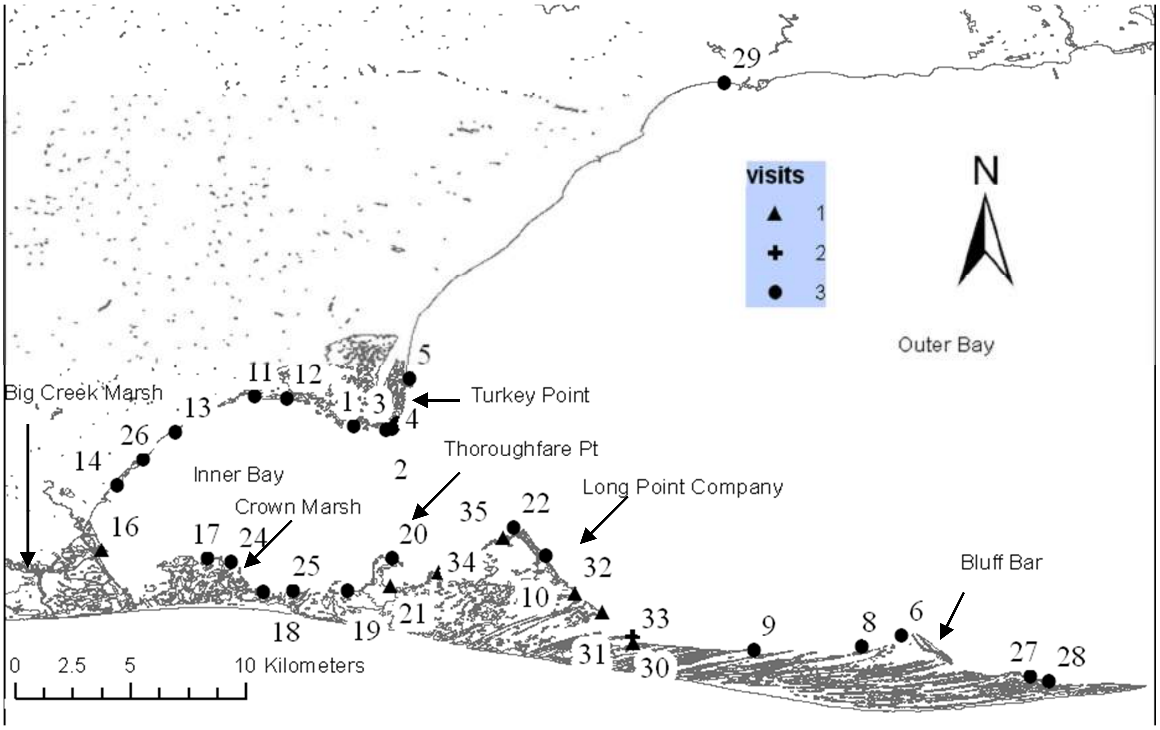

Figure 1. Location of nearshore fish sampling sites in 2007 survey. Symbols denote number of visits during length of survey.

Results

Thirty two sites were sampled in 2007 from June 21 to August 30, 2007 capturing a total of 52, 807 fish. 24 of the 32 sites were visited three times; in early, mid and late summer, one site was visited twice in the mid and late summer period, and seven sites were visited once. Of the single visit sites, two, sites 16 and 21, were electofished in the mid summer period, whereas the other sites, sites 31-35, were sampled by seining in the late summer. Physical, substrate and vegetation observations are listed in Appendix A.

Overall, 42 species were observed representing 15 families; however two of these counted species were only keyed to the generic level (Table 1). Some specimens of the Cyprinidae and Centrachidae families could only be keyed to this level, due to size and condition of the specimens. Although it is likely that many of these keyed to genera specimens were represented in specific-keyed counts, it is possible that they included other species and were counted in the richness indices.

The most common species captured was brook silverside (*Labidesthes sicculus*), accounting for 22.77% of the total catch. Blacknose shiner (*Notropis heterolepis*) represented 20.69% of the catch, and spottail shiner (*Notropis hudsonius*) 10.51%. Of the 42 species, 14 species described 97% of the total survey. Each of the remaining 28 species accounted for <1% of the total catch.

Of the commercially and recreationally important species, the dominant species captured were largemouth bass (*Micropterus salmoides*, 4.60%)., followed by yellow perch (*Perca flavescens*, 3.19%), rock bass (*Ambloplites rupestris*, 0.35%) and smallmouth bass (*Pomoxis nigromaculatus*, 0.28%). Other important species observed were white perch (*Morone americana*), northern pike (*Esox lucius*), white bass (*Morone chrysops*) and black crappie (*Micropterus dolomieu*). 8.55% of the specimens captured belonged to targeted species.

Four at-risk listed species were observed in the survey. 988 pugnose shiner (*Pimephales notatus*, COSEWIC status Endangered), were observed. These represented 1.87% of the total catch for the survey and were found at half of the sites (16) throughout the sampling period, distributed though most of the survey area. Catches were recorded from Site 5 east of the Turkey Point Marsh complex, around the inner bay to the tip of Long Point (Site 28). 46% of the observations were made at site 9, with occurrences on all three visits (182, 220 and 56 respectively for early, mid and late summer visits). The timing of capture from the other sites that reported observations varied through the sampling season, with some reporting occurrences in all visits and others less so, though there wasn't a discernable geographical pattern to the timing of observation and all broad geographical areas (Turkey Point, Inner Bay, Thoroughfare, Bluffs) had occurrences throughout the season.

Also observed were lake chubsucker (*Erimyzon sucetta*, Status: Threatened), grass pickerel (Esox *americanus vermiculatus*, Special Concern) and warmouth (*Lepomis gulosus*, Special Concern).

Table 1: Species captured and relative abundance as a % of total catch for the 2007 Long Point Bay Nearshore Survey. Species marked with an asterisk (*) denote COSEWIC listed species.

Family	Common Name	Sp Code	Scientific Name	Rel Abundance (%)
CLUPEIDAE	longnose gar	*41*	*Lepisosteus osseus*	0.02%
AMIIDAE	bowfin	*51*	*Amia calva*	0.01%
LEPISOSTEIDAE	alewife	*61*	*Alosa pseudoharengus*	0.08%
	gizzard shad	*63*	*Dorosoma cepedianum*	0.01%
ESOCIDAE	northern pike	*131*	*Esox lucius*	0.02%
	grass pickerel*	*133*	*Esox americanus vermiculatus*	0.05%
UMBRIDAE	central mudminnow	*141*	*Umbra limi*	0.02%
CATOSTOMIDAE	white sucker	*163*	*Catostomus commersoni*	0.02%
	lake chubsucker*	*164*	*Erimyzon sucetta*	<0.01%
CYPRINIDAE	cyprinidae spp	*180*		1.20%
	goldfish	*181*	*Carassius auratus*	0.01%
	common carp	*186*	*Cyprinus carpio*	<0.01%
	golden shiner	*194*	*Notemigonus crysoleucas*	0.79%
	pugnose shiner*	*195*	*Pimephales notatus*	1.87%
	emerald shiner	*196*	*Notropis atherinoides*	6.78%
	common shiner	*198*	*Luxilus cornutus*	0.09%
	blackchin shiner	*199*	*Notropis heterodon*	4.46%
	blacknose shiner	*200*	*Notropis heterolepis*	20.69%
	spottail shiner	*201*	*Notropis hudsonius*	10.51%
	spotfin shiner	*203*	*Cyprinella spiloptera*	0.28%
	mimic shiner	*206*	*Notropis volucellus*	0.04%
	bluntnose minnow	*208*	*Notropis anogenus*	2.72%
ICTALURIDAE	brown bullhead	*233*	*Ameiurus nebulosus*	0.10%
	tadpole madtom	*236*	*Noturus gyrinus*	0.03%
CYPRINODONTIDAE	banded killifish	*261*	*Fundulus diaphanus*	8.25%
PERCICHTHYIDAE	white perch	*301*	*Morone americana*	0.10%
	white bass	*302*	*Morone chrysops*	0.01%
CENTRARCHIDAE	rock bass	*311*	*Ambloplites rupestris*	0.35%
	pumpkinseed	*313*	*Lepomis gibbosus*	5.16%
	bluegill	*314*	*Lepomis macrochirus*	0.37%
	smallmouth bass	*316*	*Pomoxis nigromaculatus*	0.28%
	largemouth bass	*317*	*Micropterus salmoides*	4.60%
	black crappie	*319*	*Micropterus dolomieu*	0.00%
	Lepomis sp.	*320*		3.18%
	Warmouth*	*323*	*Lepomis gulosus*	<0.01%
PERCIDAE	yellow perch	*331*	*Perca flavescens*	3.19%
	greenside darter	*336*	*Etheostoma blennioides*	0.01%
	Iowa darter	*338*	*Etheostoma exile*	0.01%
	johnny darter	*341*	*Etheostoma nigrum*	0.33%
ATHERINIDAE	brook silverside	*361*	*Labidesthes sicculus*	22.77%
GOBIIDAE	round goby	*366*	*Neogobius melanostomus*	1.58%
SCIAENIDAE	freshwater drum	*371*	*Aplodinotus grunniens*	0.01%

Overall, the Shannon-Wiener biodiversity index for the 2007 Nearshore Survey was calculated (using Past v1.97) to be H' = 2.411 (H'max = 3.738). Site-specific calculations are illustrated in Figure 2, and range from a low of H' = 0.258 to a high of H' = 2.522, indicating a wide difference in diversity between sites.

Of note is site 9, a site with the highest richness and catch of all the sites, as well as exhibiting above average biodiversity. This site is located in the Bluffs area east of the Long Point Company, and is at the mouth of a long narrow embayment. Further study is needed to determine the factors contributing to these high readings. Not dissimilar to some other sites in substrate and plant community characteristics, other variables such as ground water seepage and hydrology may have an effect.

In 2007 and 2008, a nearshore survey of Lake Erie and Lake St. Clair was conducted by the Lake Erie Management Unit of the Ontario Ministry of Natural Resources utilizing similar methods (Yunker *et al*. 2009). Comparisons should be made with caution, as although methods of sampling were similar, they were not exactly the same, as timing and frequency of sampling and variations in methodology may produce different results. Despite this, the Shannon-Wiener index in the Long Point Bay survey is the highest of the basins (table 2) and in general indicates the area is one of the most important areas in the Lake Erie- Lake St. Clair system for biodiversity.

Table 2. Shannon- Wiener biodiversity index comparison (H') between basins in nearshore surveys of Lake Erie and Lake St Clair. Long Point Survey was conducted in 2007(this report), and independent of other basins sampled in 2007 and 2008 (Yunker et al. 2009).

Basin	Sites	H'
Lake St. Clair	8	1.34
West Lake Erie	32	0.96
West-Central Lake Erie	54	0.77
East-Central Lake Erie	7	0.78
East Lake Erie	5	1.04
Long Point Survey	32	2.41

Richness (defined as # of species) also varied considerably between sites. Overall the average richness for the survey was 15.15 species per site, however values ranged from a low of 4 (site 31) to a maximum of 29 (site 9 and 12) per site (figure 3) Catch rates also varied between sites, ranging from 606.98 fish per $100m^2$ at Site 9 to 3.61 fish per $100m^2$ at site 8 (figure 4).

There were no significant differences in catch between early, mid and late summer sampling (Kruskal-Wallis test on combined early, mid and late summer samples by species, h=0.1183, p=0.94). Seasonally, differences were expected, however the sampling period was limited to 11 weeks in the summer by the availability of summer student staff. If seasonal differences occur, this suggests using a broader temporal scale and that any date of sampling during the July – August period is comparable to other dates in the same period.

Results of the cluster analysis of effort corrected seining sites are presented in Figure 5. Using a Euclidian distance of 800, the 30 sites were divided into 9 clusters, which were spatially mapped (figure 6). Shannon t tests were completed comparing all clusters. All clusters were significantly different except for clusters 3 and 5.

In order to compare diversity between clusters, effective number of species for each cluster were determined as outlined in Jost *et al*. 2010. This value is derived from the exponent of the value of the Shannon index, and is calculated to enable direct comparison between sites (e.g. a value of 10 is twice as diverse as 5). The range in values is given in table 3. Using this index, the most diverse cluster is approximately 5 times as diverse as the lowest (cluster 8 at 10.32 and cluster 2 at 2.01 respectively, mean = 4.95). Most clusters had effective # of species values between approximately 2 and 5, whereas clusters 8 and 9 had higher values closer to 10. These high value clusters were situated at the interface of large, protected coastal marsh systems with the bay proper. Vegetation species richness at a particular site significantly influenced fish species diversity, as expressed as effective number of species ($R^2 = .063$, $p=0.0106$).

Table 3. Biodiversity indices from cluster analysis (Ward's). Richness, Shannon-Wiener index (H') and Effective number of species as expressed by exp H' is calculated for each cluster.

Cluster	Richness	Shannon	exp H'
1	16	1.184	3.267418
2	8	0.6985	2.010734
3	29	1.518	4.56309
4	31	1.611	5.007817
5	19	1.548	4.702057
6	17	1.078	2.938796
7	19	0.8126	2.25376
8	32	2.334	10.31914
9	27	2.248	9.468779

Canonical correspondence analysis (CCA) of the seining sites with environmental variables indicated sub communities within the Long Point Bay complex. Fish catch data by species were compared to environmental variables, substrate and vegetation present. The results are displayed in Figure 7. Several variables that strongly correlated with others, variables that had little effect compared to correlated variables or vegetation that had both little overall effect and were rare were suppressed in the graphic representation for clarity. pH was suppressed as there was very little variation in observations throughout the sampling period. Dissolved oxygen was measured as a percent and by mg/l, and was highly correlated. Conductivity was highly correlated with water temperature, which was used as a surrogate. The resulting analysis indicates that there are several aquatic vegetation communities; one consisting of silt substrate with wild rice, common pondweed, bulrush, wild celery and bladderwort as the predominate vegetation, a common reed and cattail vegetation community associated with a clay – gravel substrate and several other communities (a total of 5) . Table 4 lists the common plant species found at the 32 seining sites and table 5 denotes the aquatic vegetation community composition and lists suppressed aquatic vegetation variables. A large number of fish species were associated with the bulrush community cluster, and the analysis suggests that this community is diverse and productive. Three of the four listed species are associated with this cluster, namely Pugnose Shiner (*Pimephales notatus*), Grass Pickerel (*Esox americanus vermiculatus*) and Warmouth (*Lepomis gulosus*). Of species targeted by the fisheries, Largemouth Bass (*Micropterus salmoides*), Black Crappie (*Micropterus dolomieu*) and Northern Pike (*Esox lucius*) had association with this habitat cluster. Sand and gravel substrate and/or slough grass sites had very few species associated, and there were many species that did not have strong associations with variables, particularly species that were migratory taxocene as described by Jude and Pappas (1992). These fish utilize a wide niche that could consist of open water, nearshore and marsh systems, rather than being permanent wetland residents, and would utilize wetlands temporarily for food, spawning, nursery or refuge. Species such as round goby (*Neogobius melanostomus*), white bass (*Morone chrysops*), white perch (*Morone americana*), emerald shiner (*Notropis atherinoides*) and yellow perch (*Perca flavescens*) are examples that were observed in this analysis.

Table 4. List of plant species found at 32 seining sites in Long Point Bay.

Common Name	Scientific Name	Life Zone
Water Shield	*Brasenia schreberi*	Floating
Slough Grass	*Beckmannia syzigachne*	Emergent/Shoreline
Canada Bluejoint	*Calamagrostis canadensis*	Emergent/Shoreline
Muskgrass	*Chara spp.*	Submergent
Algae sp.	*Chlorophyta sp.*	Submergent
Queen Anne's Lace	*Daucus carota*	Near Shore
Common Waterweed	*Elodea canadensis*	Submergent
Milfoil sp.	*Myriophyllum sp.*	Submergent
Mixed Carolinian Forest	*N/A*	Near Shore
Fragrant White Pond Lily	*Nymphaea odorata*	Floating
Pond Lily spp.	*Nymphaea/Nuphar spp.*	Floating
Common Reed	*Phragmites australis*	Emergent/Shoreline
Pickerelweed	*Pontederia cordata*	Emergent/Shoreline
Poplar spp.	*Populus spp.*	Near Shore
Floating-leaved Pondweed	*Potamogeton natans*	Floating
Sago Pondweed	*Potamogeton pectinatus*	Submergent
Flat Leaved Pondweed	*Potamogeton robbinsii*	Submergent
Pondweed sp.	*Potamogeton sp.*	Submergent
Stiff Arrowhead	*Sagittaria rigida*	Emergent/Shoreline
Willow spp.	*Salix spp.*	Near Shore
Bulrush sp.	*Scirpus sp.*	Emergent/Shoreline
Goldenrod	*Solidago sp.*	Near Shore
Dandelion	*Taraxacum officinale*	Near Shore

Table 5: Aquatic Vegetation Communities from CCA analysis of catch and environmental variables. Communities were labelled based on easily identifiable vegetation species. The relative effect of each species (strong, medium and weak) is indicated. Species highly correlated with their designated surrogate were suppressed from graphical representation (figure 7) for clarity.

1. Bulrush [Substrate associated: Silt]

Species	Relative Effect	Notes
Bulrush	Strong	
Common Pondweed	Strong	
Floating Leaf Pondweed	Medium	Suppressed - Wild Rice surrogate
Wild Rice	Medium	
Flat Leaved Pondweed (FLP)	Weak	
Stiff Arrowhead	Weak	Suppressed –FLP surrogate
Water Shield	Weak	Suppressed –FLP surrogate
Milfoil	Weak	Suppressed –FLP surrogate
Bladderwort	Strong	

2. Cattail [Substrate associated: Gravel – Clay]

Cattail	Medium	
Algae	Medium	
Common Reed	Weak	
Pickerelweed	Weak	Suppressed –Common R surrogate
Sago Pondweed	Weak	Suppressed - Cattail surrogate

3. Pond Lily [Substrate associated : Clay – Silt]

Pond Lily	Medium	

4. Slough Grass [Substrate associated: Sand – Silt]

Slough Grass	Strong	

5. Wildcelery [Substrate associated: Silt - Clay]

Wildcelery	Strong	
Muskgrass	Strong	Suppressed – Wildcelery surrogate

There were species that were strongly associated with vegetation communities, and either could be representatives of wetland taxocene described by Judd and Pappas (i.e. resident) or migratory and sampled at a time where they were utilizing wetland habitat.

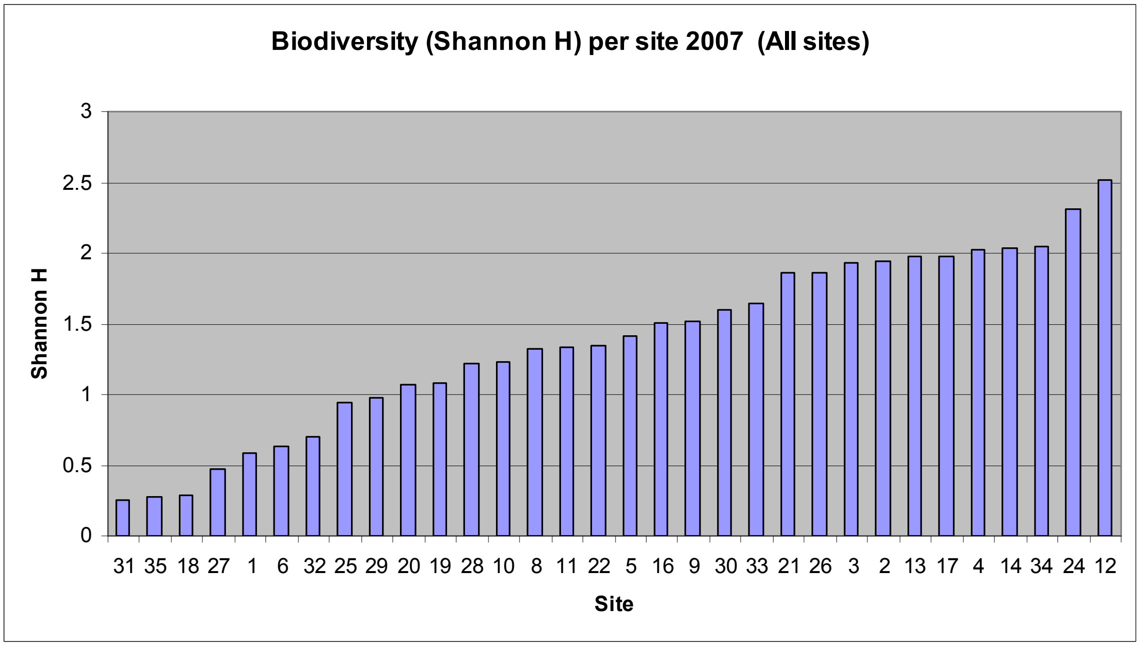

Figure 2. 2007 Biodiversity (Shannon-Wiener) per site for all sites surveyed. Sites ordered by value. Mean = 1.37

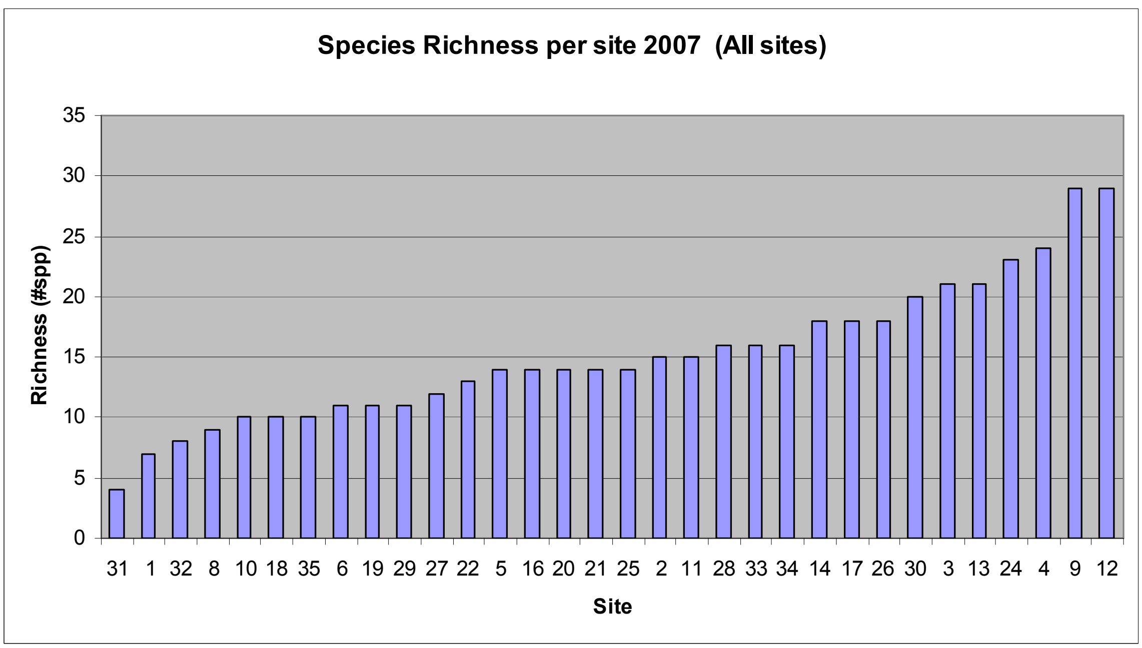

Figure 3. Species Richness (# of species captured) per site for all sites surveyed. Sites ordered by value. Mean = 15.16

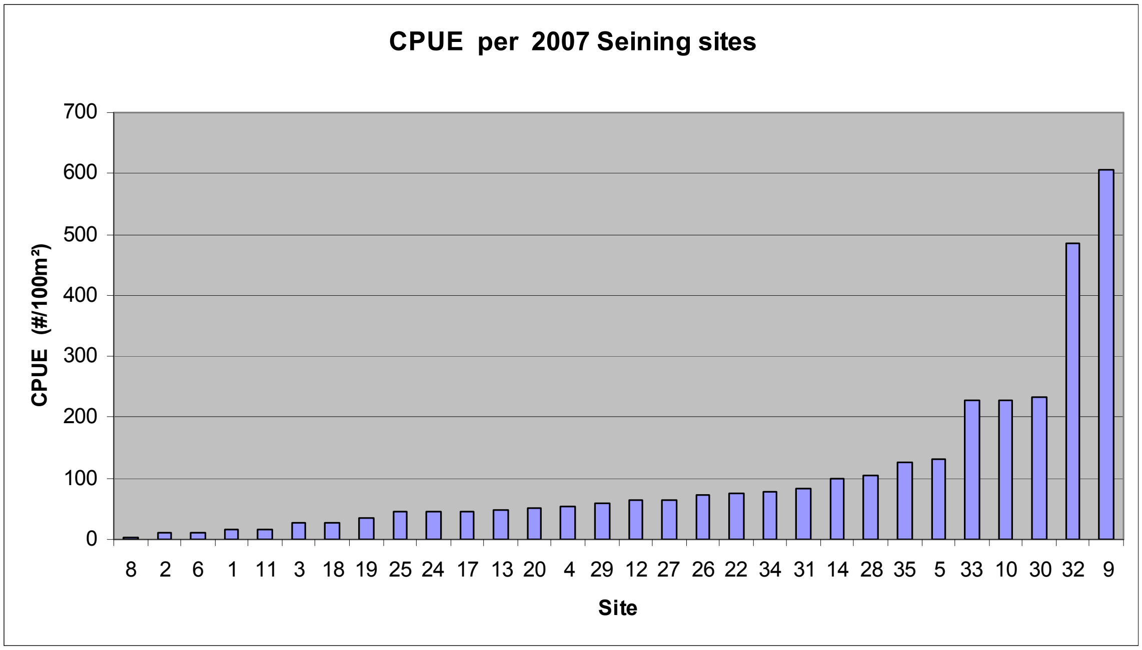

Figure 4. Catch per Unit Effort (CPUE) for all seining sites visited 2007. Electrofishing data excluded. Sites ordered by value. Mean = 105.8.

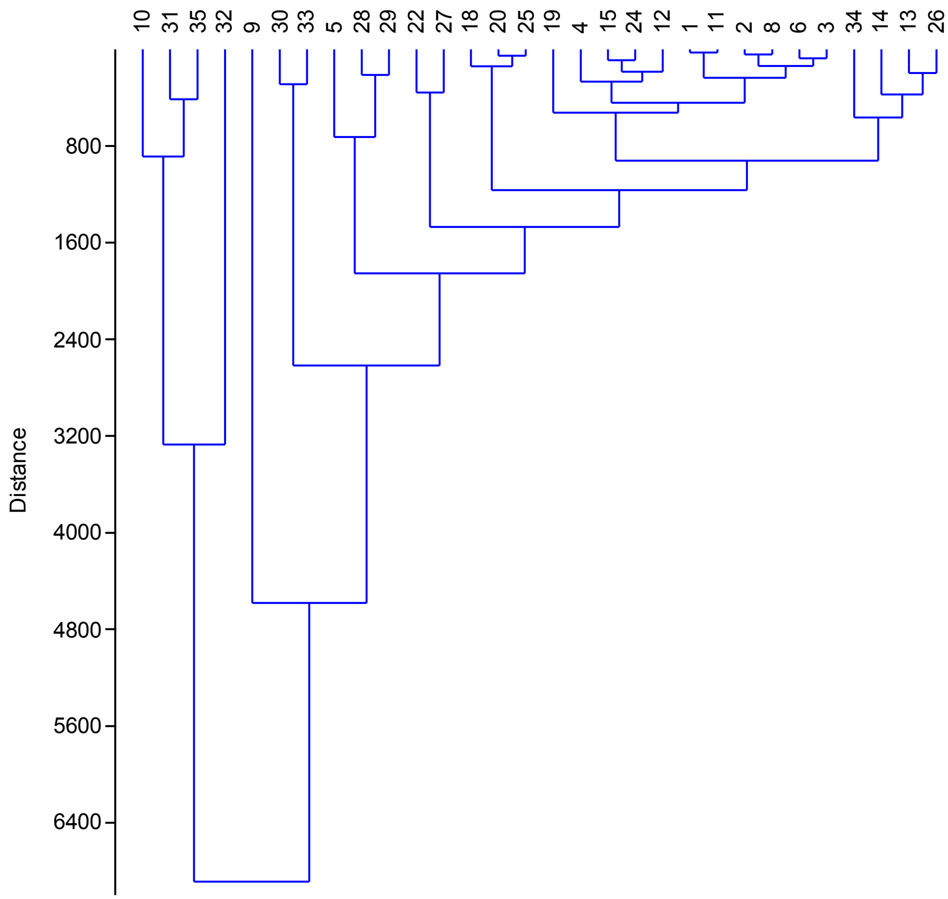

Figure 5. Cluster analysis (Ward's) for 2007 seining sites, corrected for effort. Site numbers listed on upper X axis. Coph. corr = 0.6813

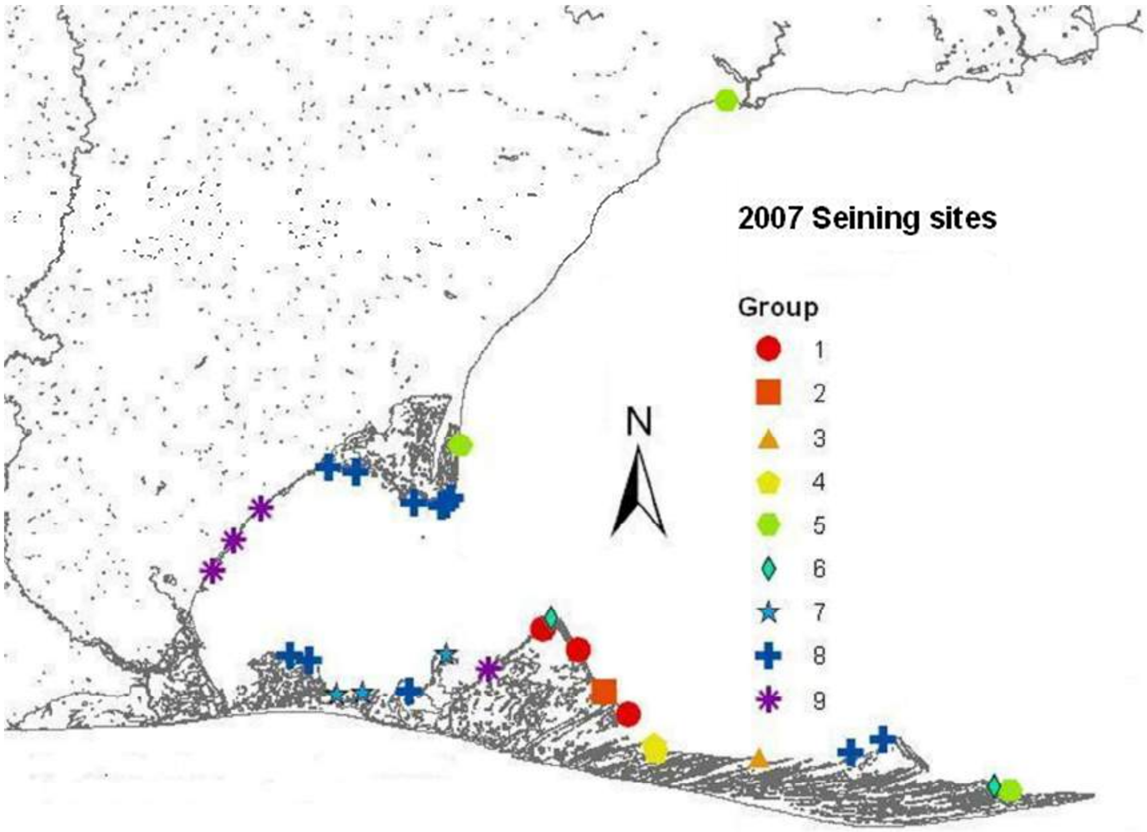

Figure 6. Distribution of Clusters (Ward's) for 2007 seining sites, corrected for effort. All clusters were significantly different except for clusters 3 and 5.

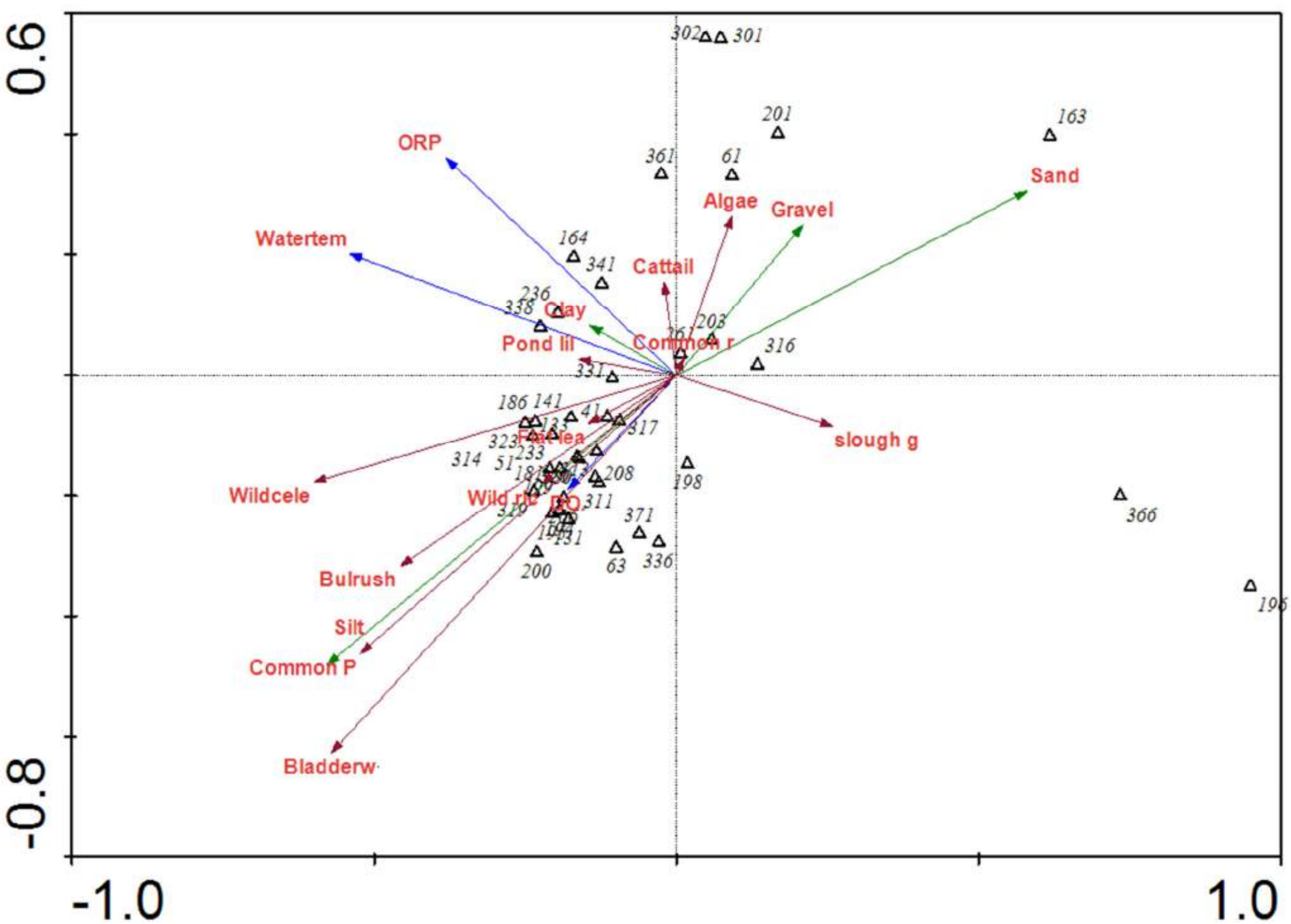

Figure 7. Canonical Correspondence Analysis (CCA) of fish species observed at all seining sites in the 2007 Nearshore Fish Survey of Long Point Bay with environmental parameters. Fish species are represented by triangles and corresponding species codes (see Table 1). Green arrows represent substrate, blue arrows physical parameters and red arrows aquatic vegetation. Some environmental parameters were suppressed on the image for clarity.

Discussion

The Long Point Bay nearshore area contains a diversity of habitats and communities, and is one of the largest wetland complexes in the lower Great Lakes. Coastal marshes contribute greatly to the fishery, producing large numbers of forage fish, feeding areas for piscivores, refuge, spawning and nursery areas for many species (Herdendorf 1987; Stephenson 1988, 1990). The high diversity values reported in this survey reinforce the importance of this complex, as the nearshore diversity indices rank as the highest in the St. Clair-Detroit River-Lake Erie system. Part of this might be attributed to the relative low anthropogenic effects on the complex, due to protection and private ownership. Jackson *et al*. (2001) found that stability and spatial connectivity contribute to increased diversity, in both riverine and lake systems.

As reported, there is variation between sampling sites, both for vegetation and fish communities. Fish catches at survey sites had a range of diversity values (Shannon-Wiener), from H'= 0.26-2.52, species caught (4 - 29) and total catch per unit effort (3.6 – 607 fish/100m²). Vegetation communities also varied from diverse wetland complexes to relatively barren sand plains.

One of the outcomes of this survey was to provide a baseline in which to compare the fish community over time and/or to measure impacts of environmental, anthropogenic or restoration changes. Differing sampling protocols would give different results. In the 1970s, Ontario Ministry of Natural Resources conducted a seining survey in the Long Point Bay area as part of the Nanticoke Fish Study (Dani *et al.* 1980). Comparison with this survey could only be achieved on a broad basis as the spatial scope, methods, frequency of sampling and gear varied considerably. Primarily, the sampling took place at sites from Nanticoke to the Inner Bay and varied in timing, but incorporated spring and autumn sampling. A 100 foot seine of 3.2mm mesh was used and set parallel to the shore at a distance of 80 to 100 feet, and then pulled in toward the shore. These differences sampled deeper water and a larger area with reduced frequency. Community composition differences could be a result of the methodology timing and survey area, as well as environmental changes, and would be difficult to differentiate. Broadly, alewife (*Alosa pseudoharengus*) were more abundant and there is a noticeable absence of round gobies (*Neogobius melanostomus*). The survey captured 58 species through the eight years, though there were differences annually as to splitting and lumping observations, and this variation could also be explained by both the sampling methods and the seasonal differences. The average annual number of species captured was 30, with a range of 22 in 1975 to 40 in 1972.

This current survey was conducted in the summer months during daylight hours, where staffing resources could be achieved, however seasonal and deil sampling does change observed catches (Reid and Mandrak 2009). Expanding the survey to include seasonal and night seining might improve and refine fish community metrics, as some species would utilize the nearshore variably, however changes in methodology may make comparisons difficult.

When fish catch data was analysed and grouped by cluster analysis, the sites within a cluster were often not spatially adjacent. The highest diversity was in the clusters 8 and 9, and calculating effective number of species (expH'=10.32 and 9.47 respectively), were at least twice as diverse the mean (expH'=4.95) and approximately 5 times higher than the lowest cluster (cluster 2, expH'=2.01). These clusters comprised primarily of sites at the mouths of large wetland complexes, specifically at Turkey Point Marsh, the Crown Marsh, the inner bay side of the Long Point Company marsh and a marsh complex near Bluff Bar. Interestingly, the two clusters didn't include all sites of similar features. The sites along the north shore, between Big Creek Marsh and Turkey Point Marsh were also included in cluster 9 of high diversity, though they were not at wetland complex mouths. These sites exhibited shoreline with a nearshore submergent and emergent vegetation community. Noted is that the Long Point Marsh complex outer bay (eastern) interface and outer Thoroughfare Point were not clustered with that group even though they were at the interface of large wetland complex and open water, and were more distant than what was expected. Marsh complex sites along the Bluffs region also were not included.

Clarke (1979) and Johnson (1989) reported that these wetland-open water interfaces were important to the fisheries, exhibiting more diverse and abundant fauna and both seasonally and temporally allowing fish egress and ingress into these areas to access prey, spawning grounds and refuge. Macrophytes increase complexity in nearshore habitats, and can influence interactions between species (Eadie and Keast 1984) This survey was conducted in daylight hours in a short period (11 weeks) over the summer months, and changes in specific site catch information can be assumed both seasonally and temporally, as some fish species would utilize nearshore habitats spawn and feed at different times of the year or day (Reid and Mandrak 2009).

Consistent with the results expressed by Eadie and Keast (1984), our survey found that fish habitats with a diverse number of plants, also exhibited a diverse fish population. Randall *et al*. (1996) studied nearshore area in the Great lakes and found fish production, as calculated by an index value using biomass and fish size was significantly higher in areas with abundant submergent macrophytes. They found that density and richness were also higher. Other factors in their study affecting nearshore fish communities besides vegetation were the slope of the littoral area, phosphorus and exposure. Wind exposure and associated fetch, was found to be negatively correlated with macrophytic species richness (Bailey 1988), most likely because exposed shorelines are susceptible to physical damage due to wave action. However, intermediate levels of exposure may be beneficial. Keddy (1983) suggests that species richness of macrophytes may peak at intermediate levels of exposure, as wave action can reduce sedimentation and can therefore enhance photosynthesis (Wetzel 1992). Thomasen *et al*. (2013) concluded from a study of nearshore zooplankton communities in Long Point Bay that zooplankton abundance was negatively correlated with exposure, and concluded that sites with adequate oxygen, hydrological connectivity and zooplankton biomass would offer the best nursery habitat for larval fish. High diversity clusters in this survey are consistent with these findings. They exhibit diverse vegetation at the interface with open water, and are somewhat sheltered from significant fetch. Exposed areas with similar vegetative and interface characteristics exhibited reduced diversity.

Some species captured in this survey have association to specific aquatic vegetation communities. The largest of these is a bulrush-bladderwort-pondweed, where canonical correspondence analysis placed the majority of species observed. Niches of different species and guilds of fish will vary, some having narrow habitat requirements, whereas others have a wider suite of conditions. The Long Point Bay nearshore and wetland complex has a diversity of habitat which logically leads to diversity in fish populations (Emery 1978; Eadie and Keast 1984). Lower productivity areas adjacent areas of high productivity areas are known to benefit (Randall *et al*. 2009). Protection and management of this diversity of nearshore habitats, rather than solely the most productive, is therefore important.

Long Point Bay does provide habitat to a number of listed fish species, including significant numbers of the endangered pugnose shiner (*Pimephales notatus*) that accounted for almost 2% of the catch. Additionally, pockets of native freshwater mussels were discovered during this survey and in subsequent studies associated with the Long Point Bay Ecological Assessment. Most notably, colonies of eastern pondmussel (*Ligumia nasuta*), listed as endangered, were found in several locations. Absence of the invasive zebra mussel (*Dreissena polymorpha)* is generally coincident with native mussel refugia (Schloesser and Masteller 1999, Napela *et al*. 1996), though from the environmental variables this survey collected, distinguishing habitat differences wasn't clearly apparent and requires further study. The occurrence of listed species and the need for more information to understand habitat requirements emphasizes that work conducted in the nearshore area of Long Point Bay should be done carefully and in consideration of this need.

The anthropogenic effects of shoreline and nearshore development, such as shore structures and urban land uses, are cumulative and are known to affect fish communities over larger spatial scales (Goforth and Carman 2009). This would include actions such as diking coastal wetlands. Dikes are often utilized to reduce water fluctuations and improve conditions for waterfowl, but costal wetlands can be blocked by roads or causeways. Diking prevents nutrient and biotic exchange, reduces productivity and coastal vegetation (Keddy and Reznicek 1985). Specifically, the Big Creek Marsh complex is diked from the Inner Bay by a causeway. Only one point of exchange with the inner bay, that of Big Creek, exists over the 3.5 km length, whereas historically, the coastal marsh had many connections with the bay.

Protection and management of the diversity of nearshore habitats, rather than solely the most productive, is therefore important. Management, planning and restoration strategies should incorporate and address both local and large scale, and immediate and cumulative impacts.

Acknowledgements

There are many people that assisted in this survey, and we would like to thank them all, and our apologies if we have overlooked some. Many thanks to Tom MacDougall of the Port Dover office of MNR for his data and survey design support. Of special mention is the field crew of Lindsay Bennett, Kyle Beringer and Kathleen Ryan, who spent many long hours seining and documenting the thousands of fish observed. Lake Erie Management Unit (LEMU) Operations Coordinator Dixie Greenwood provided logistic support and ensured a smooth operation. Vessel master Gord Ives provided oversight of the vessels and electrofishing support, and our technical staff, Wyatt Hall, Tina Werner and Heather Whitford assisted in backup field support and data entry.

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Appendix A

A Summary of Site Data and Fish Caught During the 2007 Nearshore Seining of Long Point Bay.

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Table A1. Locations of each seining and electrofishing site throughout Long Point Bay

GPS#	Northing	Easting
S01	42.649567	-80.351600
S02	42.648283	-80.338817
S03	42.648950	-80.336500
S04	42.650850	-80.334617
S05	42.668300	-80.329933
S06	42.568417	-80.138333
S08	42.563967	-80.153600
S09	42.562617	-80.195533
S10	42.599133	-80.276983
S11	42.661483	-80.390267
S12	42.660150	-80.377467
S13	42.647450	-80.421320
S14	42.626533	-80.443767
S15	42.606817	-80.449800
S16	42.601617	-80.449383
S17	42.598117	-80.408483
S18	42.584967	-80.386917
S19	42.585800	-80.354183
S20	42.598283	-80.336833
S21	42.587467	-80.337050
S22	42.610117	-80.289317
S23	42.638267	-80.348117
S24	42.596460	-80.399370
S25	42.585450	-80.375320
S26	42.636700	-80.433580
S27	42.552210	-80.088020
S28	42.550290	-80.080710
S29	42.783646	-80.207410
S30	42.567520	-80.243040
S31	42.577228	-80.254612
S32	42.584812	-80.265255
S33	42.565219	-80.242424
S34	42.592932	-80.318449
S35	42.606461	-80.293193

Site 1

Table A1.1. List and amounts of fish species caught during each sampling period at site 1

Site 1	Number of Individuals Caught per Seining Event			Total Number
Species Caught = 7	**25-Jun-07**	**16-Jul-07**	**9-Aug-07**	**of Individuals**
Alewife	0	0	1	**1**
Brook Silverside	10	19	482	**511**
Emerald Shiner	1	2	0	**3**
Johnny Darter	0	0	4	**4**
Largemouth Bass	2	0	0	**2**
Smallmouth Bass	0	3	0	**3**
Yellow Perch	0	69	39	**108**
Catch Totals=	**13**	**93**	**526**	**632**

Table A1.2. List of plant species present at site 1

Emergent/Shoreline	Submergent
Bulrush sp.	Milfoil sp.
Canada Bluejoint	Muskgrass
Cattail spp.	Wild Celery

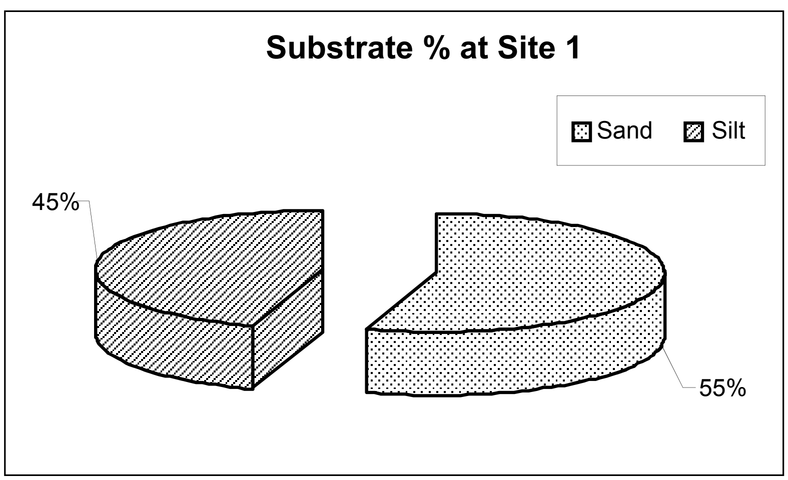

Figure A1.1. Substrate mixture (%) at site 1

Table A1.3. Weather conditions for each seining event at site 1

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
25-06-07	11:54	---	SW	10	<0.5	5	29.3	---
16-07-07	12:30	13:45	W	5	<0.5	30	25.4	25.9
09-08-07	10:30	11:50	NE	5	<0.5	100	19.2	19.5

Table A1.4. Water quality parameters for each seining event at site 1

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
25-06-07	11:54	24.91	8.87	0.265	125.4	---	---	0.21
16-07-07	12:30	23.66	8.74	0.267	144.7	12.21	128.2	---
09-08-07	10:30	24.16	8.80	0.264	76	6.35	150.6	---

Site 2

Table A2.1. List and amounts of fish species caught during each sampling period at site 2

Site 2 Species Caught = 15	Number of Individuals Caught per Seining Event 25-Jun-07	 16-Jul-07	 9-Aug-07	Total Number of Individuals
Banded Killifish	0	9	0	**9**
Blackchin Shiner	1	0	0	**1**
Bluntnose Minnow	0	0	8	**8**
Brook Silverside	8	20	7	**35**
Johnny Darter	0	0	11	**11**
Largemouth Bass	8	1	48	**57**
Longnose Gar	0	0	1	**1**
Pumpkinseed	9	0	1	**10**
Round Goby	0	1	0	**1**
Smallmouth Bass	0	6	0	**6**
Spotfin Shiner	1	2	0	**3**
Spottail Shiner	1	0	0	**1**
Tadpole Madtom	0	0	1	**1**
Yellow Perch	0	20	33	**53**
YOY Lepomis spp.	0	2	0	**2**
Catch Totals=	**28**	**61**	**110**	**199**

Table A2.2. List of plant species present at site 2

Emergent/Shoreline	Submergent
Bulrush sp.	Milfoil sp.
Cattail spp.	Muskgrass
Common Reed	Wild Celery

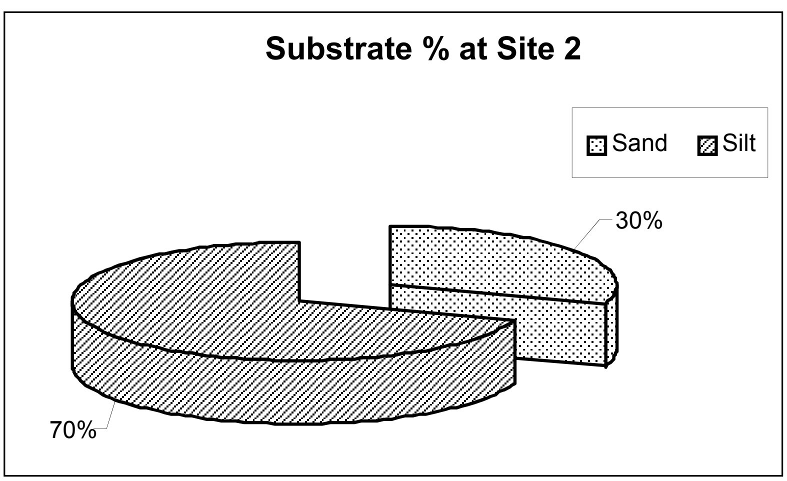

Figure A2. Substrate mixture (%) at site 2

Table A2.3. Weather conditions for each seining event at site 2

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
25-06-07	13:05	14:05	SW	10	<0.5	0	29.2	28.6
16-07-07	14:00	15:15	W	30	<0.5	70	25.9	25.6
09-08-07	12:30	13:45	NE	15	<0.5	100	20.2	21.5

Table A2.4. Water quality parameters for each seining event at site 2

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
25-06-07	13:05	24.69	8.8	0.365	145.1	---	---	0.035
16-07-07	14:00	23.85	8.81	0.255	161.2	13.57	111.5	0.096
09-08-07	12:30	23.28	8.33	0.27	---	---	150.2	0.033

Site 3

Table A3.1. List and amounts of fish species caught during each sampling period at site 3

Site 3 Species Caught = 21	Number of Individuals Caught per Seining Event 25-Jun-07	 17-Jul-07	 9-Aug-07	Total Number of Individuals
Banded Killifish	147	26	16	**189**
Blackchin Shiner	0	180	1	**181**
Bluegill	0	7	0	**7**
Bluntnose Minnow	0	13	0	**13**
Brook Silverside	8	0	4	**12**
Brown Bullhead	0	3	0	**3**
Common Shiner	0	1	0	**1**
Iowa Darter	0	2	0	**2**
Johnny Darter	0	1	5	**6**
Largemouth Bass	13	48	11	**72**
Mimic Shiner	0	2	0	**2**
Pugnose Shiner	0	2	0	**2**
Pumpkinseed	0	79	0	**79**
Rock Bass	0	1	0	**1**
Round Goby	7	0	0	**7**
Smallmouth Bass	0	1	0	**1**
Spotfin Shiner	0	4	0	**4**
Spottail Shiner	0	7	0	**7**
Tadpole Madtom	0	0	1	**1**
Yellow Perch	0	13	27	**40**
YOY Lepomis spp.	0	4	0	**4**
Catch Totals=	**175**	**394**	**65**	**634**

Table A3.2. List of plant species present at site 3

Emergent/Shoreline	Submergent
Bulrush sp.	Common Waterweed
Cattail spp.	Muskgrass
Canada Bluejoint	Sago Pondweed
Common Reed	Wild Celery

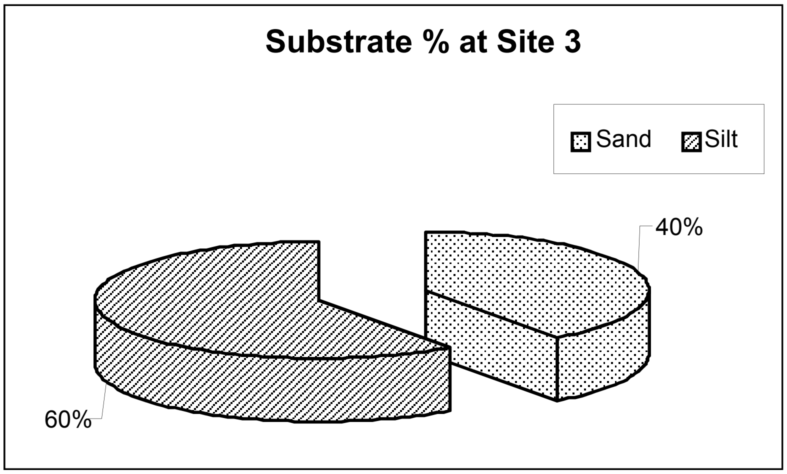

Figure A8. Substrate mixture (%) at site 3

Table A3.3. Weather conditions for each sampling event at site 3

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
25-06-07	14:25	---	SW	10	<0.5	0	28.6	---
17-07-07	9:30	11:45	S	<5	<0.5	100	19.9	22.7
09-08-07	13:45	14:50	NE	20	<0.5	100	21.5	22.2

Table A3.4. Water quality parameters for each seining event at site 3

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
25-06-07	14:25	25.78	8.88	0.268	157.3	---	---	0.239
17-07-07	9:30	21.91	8.3	0.278	91.7	7.81	143.5	---
09-08-07	13:45	23.27	8.71	0.268	---	---	142.8	---

Site 4

Table A4.1. List and amounts of fish species caught during each sampling period at site 4

Site 4	Number of Individuals Caught per Seining Event			Total Number
Species Caught = 24	**26-Jun-07**	**17-Jul-07**	**13-Aug-07**	**of Individuals**
Banded Killifish	56	12	11	**79**
Blackchin Shiner	474	0	1	**475**
Blacknose Shiner	1	0	0	**1**
Bluegill	33	0	0	**33**
Bluntnose Minnow	13	0	1	**14**
Brook Silverside	5	0	1	**6**
Central Mudminnow	0	1	0	**1**
Common Shiner	16	0	0	**16**
Golden Shiner	36	0	0	**36**
Grass Pickerel	0	3	0	**3**
Iowa Darter	0	0	1	**1**
Johnny Darter	1	0	0	**1**
Largemouth Bass	42	22	28	**92**
Longnose Gar	2	0	0	**2**
Pugnose Shiner	126	0	0	**126**
Pumpkinseed	128	7	6	**141**
Rock Bass	8	3	1	**12**
Smallmouth Bass	10	13	0	**23**
Spotfin Shiner	5	0	0	**5**
Spottail Shiner	11	0	1	**12**
Tadpole Madtom	0	4	4	**8**
Yellow Perch	7	2	14	**23**
YOY Cyprinid spp.	0	1	0	**1**
YOY Lepomis spp.	0	4	2	**6**
Catch Totals=	**974**	**72**	**71**	**1117**

Table A4.2. List of plant species present at site 4

Near Shore	Emergent/Shoreline	Floating Leaf	Submergent
Willow spp.	Bulrush sp.	Pond Lily sp.	Common Waterweed
---	Cattail spp.	---	Milfoil sp.
---	Common Reed	---	Muskgrass
---	Wild Rice	---	Sago Pondweed
---	---	---	Wild Celery

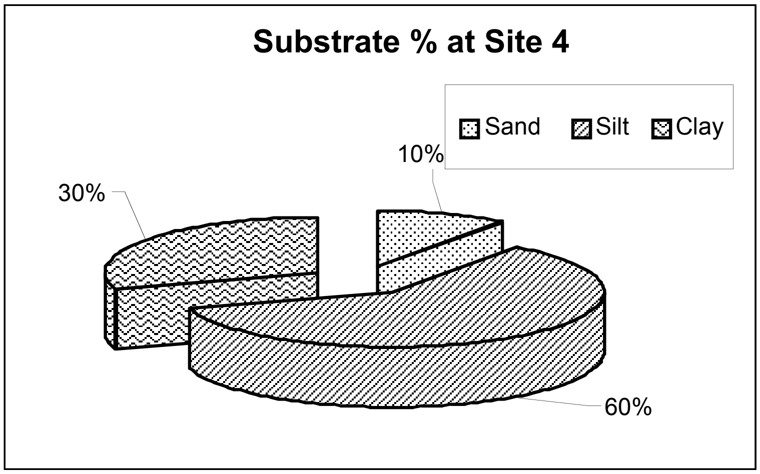

Figure A9. Substrate mixture (%) for site 4

Table A4.3. Weather conditions for each seining event at site 4

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
26-06-07	9:50	15:13	S	0	0	0	29	31.1
17-07-07	12:20	13:45	SE	<5	0	80	22.7	22.2
13-08-07	10:15	11:10	N	5	<0.5	0	23.6	25.2
30-08-07	14:00	---	NW	<5	<0.5	90	25	---

Table A4.4. Water quality parameters for site 4

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
26-06-07	9:50	24.95	8.86	0.252	137.1	---	---	0.099
17-07-07	12:20	23.5	8.38	0.283	144.1	12.26	133.1	0.062
13-08-07	10:15	22.16	8.16	0.304	---	---	145.8	---
30-08-07	14:00	24.64	---	0.325	86.9	7.18	84.7	0.089

x

Site 5

Table A5.1. List and amounts of fish species caught during each sampling period at site 5

Site 5	Number of Individuals Caught per Seining Event			Total Number
Species Caught = 14	21-Jun-07	11-Jul-07	8-Aug-07	of Individuals
Banded Killifish	3	4	49	**56**
Bluntnose Minnow	8	0	0	**8**
Brook Silverside	0	0	372	**372**
Common Shiner	1	0	0	**1**
Emerald Shiner	1386	30	0	**1416**
Largemouth Bass	34	0	18	**52**
Longnose Gar	0	1	0	**1**
Pugnose Shiner	0	0	1	**1**
Pumpkinseed	1	0	0	**1**
Round Goby	406	166	2	**574**
Smallmouth Bass	0	46	0	**46**
Spotfin Shiner	0	4	0	**4**
Spottail Shiner	134	75	6	**215**
Yellow Perch	0	4	0	**4**
Catch Totals=	**1973**	**330**	**448**	**2751**

Table A5.2. List of plant species present at site 5

Riparian	Emergent/Shoreline	Submergent
Dandelion	Cattail spp.	Algae sp.
---	Common Reed	Muskgrass

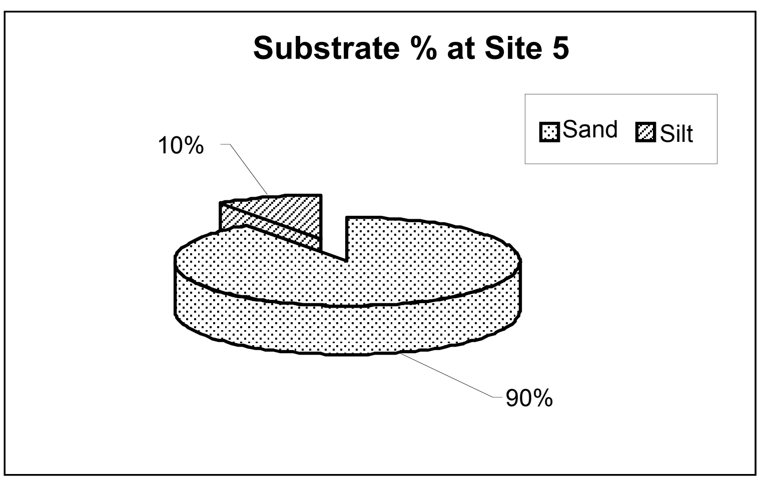

Figure A5. Substrate mixture (%) at site 5

Table A5.3. Weather conditions for each seining event at site 5

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
21-06-07	10:10	14:00	W	5	<0.5	10	24.3	24.5
25-06-07	10:00	---	SW	5	<0.5	0	26.3	---
11-07-07	10:00	11:45	W	10	<0.5	100	23	23.3
16-07-07	9:20	---	W	5	<0.5	---	21.6	---
08-08-07	9:20	10:28	NW	5	<0.5	5	25.6	26.9

Table A5.4. Water quality parameters at site 5

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
25-06-07	10:00	19.87	8.61	0.264	134.3	---	---	0.0.45
11-07-07	10:00	21.92	8.61	0.252	104.7	9.13	---	---
16-07-07	9:20	19.02	8.34	0.274	146.3	16.5	143.7	---
08-08-07	9:20	24.7	8.7	0.264	---	---	158.1	---

Site 6

Table A6.1. List and amounts of fish species caught during each sampling period at site 6

Site 6	Number of Individuals Caught per Seining Event			Total Number
Species Caught = 11	5-Jul-07	30-Jul-07	28-Aug-07	of Individuals
Banded Killifish	106	107	19	**232**
Bluntnose Minnow	0	2	0	**2**
Brook Silverside	2	11	0	**13**
Common Shiner	2	0	0	**2**
Johnny Darter	0	3	1	**4**
Largemouth Bass	2	2	2	**6**
Round Goby	1	0	0	**1**
Smallmouth Bass	0	1	0	**1**
Spotfin Shiner	1	0	0	**1**
Yellow Perch	0	0	4	**4**
YOY Lepomis spp.	1	0	0	**1**
Catch Totals=	**115**	**126**	**26**	**267**

Table A6.2. List and abundance of vegetation present at site 6

Emergent/Shoreline	Submergent
Bulrush sp.	Common Waterweed
Common Reed	Milfoil sp.
Pickerelweed	Muskgrass
---	Sago Pondweed
---	Wild Celery

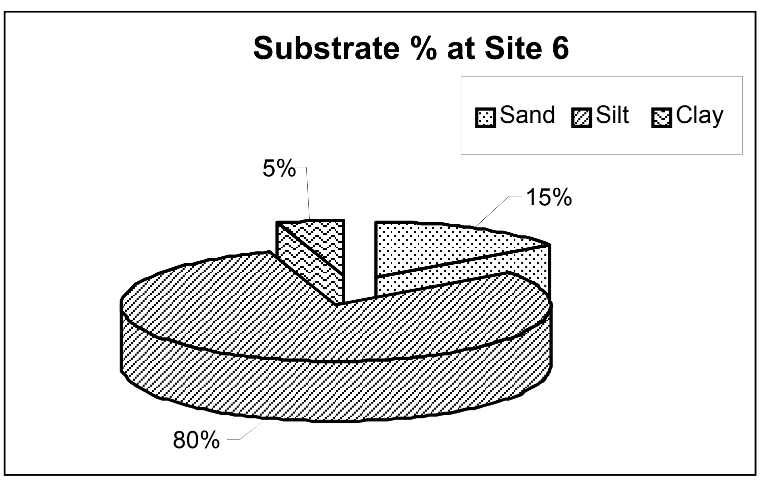

Figure A6. Substrate mixture (%) for site 6

Table A6.3. Weather conditions for each seining event at site 6

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
05-07-07	10:15	11:56	W	5	<0.5	95	21.1	24.6
30-07-07	14:20	15:30	N	<5	<0.5	0	28.9	29
28-08-07	14:40	15:30	SW	<5	<0.5	5	26.3	25.9

Table A6.4. Water quality parameters for each seining event at site 6

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
05-07-07	10:15	21.69	8.75	0.251	123.3	10.87	---	---
30-07-07	14:20	30.26	9.28	0.237	182.8	13.45	129.7	0.017
28-08-07	14:40	28.8	---	0.233	214.4	16.5	36.5	0.138

Site 8

Table A8.1. List and amounts of fish species caught during each sampling period at site 8

Site 8	Number of Individuals Caught per Seining Event			Total Number
Species Caught = 9	**5-Jul-07**	**1-Aug-07**	**27-Aug-07**	**of Individuals**
Banded Killifish	61	14	13	88
Brook Silverside	2	0	13	15
Johnny Darter	0	1	0	1
Largemouth Bass	16	4	3	23
Pumpkinseed	2	0	0	2
Rock Bass	0	14	2	16
Spotfin Shiner	4	0	0	4
Tadpole Madtom	0	0	1	1
YOY Lepomis spp.	1	0	0	1
Catch Totals=	86	33	32	151

Table A8.2. List of plant species present at site 8

Near Shore	Shoreline/Emergent	Floating Leaf	Submergent
Poplar spp.	Bulrush sp.	Floating-leaved Pondweed	Algae spp.
---	Cattail spp.	Pond Lily sp.	Common Waterweed
---	Common Reed	---	Milfoil sp.
---	Pickerelweed	---	Muskgrass
---	---	---	Sago Pondweed
---	---	---	Wild Celery

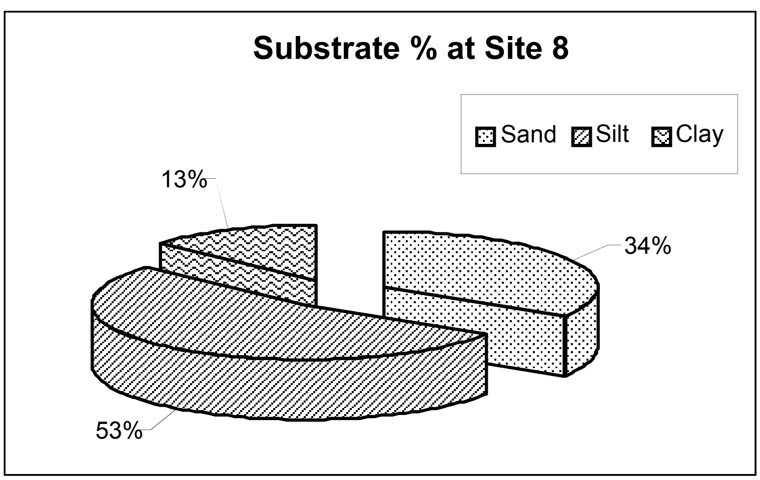

Figure A8. Substrate mixture (%) for site 8

Table A8.3. Weather conditions for each seining event at site 8

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
05-07-07	12:40	14:15	W	10	<0.5	100	26.4	27.3
01-08-07	10:40	11:40	SW	<5	<0.5	0	30.2	30.5
27-08-07	15:10	16:00	S	5	<0.5	10	24.7	24.9

Table A8.4. Water quality parameters for each seining event at site 8

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
05-07-07	12:40	23.22	8.99	0.243	144.9	12.34	---
01-08-07	10:40	27.95	9.09	0.241	121.7	9.52	117.1
27-08-07	15:10	28.22	---	0.245	181.8	14.16	36.8

Site 9

Table A9.1. List and amounts of fish species caught during each sampling period at site 9

Site 9	Number of Individuals Caught per Seining Event			Total Number
Species Caught = 29	**18-Jul-07**	**7-Aug-07**	**27-Aug-07**	**of Individuals**
Alewife	0	1	2	**3**
Banded Killifish	50	13	93	**156**
Blackchin Shiner	177	248	60	**485**
Blacknose Shiner	586	4455	2996	**8037**
Bluegill	2	6	0	**8**
Bluntnose Minnow	110	310	91	**511**
Bowfin	1	0	0	**1**
Brook Silverside	3	2	1047	**1052**
Brown Bullhead	6	0	0	**6**
Common Shiner	10	0	0	**10**
Emerald Shiner	8	0	0	**8**
Gizzard Shad	0	1	0	**1**
Golden Shiner	39	65	18	**122**
Grass Pickerel	3	1	2	**6**
Iowa Darter	1	0	0	**1**
Johnny Darter	2	0	0	**2**
Largemouth Bass	93	120	39	**252**
Mimic Shiner	4	2	1	**7**
Northern Pike	2	1	1	**4**
Pugnose Shiner	182	220	56	**458**
Pumpkinseed	261	210	62	**533**
Rock Bass	20	11	26	**57**
Round Goby	5	0	0	**5**
Smallmouth Bass	1	0	0	**1**
Spotfin Shiner	8	8	7	**23**
Spottail Shiner	19	13	40	**72**
Yellow Perch	15	7	6	**28**
YOY Cyprinid spp.	578	0	0	**578**
YOY Lepomis spp.	65	133	67	**265**
Catch Totals=	**2251**	**5827**	**4614**	**12692**

Table A9.2. List of plant species present at site 9

Near Shore	Shoreline/Emergent	Floating Leaf	Submergent
Poplar spp.	Bulrush sp.	Floating-leaved Pondweed	Common Waterweed
Willow spp.	Cattail spp.	---	Milfoil sp.
---	Common Reed	---	Muskgrass
---	Wild Rice	---	Wild Celery

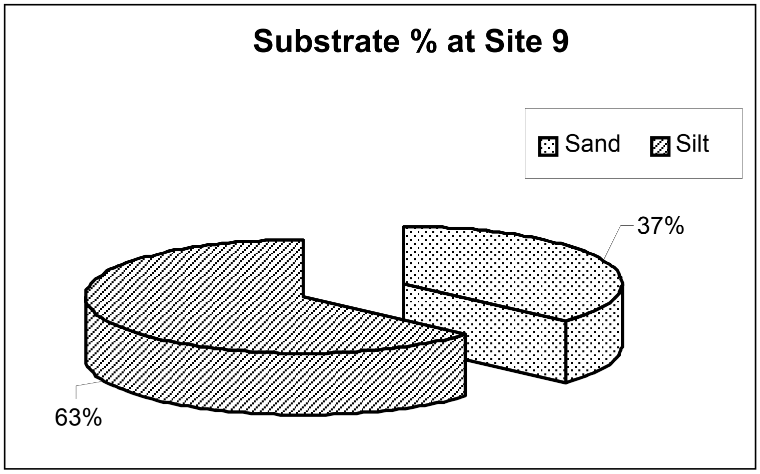

Figure A9. Substrate mixture (%) for site 9

Table A9.3. Weather conditions for each seining event at site 9

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
18-07-07	10:10	14:30	SW	5	<0.5	50	21.8	26
07-08-07	10:15	16:00	E	10	<0.5	100	22.5	22.9
27-08-07	10:00	14:15	S	<5	<0.5	5	22.5	24.9

Table A9.4. Water quality parameters for each seining event at site 9

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
18-07-07	10:10	21.57	8.62	0.268	158.9	14	147	0.062
07-08-07	10:15	25.24	8.65	0.269	91	7.52	99.4	0.165
27-08-07	10:00	23.64	---	0.277	108.6	9.13	26.9	0.126

Site 10

Table A10.1. List and amounts of fish species caught during each sampling period at site 10

Site 10	Number of Individuals Caught per Seining Event			Total Number
Species Caught =10	**5-Jul-07**	**24-Jul-07**	**29-Aug-07**	**of Individuals**
Alewife	0	0	1	**1**
Banded Killifish	6	5	41	**52**
Brook Silverside	0	23	1866	**1889**
Emerald Shiner	1704	0	0	**1704**
Golden Shiner	0	1	0	**1**
Largemouth Bass	3	14	22	**39**
Round Goby	24	0	0	**24**
Spottail Shiner	50	88	891	**1029**
White Bass	0	0	6	**6**
White Perch	0	0	38	**38**
Catch Totals=	**1787**	**131**	**2865**	**4783**

Table A10.2. List of plant species present at site 10

Near Shore	Emergent/Shoreline	Submergent
Goldenrod	Canada Bluejoint	Algae spp.
Poplar spp.	Common Reed	Muskgrass
Queen Anne's Lace	---	Wild Celery
Willow spp.	---	---

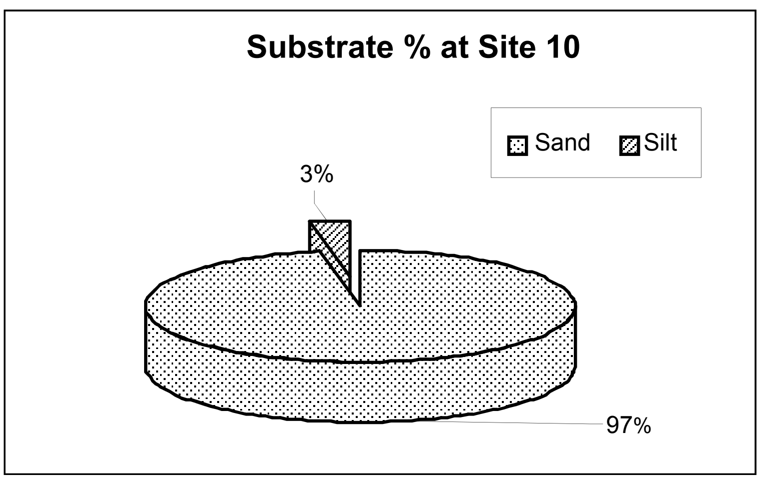

Figure A10. Substrate mixture (%) for site 10

Table A10.3. Weather conditions for each seining event at site 10

Date	Time	Time	Wind	Wind	Waves	Cloud	Air Temp	Air Temp

dd-mm-yy	arrival	departure	direction	speed(kts)	(m)	(% cover)	arrival (°C)	departure(°C)
05-07-07	14:30	16:10	NW	5	<0.5	85	27.3	26.2
24-07-07	10:30	11:30	S	<5	<0.5	100	20.3	20.4
29-08-07	10:15	12:40	S	5	<0.5	0	27	29.9

Table A10.4. Water quality parameters for each seining event at site 10

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
05-07-07	14:30	23.62	8.58	0.253	114.3	9.66	---
24-07-07	10:30	21.31	8.37	0.261	---	---	134.6
29-08-07	10:15	23.88	---	0.283	120.5	10.14	63.6

Site 11

Table A11.1. List and amounts of fish species caught during each sampling period at site 11

Site 11	Number of Individuals Caught per Seining Event			Total Number
Species Caught =15	**22-Jun-07**	**11-Jul-07**	**8-Aug-07**	**of Individuals**
Banded Killifish	1	0	24	**25**
Blackchin Shiner	0	0	1	**1**
Bluegill	0	1	0	**1**
Bluntnose Minnow	0	0	2	**2**
Brook Silverside	23	6	405	**434**
Common Shiner	0	1	0	**1**
Emerald Shiner	2	0	0	**2**
Largemouth Bass	6	7	22	**35**
Pugnose Shiner	0	0	1	**1**
Pumpkinseed	0	8	36	**44**
Round Goby	0	0	10	**10**
Smallmouth Bass	0	3	0	**3**
Yellow Perch	2	22	46	**70**
YOY Cyprinid spp.	0	0	3	**3**
YOY Lepomis spp.	0	19	24	**43**
Catch Totals=	**34**	**67**	**574**	**675**

Table A11.2. List of plant species present at site 11

Emergent/Shoreline	Submergent
Bulrush sp.	Common Waterweed
Canada Bluejoint	Milfoil sp.
Cattail spp.	Muskgrass
---	Wild Celery

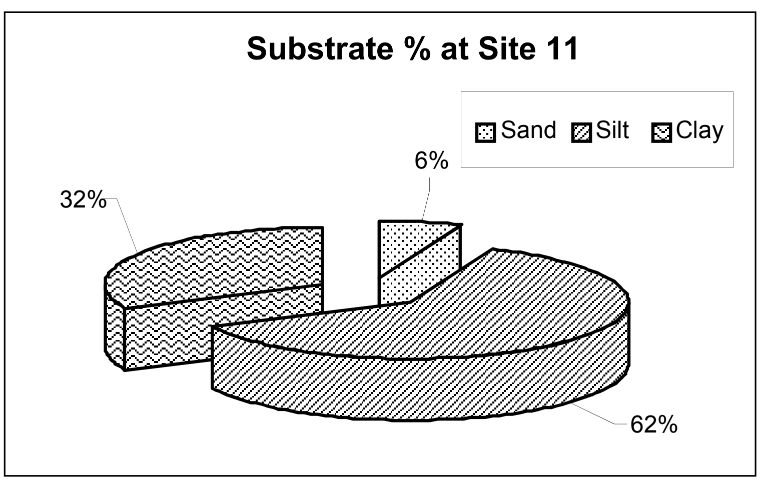

Figure A11. Substrate mixture (%) at site 11

Table A11.3. Weather conditions for each seining period at site 11

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
22-06-07	9:34	11:24	N	10	<0.5	0	18.8	20.3
25-06-07	10:51	---	SW	5	<0.5	0	27.4	---
11-07-07	12:40	14:21	W	5	<0.5	50	22.7	22.6
08-08-07	11:15	13:00	W	10	<0.5	0	28.1	29.9

Table A11.4. Water quality parameters for each seining event at site 11

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
25-06-07	10:51	24.53	9.22	0.248	116.2	---	---	0.17
11-07-07	12:40	25.97	9.57	0.239	106.3	8.66	---	0.029
16-07-07	---	22.53	9.46	0.25	136.5	11.69	100.5	0.016
08-08-07	11:15	26.18	9.17	0.254	78.4	6.44	132	---

Site 12

Table A12.1. List and amounts of fish species caught during each sampling period at site 12

Site 12	Number of Individuals Caught per Seining Event			Total Number
Species Caught =22	**22-Jun-07**	**16-Jul-07**	**8-Aug-07**	**of Individuals**
Banded Killifish	13	13	20	**46**
Blackchin Shiner	0	52	40	**92**
Blacknose Shiner	2	0	7	**9**
Bluegill	0	3	1	**4**
Bluntnose Minnow	173	0	4	**177**
Brook Silverside	4	3	57	**64**
Common Shiner	10	0	0	**10**
Emerald Shiner	0	16	0	**16**
Golden Shiner	0	0	43	**43**
Grass Pickerel	0	0	1	**1**
Largemouth Bass	50	49	23	**122**
Longnose Gar	0	0	1	**1**
Pugnose Shiner	3	1	0	**4**
Pumpkinseed	182	23	51	**256**
Rock Bass	0	1	0	**1**
Round Goby	2	0	0	**2**
Smallmouth Bass	0	1	0	**1**
Spottail Shiner	26	20	0	**46**
Tadpole Madtom	0	0	1	**1**
White Perch	2	0	1	**3**
Yellow Perch	10	54	22	**86**
YOY Lepomis spp.	0	8	36	**44**
Catch Totals=	**477**	**244**	**308**	**1029**

Table A12.2. List of plant species present at site 12

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Pond Lily sp.	Common Waterweed
Canada Bluejoint	---	Milfoil sp.
Cattail spp.	---	Muskgrass
---	---	Pondweed sp.
---	---	Wild Celery

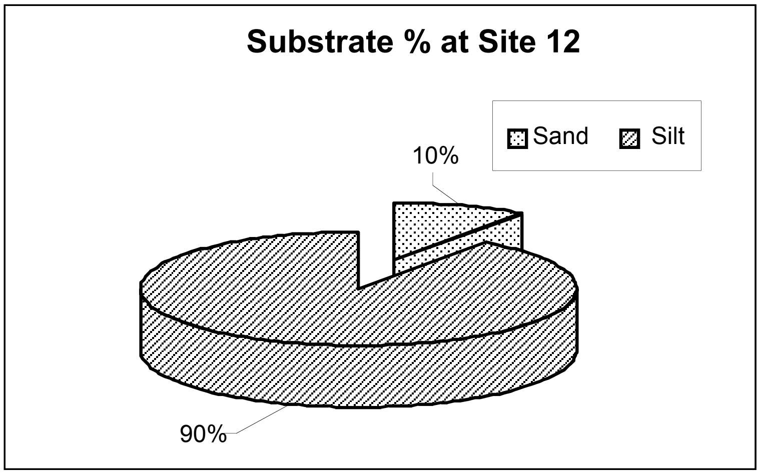

Figure A12. Substrate mixture (%) for site 12

Table A12.3. Weather conditions for each seining event at site 12

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
22-06-07	12:00	14:15	N	10	<0.5	25	20.8	21
25-06-07	11:12	---	SW	5	<0.5	0	27.4	---
16-07-07	10:05	12:00	W	5	<0.5	10	22.7	24.9
08-08-07	13:50	16:00	W	10	<0.5	20	29.1	27.5

Table A12.4. Water quality parameters for each seining event at site 12

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
25-06-07	11:12	24.35	8.81	0.274	114.7	---	---	0.194
16-07-07	10:05	22.34	9.32	0.258	132.8	11.34	102.2	---
08-08-07	13:50	27.9	8.79	0.276	104.2	8.14	140.8	0.082

Site 12 – Electrofishing

Table C1.5. List and amounts of fish species caught during electrofishing at site 12

Site 12 - Electrofishing	**Number of Individuals Caught**
Species Caught = 23	**26-Jul-07**
Blackchin Shiner	**68**
Blacknose Shiner	**13**
Bluegill	**31**
Bluntnose Minnow	**10**
Bowfin	**3**
Brook Silverside	**5**
Brown Bullhead	**30**

Central Mudminnow	**7**
Common Carp	**1**
Golden Shiner	**43**
Goldfish	**2**
Grass Pickerel	**5**
Largemouth Bass	**92**
Northern Pike	**2**
Pugnose Shiner	**7**
Pumpkinseed	**62**
Rainbow Darter	**1**
Rock Bass	**13**
Round Goby	**1**
Smallmouth Bass	**1**
Spottail Shiner	**5**
Warmouth	**1**
Yellow Perch	**50**
Catch Total=	**453**

Table A12.6. List of plant species present at site 12EF

Emergent/Shoreline	Floating Leaf	Submergent
Cattail spp.	Pond Lily sp.	Common Waterweed
---	---	Milfoil sp.
---	---	Wild Celery

Table A12.7. Weather conditions for electrofishing visit at site 12EF

Date dd-mm-yy	Time arrival	Time departure	Wind direction	Wind speed(kts)	Waves (m)	Cloud (% cover)	Air Temp arrival (°C)	Air Temp departure(°C)
26-07-07	9:30	11:30	S	10	<0.5	30	21	23.3

Table A12.8. Water quality parameters for electrofishing visit at site 12EF

Date dd-mm-yy	Time arrival	Temp. (°C)	pH	Cond. mS/cm	DO %	DO mg/L	ORP	Depth (m)
26-07-07	9:30	24.06	8.41	0.276	166	13.19	98.6	0.032

Site 13

Table A13.1. List and amounts of fish species caught during each sampling period at site 13

Site 13	Number of Individuals Caught per Seining Event			Total Number
Species Caught =21	**27-Jun-07**	**17-Jul-07**	**13-Aug-07**	**of Individuals**
Banded Killifish	7	5	18	**30**
Black Crappie	0	1	0	**1**
Blackchin Shiner	12	74	13	**99**
Blacknose Shiner	2	0	0	**2**
Bluegill	37	6	4	**47**
Bluntnose Minnow	16	1	0	**17**
Brook Silverside	3	13	3	**19**
Common Shiner	1	0	0	**1**
Emerald Shiner	1	28	0	**29**
Golden Shiner	12	21	14	**47**
Goldfish	0	0	1	**1**
Largemouth Bass	149	134	67	**350**
Longnose Gar	0	2	0	**2**
Pugnose Shiner	7	0	0	**7**
Pumpkinseed	34	11	0	**45**
Rock Bass	0	1	11	**12**
Round Goby	2	1	0	**3**
Spotfin Shiner	2	2	0	**4**
Spottail Shiner	4	1	0	**5**
Yellow Perch	6	9	0	**15**
YOY Lepomis spp.	0	10	271	**281**
Catch Totals=	**295**	**320**	**402**	**1017**

Table A13.2.6 List of plant species present at site 13

Near Shore	Emergent/Shoreline	Submergent
Poplar spp.	Bulrush sp.	Common Waterweed
Willow spp.	Cattail spp.	Milfoil sp.
---	Common Reed	Muskgrass
---	Stiff Arrowhead	Pondweed sp.
---	---	Wild Celery

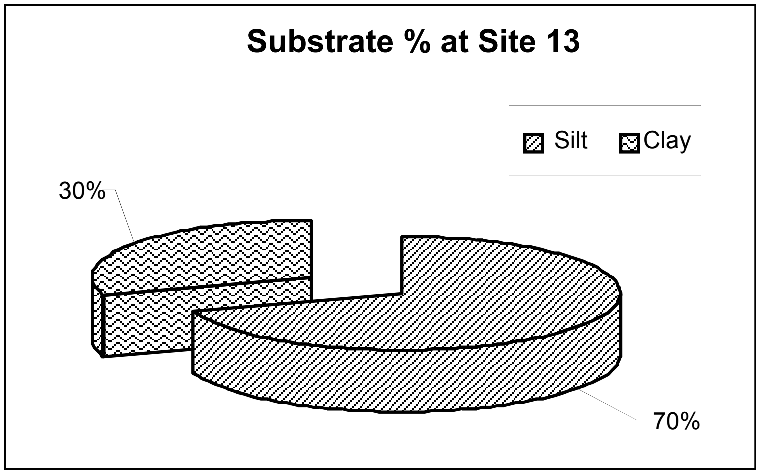

Figure A13. Substrate mixture (%) for site 13

Table A13.3. Weather conditions for each seining event at site 13

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
27-06-07	10:10	---	SW	25	0.5	0	29.1	---
17-07-07	14:20	---	S	<5	<0.5	100	22.2	---
13-08-07	12:10	13:45	NW	<5	<0.5	20	25.8	26.1
30-08-07	15:55	---	NW	<5	<0.5	40	25.3	---

Table A13.4. Water quality parameters for each seining event at site 13

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
27-06-07	10:10	27.33	9.58	0.248	120.9	---	---	0.034
17-07-07	14:20	23.82	9.8	0.267	174	14.52	84.1	0.123
13-08-07	12:10	25.27	9.62	0.268	---	---	115.5	0.109
30-08-07	15:55	26.36	---	0.277	169.9	13.89	38.7	0.129

Site 14

Table C2.1. List and amounts of fish species caught during each sampling period at site 14

Site 14	Number of Individuals Caught per Seining Event			Total Number
Species Caught =18	**27-Jun-07**	**18-Jul-07**	**13-Aug-07**	**of Individuals**
Banded Killifish	67	14	29	**110**
Blackchin Shiner	140	43	181	**364**
Blacknose Shiner	0	0	7	**7**
Bluegill	29	0	2	**31**
Bluntnose Minnow	0	0	25	**25**
Brook Silverside	1	4	136	**141**
Emerald Shiner	0	1	0	**1**
Golden Shiner	1	1	0	**2**
Largemouth Bass	190	72	87	**349**
Pugnose Shiner	112	1	3	**116**
Pumpkinseed	402	88	121	**611**
Rock Bass	3	3	4	**10**
Round Goby	10	2	0	**12**
Smallmouth Bass	3	0	0	**3**
Spotfin Shiner	1	0	0	**1**
Spottail Shiner	26	0	0	**26**
Yellow Perch	10	10	6	**26**
YOY Lepomis spp.	0	21	241	**262**
Catch Totals=	**995**	**260**	**842**	**2097**

Table A14.2. List of plant species present at site 14

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Pond Lily sp.	Common Waterweed
Cattail spp.	---	Milfoil sp.
Stiff Arrowhead	---	Muskgrass
---	---	Pondweed sp.
---	---	Wild Celery

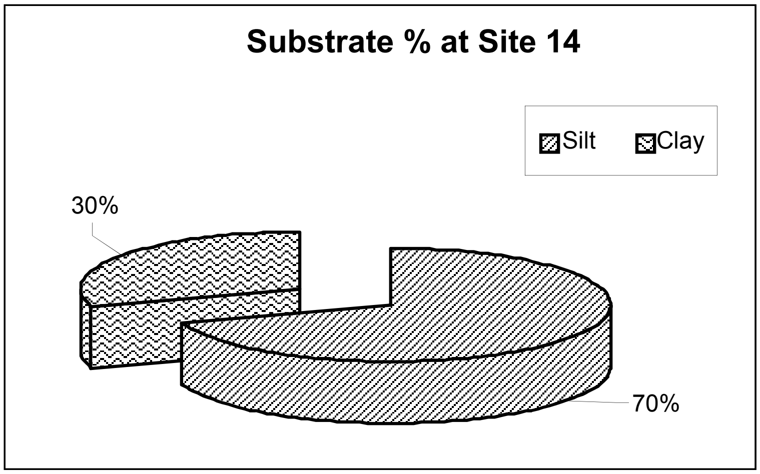

Figure A14. Substrate mixture (%) for site 14

Table A14.3. Weather conditions for each seining event at site 14

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
27-06-07	13:01	16:45	SW	25	<0.5	0	28.4	25.2
18-07-07	15:30	16:50	SW	5	<0.5	60	25.3	24.1
13-08-07	14:10	16:30	NW	5	<0.5	0	26.1	25.4
30-08-07	15:50	---	NW	<5	<0.5	20	25.3	---

Table A14.4. Water quality parameters for each seining event at site 14

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
27-06-07	13:01	29.32	9.66	0.287	171.7	---	---	0.08
18-07-07	15:30	27.14	9.51	0.281	265.4	21.15	54.9	0.04
13-08-07	14:10	27.53	8.83	0.311	---	---	151.5	0.082
30-08-07	15:50	25.8	---	0.254	156.5	12.63	49.6	0.126

Site 16 - Electrofishing

Table A16.1. List and amounts of fish species caught during electrofishing at site 16

Site 16 - Electrofishing	Number of Individuals Caught
Species Caught =14	**26-Jul-07**
Bluegill	**8**
Brook Silverside	**3**
Brown Bullhead	**2**
Emerald Shiner	**3**
Freshwater Drum	**4**
Gizzard Shad	**4**
Grass Pickerel	**2**
Largemouth Bass	**15**
Pumpkinseed	**107**
Rock Bass	**4**
Round Goby	**1**
Spottail Shiner	**1**
White Perch	**1**
Yellow Perch	**25**
Catch Total=	**180**

Table A16.2. List of plant species present at site 16

Emergent/Shoreline	Floating Leaf
Cattail spp.	Pond Lily sp.

Table A16.3. Weather conditions during electrofishing visit at site 16

Date dd-mm-yy	Time arrival	Time departure	Wind direction	Wind speed(kts)	Waves (m)	Cloud (% cover)	Air Temp arrival (°C)	Air Temp departure(°C)
26-07-07	12:45	14:00	S	<5	<0.5	10	25.5	23.7

Table A16.4. Water quality parameters for electrofishing visit at site 16

Date dd-mm-yy	Time arrival	Temp. (°C)	pH	Cond. mS/cm	DO (%)	DO (mg/L)	ORP	Depth Range (m)
26-07-07	12:45	21.04	7.86	0.526	142.7	12.76	105.7	1.334

Site 17

Table A17.1. List and amounts of fish species caught during each sampling period at site 17

Site 17	Number of Individuals Caught per Seining Event			Total Number
Species Caught =18	**3-Jul-07**	**23-Jul-07**	**20-Aug-07**	**of Individuals**
Banded Killifish	131	89	10	**230**
Blackchin Shiner	70	0	4	**74**
Blacknose Shiner	1	4	0	**5**
Bluegill	1	3	0	**4**
Bluntnose Minnow	2	0	0	**2**
Brook Silverside	6	60	0	**66**
Emerald Shiner	0	1	0	**1**
Greenside Darter	1	0	0	**1**
Largemouth Bass	97	65	9	**171**
Pugnose Shiner	13	0	0	**13**
Pumpkinseed	13	127	22	**162**
Rock Bass	2	0	0	**2**
Smallmouth Bass	0	1	0	**1**
Spotfin Shiner	0	0	7	**7**
Spottail Shiner	28	0	0	**28**
Yellow Perch	61	97	34	**192**
YOY Cyprinid spp.	0	1	0	**1**
YOY Lepomis spp.	0	5	0	**5**
Catch Totals=	**426**	**453**	**86**	**965**

Table A17.2. List of plant species present at site 17

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Pond Lily sp.	Common Waterweed
Cattail spp.	---	Milfoil sp.
Wild Rice	---	Muskgrass
---	---	Pondweed sp.
---	---	Wild Celery

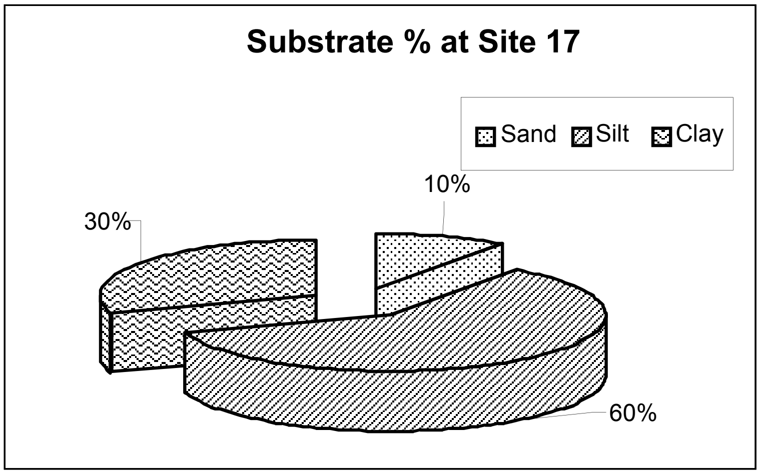

Figure A17. Substrate mixture (%) at site 17

Table A17.3. Weather conditions during each seining event at site 17

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
03-07-07	10:50	13:35	S	5	<0.5	60	22.8	24.4
23-07-07	11:00	13:00	NE	15	<0.5	75	25.6	26
20-08-07	11:20	12:30	NE	15	<0.5	100	15.2	14.2
30-08-07	15:30	---	NW	<5	<0.5	40	25.3	---

Table A17.4. Water quality parameters for each seining event at site 17

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
03-07-07	10:50	21.74	8.25	0.287	90.2	7.91	---	0.124
23-07-07	11:00	23.05	8.21	0.299	---	---	134	0.089
20-08-07	11:20	18.31	7.28	0.371	---	---	220.7	0.042
30-08-07	15:30	25.28	---	0.322	131.8	10.75	77	0.128

Site 18

Table A18.1. List and amounts of fish species caught during each sampling period at site 18

Site 18 Species Caught =10	Number of Individuals Caught per Seining Event 28-Jun-07	 18-Jul-07	 14-Aug-07	Total Number of Individuals
Alewife	0	1	0	**1**
Bluegill	1	0	0	**1**
Brook Silverside	11	714	368	**1093**
Johnny Darter	0	1	0	**1**
Largemouth Bass	2	0	0	**2**
Northern Pike	1	0	0	**1**
Pumpkinseed	7	0	0	**7**
Smallmouth Bass	0	4	1	**5**
Spotfin Shiner	2	3	0	**5**
Spottail Shiner	0	34	8	**42**
Catch Totals=	**24**	**757**	**377**	**1158**

Table A18.2. List of plant species present at site 18

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Pond Lily sp.	Muskgrass
Cattail spp.	---	Wild Celery
Wild Rice	---	---

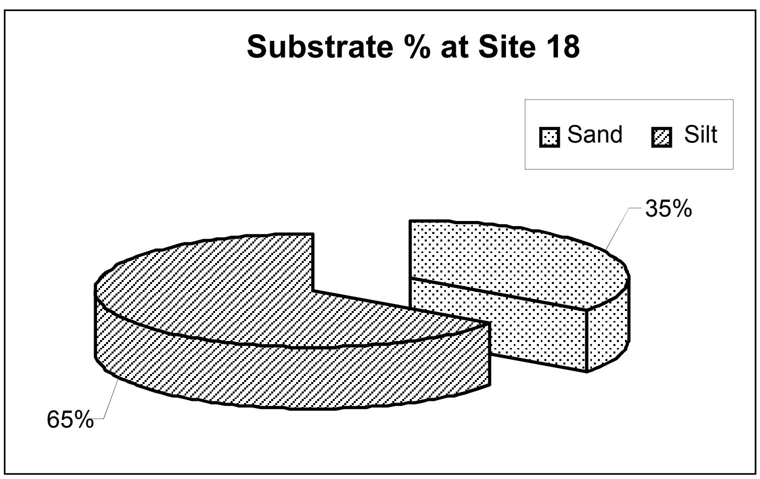

Figure A18. Substrate mixture (%) for site 18

Table A18.3. Weather conditions for each seining event at site 18

Date dd-mm-	Time arrival	Time departur	Wind direction	Wind speed(kts	Waves (m)	Cloud (%	Air Temp arrival	Air Temp departure(°C

yy		e		)		cover)	(°C)	)
28-06-07	9:55	11:45	NW	5	<0.5	40	25.7	27.3
19-07-07	12:30	14:00	W	5	<0.5	60	25.3	26.2
14-08-07	15:00	16:10	SW	15	<0.5	20	24.7	24.7
30-08-07	15:10	---	NW	<5	<0.5	60	24.9	---

Table A18.4. Water quality parameters for each seining event at site 18

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
28-06-07	9:55	24.95	8.08	0.286	81.3	---	---	0.058
19-07-07	12:30	25.16	8.66	0.241	139	11.45	116.8	---
14-08-07	15:00	25.6	8.97	0.253	---	---	150.6	---
30-08-07	15:10	25.27	---	0.237	128.1	10.45	85.1	0.086

Site 19

Table A19.1. List and amounts of fish species caught during each sampling period at site 19

Site 19	Number of Individuals Caught per Seining Event			Total Number
Species Caught =11	**4-Jul-07**	**23-Jul-07**	**21-Aug-07**	**of Individuals**
Banded Killifish	15	4	0	**19**
Blackchin Shiner	2	0	0	**2**
Brook Silverside	9	78	90	**177**
Johnny Darter	0	1	2	**3**
Largemouth Bass	18	24	0	**42**
Longnose Gar	0	1	0	**1**
Pugnose Shiner	1	0	0	**1**
Punkinseed	5	15	0	**20**
Yellow Perch	209	3	265	**477**
YOY Cyprinid spp.	3	0	0	**3**
YOY Lepomis spp.	3	1	0	**4**
Catch Totals=	**266**	**127**	**357**	**750**

Table A19.2. List of plant species present at site 19

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Pond Lily sp.	Common Waterweed
Cattail spp.	---	Milfoil sp.
Wild Rice	---	Muskgrass
---	---	Pondweed sp.
---	---	Wild Celery

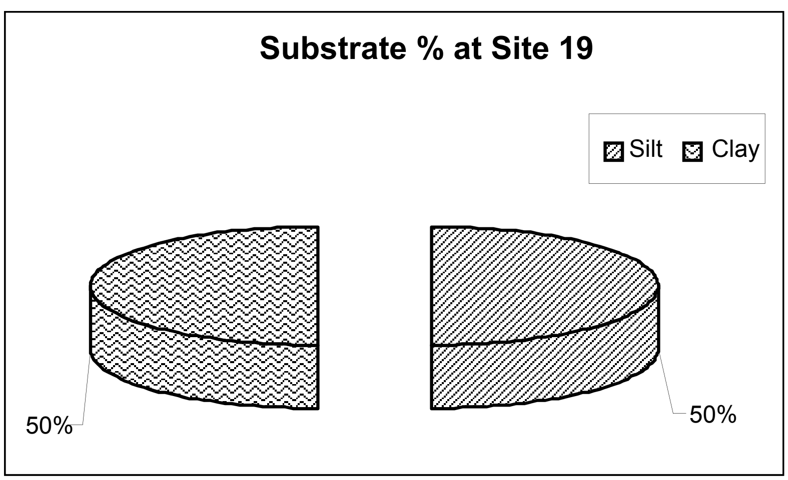

Figure A19. Substrate mixture (%) at site 19

Table A19.3. Weather conditions for each seining event at site 19

Date dd-mm-yy	Time arrival	Time departure	Wind direction	Wind speed(kts)	Waves (m)	Cloud (% cover)	Air Temp arrival (°C)	Air Temp departure(°C)
04-07-07	10:15	12:00	NE	0	0	100	17.2	17.6
23-07-07	15:20	16:50	E	5	<0.5	100	25.6	24
21-08-07	10:00	10:55	NE	5	<0.5	100	15.8	15.8

Table A19.4. Water quality parameters for each seining event at site 19

Date dd-mm-yy	Time arrival	Temp. (°C)	pH	Cond. mS/cm	DO %	DO mg/L	ORP	Depth (m)
04-07-07	10:15	22.7	8.92	0.247	103.2	8.93	---	0.014
23-07-07	15:20	25.55	8.41	0.266	---	---	118.9	0.054
21-08-07	10:00	17.95	---	0.287	77	7.18	18.5	0.086

Site 20

Table A20.1. List and amounts of fish species caught during each sampling period at site 20

Site 20	Number of Individuals Caught per Seining Event			Total Number
Species Caught =14	6-Jul-07	24-Jul-07	22-Aug-07	of Individuals
Alewife	0	6	0	**6**
Banded Killifish	2	0	6	**8**
Bluntnose Minnow	0	0	33	**33**
Brook Silverside	41	656	120	**817**
Common Shiner	1	0	0	**1**
Emerald Shiner	0	1	0	**1**
Johnny Darter	6	27	7	**40**
Largemouth Bass	22	5	8	**35**
Pumpkinseed	18	19	1	**38**
Round Goby	0	0	6	**6**
Smallmouth Bass	0	1	0	**1**
Spotfin Shiner	0	0	3	**3**
Spottail Shiner	1	1	73	**75**
Yellow Perch	2	0	21	**23**
Catch Totals=	**93**	**716**	**278**	**1087**

Table A20.2. List of plant species present at site 20

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Fragrant White Water Lily	Common Waterweed
Canada Bluejoint	---	Milfoil sp.
Cattail spp.	---	Muskgrass
Wild Rice	---	Wild Celery

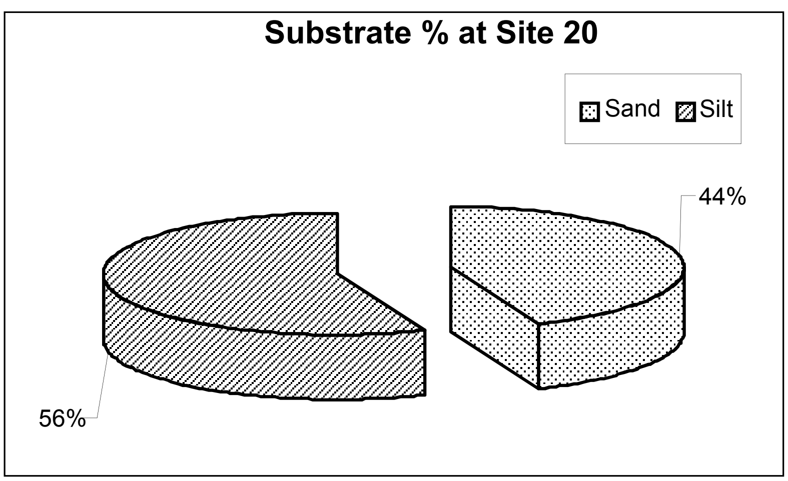

Figure A20. Substrate mixture (%) for site 20

Table A20.3. Weather conditions for each seining event at site 20

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
06-07-07	10:50	12:45	W	5	<0.5	0	24.8	25.9
24-07-07	14:50	16:30	S	<5	<0.5	30	23.3	23.5
22-08-07	10:00	11:20	W	<5	<0.5	80	19.4	21

Table A20.4. Water quality parameters for each seining event at site 20

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
06-07-07	10:50	23.15	8.96	0.241	112.4	10.62	---	0.006
24-07-07	14:50	24.01	8.85	0.234	159.9	13.54	89.8	0.04
22-08-07	10:00	18.88	---	0.259	92.9	8.61	101.7	0.117

Site 21 - Electrofishing

Table A21.1. List and amounts of fish species caught during electrofishing at site 21

Site 21 - Electrofishing Species Caught =14	Number of Individuals Caught 26-Jul-07
Banded Killifish	**1**
Blackchin Shiner	**22**
Bluntnose Minnow	**3**
Brown Bullhead	**6**
Central Mudminnow	**3**
Golden Shiner	**8**
Grass Pickerel	**4**
Largemouth Bass	**18**
Northern Pike	**1**
Pugnose Shiner	**5**
Pumpkinseed	**47**
Rock Bass	**3**
Yellow Perch	**74**
YOY Lepomis spp.	**1**
Catch Total=	**196**

Table A21.2. List of plant species present at site 21

Emergent/Shoreline	Floating Leaf	Submergent
Bulrush sp.	Pond Lily spp.	Common Waterweed
Cattail spp.	Water Shield	Milfoil sp.
---	---	Muskgrass
---	---	Sago Pondweed
---	---	Wild Celery

Table A21.3. Weather conditions for electrofishing at site 21

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
26-07-07	14:40	15:50	S	<5	<0.5	75	23.8	24.9

Table A21.4. Water quality parameters for electrofishing at site 21

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
26-07-07	14:40	25.89	9.03	0.222	191.4	15.49	73.1	0.282

Site 22

Table A22.1. List and amounts of fish species caught during each sampling period at site 22

Site 22	Number of Individuals Caught per Seining Event			Total Number
Species Caught =13	6-Jul-07	24-Jul-07	16-Aug-07	of Individuals
Alewife	0	2	0	**2**
Banded Killifish	97	236	321	**654**
Brook Silverside	1	215	235	**451**
Common Shiner	2	0	0	**2**
Emerald Shiner	10	3	0	**13**
Johnny Darter	1	0	0	**1**
Largemouth Bass	4	23	12	**39**
Rock Bass	0	0	1	**1**
Round Goby	4	1	0	**5**
Spotfin Shiner	0	6	0	**6**
Spottail Shiner	195	17	175	**387**
Yellow Perch	0	4	0	**4**
YOY Cyprinid spp.	0	0	25	**25**
Catch Totals=	**314**	**507**	**769**	**1590**

Table A22.2. List of plant species present at site 22

Near Shore	Emergent/Shoreline	Submergent
Willow spp.	Bulrush sp.	Algae spp.
---	Common Reed	Muskgrass
---	---	Sago Pondweed
---	---	Wild Celery

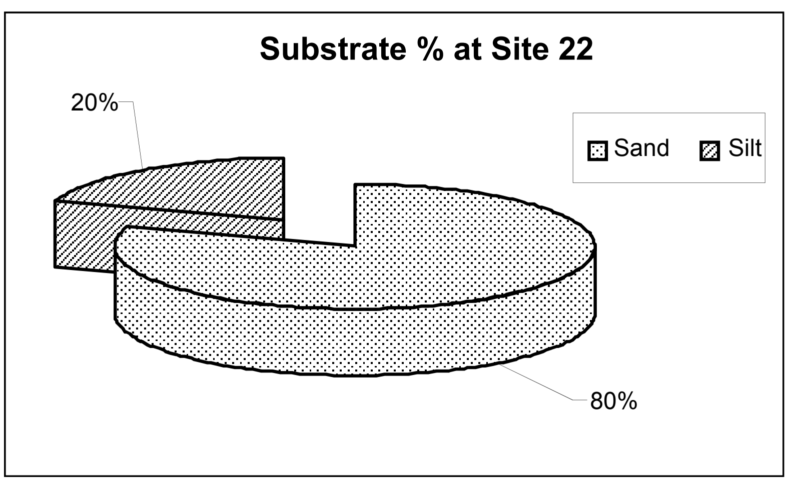

Figure A22. Substrate mixture (%) at site 22

Table A22.3. Weather conditions for each seining event at site 22

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
06-07-07	13:50	15:00	NW	20	0.5	5	26.7	26.8
24-07-07	12:15	14:17	S	<5	<0.5	100	20.3	21.9
16-08-07	14:10	15:40	NW	15	<0.5	30	27.5	26.5

Table A22.4. Water quality parameters for each seining event at site 22

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
06-07-07	13:50	25.54	8.62	0.253	111.7	9.12	---	0.042
24-07-07	12:15	22.41	8.62	0.254	183.5	13.05	69.1	0.144
16-08-07	14:10	26.38	8.95	0.236	---	---	163.1	0.011

Site 24

Table A24.1. List and amounts of fish species caught during each sampling period at site 24

Site 24	Number of Individuals Caught per Seining Event			Total Number
Species Caught =23	**9-Jul-07**	**25-Jul-07**	**21-Aug-07**	**of Individuals**
Banded Killifish	1	56	102	**159**
Blackchin Shiner	31	103	21	**155**
Blacknose Shiner	0	19	73	**92**
Bluegill	0	0	3	**3**
Bluntnose Minnow	0	5	29	**34**
Brook Silverside	8	30	20	**58**
Brown Bullhead	0	0	1	**1**
Golden Shiner	1	1	0	**2**
Greenside Darter	0	0	5	**5**
Iowa Darter	0	1	0	**1**
Johnny Darter	0	7	0	**7**
Largemouth Bass	24	33	33	**90**
Mimic Shiner	1	0	0	**1**
Pugnose Shiner	3	5	8	**16**
Pumpkinseed	20	16	10	**46**
Rock Bass	4	0	3	**7**
Smallmouth Bass	13	1	2	**16**
Spotfin Shiner	8	0	0	**8**
Spottail Shiner	2	1	0	**3**
Tadpole Madtom	0	0	2	**2**
Yellow Perch	90	92	28	**210**
YOY Cyprinid spp.	2	1	0	**3**
YOY Lepomis spp.	4	23	11	**38**
Catch Totals=	**212**	**394**	**351**	**957**

Table A24.2. List of plant species present at site 24

Riparian	Emergent/Shoreline	Floating Leaf	Submergent
Willow sp.	Bulrush sp.	Pond Lily sp.	Common Waterweed
---	Cattail spp.	---	Milfoil sp.
---	Stiff Arrowhead	---	Muskgrass
---	---	---	Pondweed sp.
---	---	---	Wild Celery

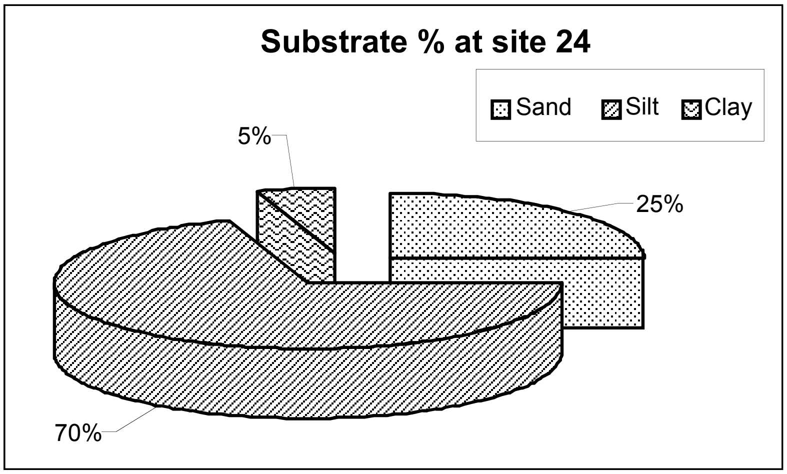

Figure A24. Substrate mixture (%) at site 24

Table A24.3. Weather conditions for each seining event at site 24

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
09-07-07	10:40	13:00	W	20	<0.5	65	30.8	31.9
25-07-07	9:50	11:50	SW	5	<0.5	90	18.3	21.1
21-08-07	13:00	14:30	NE	15	<0.5	100	17.1	18.3

Table A24.4. Water quality parameters for each seining event at site 24

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
09-07-07	10:40	24.71	8.53	0.284	114.3	9.47	---	0.081
25-07-07	9:50	23.06	8.17	0.288	139.9	10.77	117.7	0.216
21-08-07	13:00	18.06	---	0.296	104.3	9.81	14.2	---

Site 25

Table A25.1. List and amounts of fish species caught during each sampling period at site 25

Site 25	Number of Individuals Caught per Seining Event			Total Number
Species Caught =14	**9-Jul-07**	**25-Jul-07**	**22-Aug-07**	**of Individuals**
Bluegill	2	0	0	**2**
Brook Silverside	26	320	378	**724**
Brown Bullhead	1	0	0	**1**
Common Shiner	4	0	0	**4**
Emerald Shiner	0	1	0	**1**
Johnny Darter	10	5	0	**15**
Largemouth Bass	25	8	1	**34**
Pumpkinseed	4	0	14	**18**
Smallmouth Bass	21	4	1	**26**
Spotfin Shiner	4	12	0	**16**
Spottail Shiner	18	60	3	**81**
Yellow Perch	0	0	2	**2**
YOY Cyprinid spp.	5	0	0	**5**
YOY Lepomis spp.	2	0	0	**2**
Catch Totals=	**122**	**410**	**399**	**931**

Table A25.2. List of plant species present at site 25

Near Shore	Emergent/Shoreline	Floating Leaf	Submergent
Willow spp.	Bulrush sp.	Floating-leaved Pondweed	Common Waterweed
---	Canada Bluejoint	Pond Lily sp.	Milfoil sp.
---	Cattail spp.	---	Muskgrass
---	Common Reed	---	Pondweed sp.
---	---	---	Wild Celery

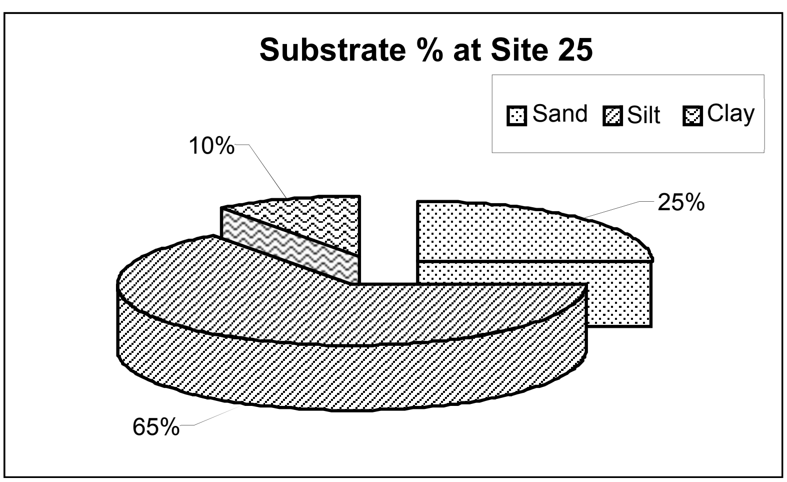

Figure A25. Substrate mixture (%) at site 25

Table A25.3. Weather conditions for each seining event at site 25

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
09-07-07	14:30	15:55	S	20	<0.5	0	29.1	30.2
25-07-07	12:50	14:45	SE	<5	<0.5	15	22.5	24.3
22-08-07	12:15	13:45	E	<5	<0.5	100	21.7	23.3

Table A25.4. Water quality parameters for each seining event at site 25

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
09-07-07	14:30	29.7	8.44	0.284	113.9	8.67	---
25-07-07	12:50	25.44	8.24	0.294	132.6	10.86	71.3
22-08-07	12:15	20.9	---	0.267	103.5	9.14	87.1

Site 26

Table A26.1. List and amounts of fish species caught during each sampling period at site 26

Site 26 Species Caught =18	Number of Individuals Caught per Seining Event 10-Jul-07	 30-Jul-07	 22-Aug-07	Total Number of Individuals
Banded Killifish	32	36	91	**159**
Blackchin Shiner	62	3	10	**75**
Blacknose Shiner	0	1	0	**1**
Bluegill	4	4	0	**8**
Bluntnose Minnow	0	2	11	**13**
Brook Silverside	0	11	110	**121**
Brown Bullhead	0	3	0	**3**
Emerald Shiner	2	0	0	**2**
Golden Shiner	0	2	11	**13**
Johnny Darter	0	1	4	**5**
Largemouth Bass	93	117	41	**251**
Pugnose Shiner	7	0	0	**7**
Pumpkinseed	79	61	47	**187**
Rock Bass	2	15	2	**19**
Round Goby	0	10	0	**10**
Spottail Shiner	0	5	0	**5**
Yellow Perch	4	4	13	**21**
YOY Lepomis spp.	2	203	404	**609**
Catch Totals=	**287**	**478**	**744**	**1509**

Table A26.2. List of plant species present at site 26

Near Shore	Emergent/Shoreline	Floating Leaf	Submergent
Willow spp.	Bulrush sp.	Pond Lily sp.	Common Waterweed
---	Cattail spp.	---	Milfoil sp.
---	Common Reed	---	Muskgrass
---	Stiff Arrowhead	---	Pondweed sp.
---	---	---	Sago Pondweed
---	---	---	Wild Celery

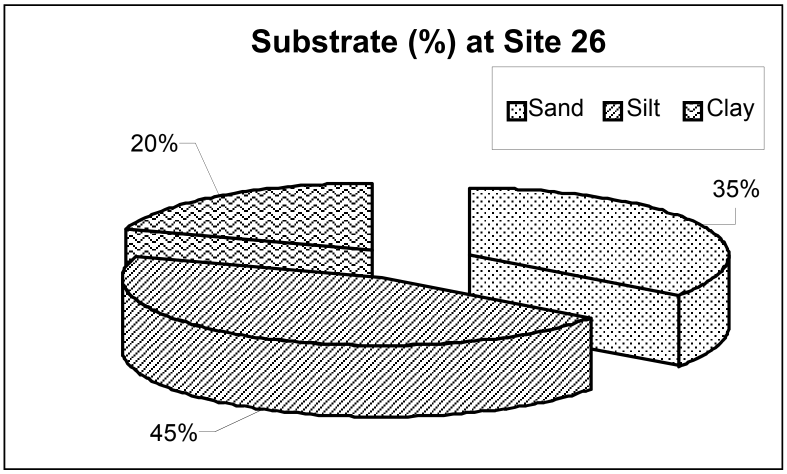

Figure A26. Substrate mixture (%) at site 26

Table A26.3. Weather conditions for each seining event at site 26

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
10-07-07	11:30	13:30	SW	10	<0.5	10	29.3	31.1
30-07-07	10:30	12:50	N	5	<0.5	0	28	28.9
22-08-07	14:20	16:00	SE	<5	<0.5	60	23.3	24.7

Table A26.4. Water quality parameters for each seining event at site 26

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
10-07-07	11:30	28.05	9.86	0.277	152.6	11.94	---
30-07-07	10:30	25.22	9.85	0.269	165.5	12.3	118.2
22-08-07	14:20	22.87	---	0.275	164.4	14.06	59.6

Site 27

Table A27.1. List and amounts of fish species caught during each sampling period at site 27

Site 27	Number of Individuals Caught per Seining Event			Total Number
Species Caught =12	12-Jul-07	31-Jul-07	28-Aug-07	of Individuals
Alewife	0	1	0	**1**
Banded Killifish	143	1097	125	**1365**
Blacknose Shiner	1	0	0	**1**
Bluegill	0	1	0	**1**
Brook Silverside	5	5	34	**44**
Emerald Shiner	2	0	0	**2**
Largemouth Bass	2	13	3	**18**
Pumpkinseed	0	9	0	**9**
Round Goby	5	0	0	**5**
Smallmouth Bass	1	1	0	**2**
Spottail Shiner	37	4	21	**62**
Yellow Perch	1	0	2	**3**
Catch Totals=	**197**	**1131**	**185**	**1513**

Table A27.2. List of plant species present at site 27

Near Shore	Emergent/Shoreline	Submergent
Poplar sp.	Bulrush sp.	Algae spp.
---	Common Reed	Sago Pondweed
---	---	Wild Celery

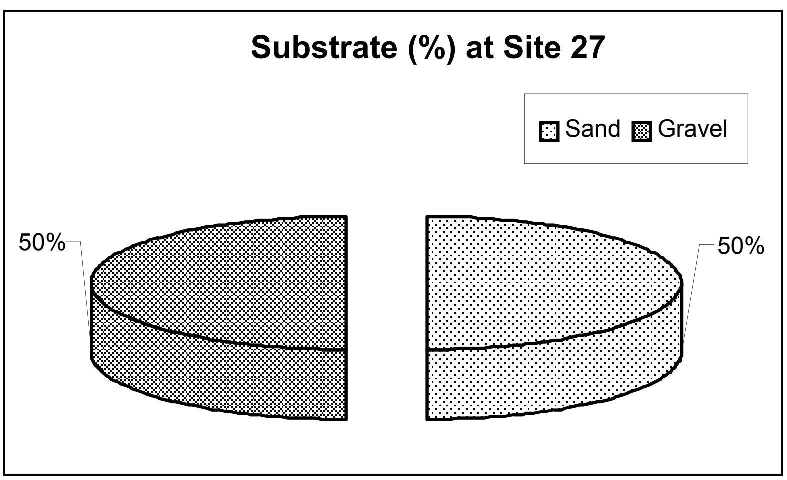

Figure A27. Substrate mixture (%) at site 27

Table A27.3. Weather conditions for each seining event at site 27

Date	Time	Time	Wind	Wind	Waves	Cloud	Air Temp	Air Temp

dd-mm-yy	arrival	departure	direction	speed(kts)	(m)	(% cover)	arrival (°C)	departure(°C)
12-07-07	11:00	12:40	SW	15	<0.5	20	23.8	24.1
31-07-07	12:30	14:15	NW	5	<0.5	0	30.7	31
28-08-07	12:45	14:00	W	<5	<0.5	0	26.5	26.8

Table A27.4. Water quality parameters for each seining event at site 27

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
12-07-07	11:00	22.8	8.86	0.251	113.6	9.77	---
31-07-07	12:30	29.77	8.78	0.142	124.9	9.56	131.7
28-08-07	12:45	28.16	---	0.274	125.9	9.84	24

Site 28

Table A28.1. List and amounts of fish species caught during each sampling period at site 28

Site 28	Number of Individuals Caught per Seining Event			Total Number
Species Caught =16	**12-Jul-07**	**31-Jul-07**	**28-Aug-07**	**of Individuals**
Alewife	0	11	1	**12**
Banded Killifish	3	0	2	**5**
Blacknose Shiner	2	16	0	**18**
Bluntnose Minnow	0	42	0	**42**
Brook Silverside	4	15	36	**55**
Emerald Shiner	278	33	1	**312**
Largemouth Bass	9	34	14	**57**
Pugnose Shiner	0	2	0	**2**
Pumpkinseed	5	20	2	**27**
Round Goby	94	0	10	**104**
Smallmouth Bass	2	1	0	**3**
Spotfin Shiner	8	8	0	**16**
Spottail Shiner	63	883	546	**1492**
White Perch	0	0	14	**14**
Yellow Perch	2	4	1	**7**
YOY Cyprinid spp.	13	0	0	**13**
Catch Totals=	**483**	**1069**	**627**	**2179**

Table A28.2. List of plant species present at site 28

Near Shore	Emergent/Shoreline	Submergent
Poplar spp.	Canada Bluejoint	Algae spp.
Willow spp.	Common Reed	Common Waterweed
---	---	Sago Pondweed
---	---	Wild Celery
---	---	Muskgrass

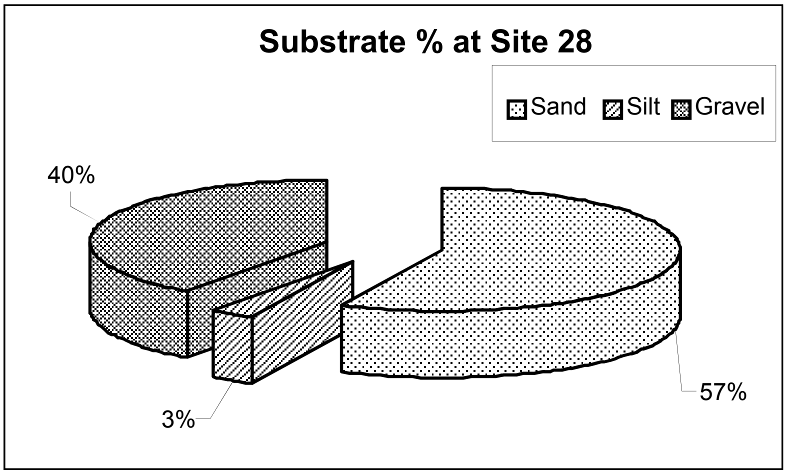

Figure A28. Substrate mixture (%) at site 28

Table A28.3. Weather conditions for each seining event at site 28

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
19-07-07	9:20	10:30	W	5	<0.5	100	21.9	23.9
09-08-07	8:45	9:30	N	<5	<0.5	100	19	19
30-08-07	10:30	11:30	NW	5	<0.5	90	20.8	21.9

Table A28.4. Water quality parameters for each seining event at site 28

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
19-07-07	9:20	21.84	8.35	0.288	134.9	17.21	137.9	---
09-08-07	8:45	22.07	8.4	0.3	82.5	7.16	135.9	---
30-08-07	10:30	23.44	---	0.279	128.6	10.96	70.8	0.029

Site 29

Table A29.1. List and amounts of fish species caught during each sampling period at site 29

Site 29 Species Caught =11	Number of Individuals Caught per Seining Event 19-Jul-07	 9-Aug-07	 30-Aug-07	Total Number of Individuals
Alewife	0	0	5	**5**
Banded Killifish	0	0	12	**12**
Bluntnose Minnow	2	0	0	**2**
Brook Silverside	0	17	82	**99**
Emerald Shiner	59	1	6	**66**
Largemouth Bass	3	6	3	**12**
Round Goby	51	2	8	**61**
Smallmouth Bass	0	0	4	**4**
Spotfin Shiner	4	4	15	**23**
Spottail Shiner	91	230	612	**933**
White Sucker	13	0	0	**13**
Catch Totals=	**223**	**260**	**747**	**1230**

Table A29.2. List of plant species present at site 29

Near Shore	Submergent
Willow sp.	Muskgrass

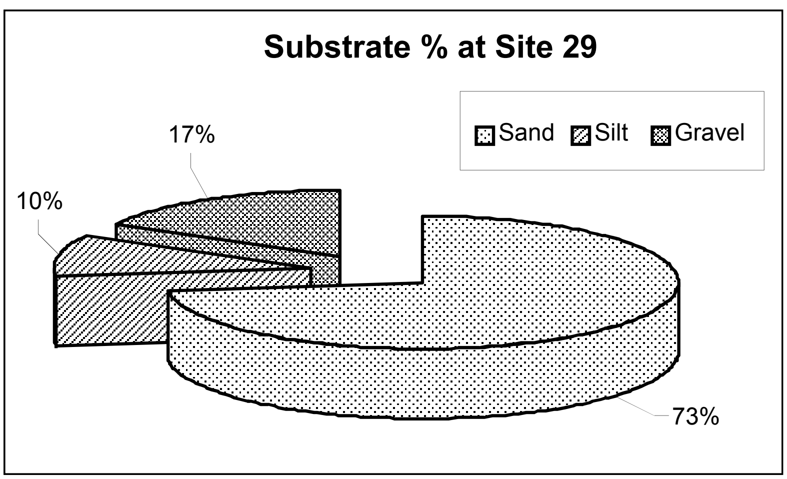

Figure A29. Substrate mixture (%) at site 29

Table A29.3. Weather conditions for each seining event at site 29

Date dd-mm-yy	Time arrival	Time departure	Wind direction	Wind speed(kts)	Waves (m)	Cloud (% cover)	Air Temp arrival (°C)	Air Temp departure(°C)
19-07-07	9:20	10:30	W	5	<0.5	100	21.9	23.9
09-08-07	8:45	9:30	N	<5	<0.5	100	19	19

30-08-07	10:30	11:30	NW	5	<0.5	90	20.8	21.9

Table A29.4. Water quality parameters for each seining event at site 29

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
19-07-07	9:20	21.84	8.35	0.288	134.9	17.21	137.9	---
09-08-07	8:45	22.07	8.4	0.3	82.5	7.16	135.9	---
30-08-07	10:30	23.44	---	0.279	128.6	10.96	70.8	0.029

Site 30

Table A30.1. List and amounts of fish species caught during each sampling period at site 30

Site 30 Species Caught =20	Number of Individuals Caught per Seining Event 1-Aug-07	 29-Aug-07	Total Number of Individuals
Banded Killifish	185	116	**301**
Blackchin Shiner	68	132	**200**
Blacknose Shiner	353	1557	**1910**
Bluegill	2	0	**2**
Bluntnose Minnow	57	159	**216**
Brook Silverside	13	6	**19**
Brown Bullhead	0	2	**2**
Golden Shiner	11	75	**86**
Grass Pickerel	0	1	**1**
Largemouth Bass	25	24	**49**
Mimic Shiner	9	0	**9**
Northern Pike	1	0	**1**
Pugnose Shiner	21	156	**177**
Pumpkinseed	69	65	**134**
Rock Bass	8	7	**15**
Round Goby	2	0	**2**
Spotfin Shiner	6	8	**14**
Spottail Shiner	27	27	**54**
Yellow Perch	8	4	**12**
YOY Lepomis spp.	7	35	**42**
Catch Totals=	**872**	**2374**	**3246**

Table A30.2. List of plant species present at site 30

Near Shore	Emergent/Shoreline	Submergent
Poplar spp.	Bulrush sp.	Common Waterweed
---	Cattail spp.	Milfoil sp.
---	Common Reed	Muskgrass
---	Wild Rice	Sago Pondweed
---	---	Wild Celery

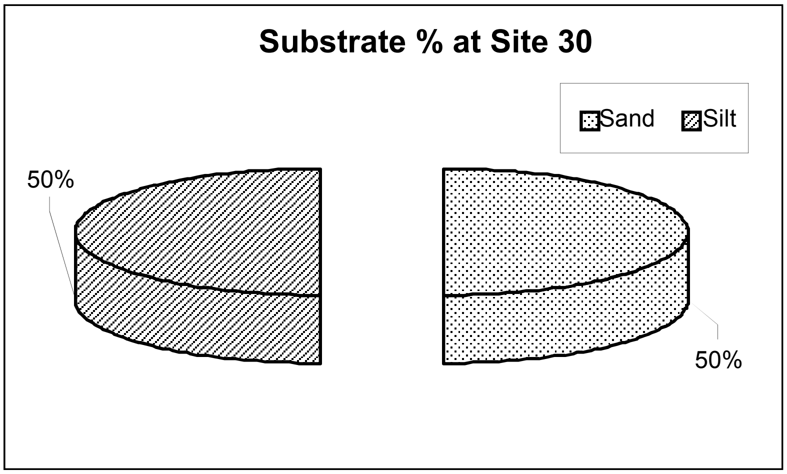

Figure A30. Substrate mixture (%) at site 30

Table A30.3. Weather conditions for each seining event at site 30

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
01-08-07	12:50	15:10	SW	<5	<0.5	0	31.8	30.1
29-08-07	14:10	17:05	SW	5	<0.5	0	29.9	28.9

Table A30.4. Water quality parameters for each seining event at site 30

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
01-08-07	12:50	29.55	8.76	0.262	120.8	9.2	142.5
29-08-07	14:10	28.24	---	0.276	134.5	10.39	71.5

Site 31

Table A31.1. List and amounts of fish species caught during the sampling period at site 31

Site 31	Number of Individuals Caught
Species Caught = 4	**14-Aug-07**
Brook Silverside	**543**
Largemouth Bass	**15**
Pumpkinseed	**14**
Spottail Shiner	**2**
Catch Total=	**574**

Table A31.2. List of plant species present at site 31

Emergent/Shoreline	Submergent
Bulrush sp.	Wild Celery
Canada Bluejoint	---
Common Reed	---

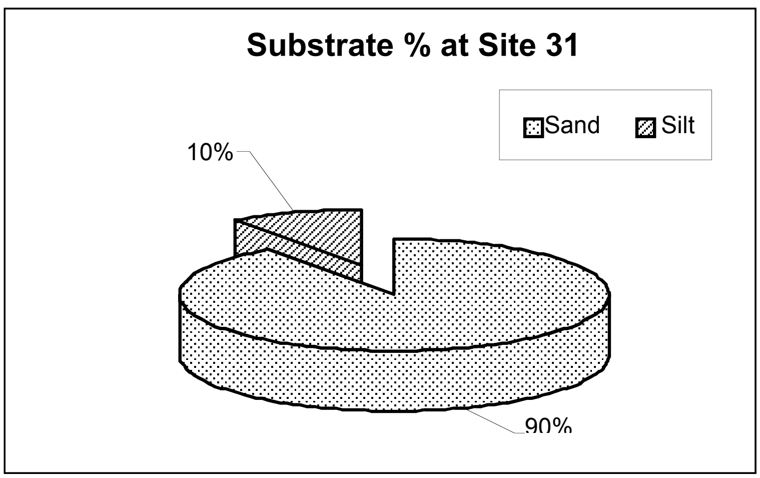

Figure A31. Substrate mixture (%) at site 31

Table A31.3. Weather conditions for each seining event at site 31

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
14-08-07	11:30	12:53	SW	5	<0.5	30	23.3	24.8
29-08-07	15:30	---	SW	<5	<0.5	0	29.5	---

Table A31.4. Water quality parameters for each seining event at site 31

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
14-08-07	12:50	23.53	8.76	0.268	---	---	150.7	0.081
29-08-07	14:10	25.2	---	0.277	126.4	10.27	96.8	0.042

Site 32

Table A32.1. List and amounts of fish species caught during the sampling period at site 32

Site 32	Number of Individuals Caught
Species Caught = 8	**15-Aug-07**
Alewife	**7**
Banded Killifish	**50**
Bluntnose Minnow	**1**
Brook Silverside	**2350**
Emerald Shiner	**1**
Largmouth Bass	**1**
Spottail Shiner	**962**
YOY Cyprinid spp.	**3**
Catch Total=	**3375**

Table A32.3. List of plant species present at site 32

Near Shore	Submergent
Willow spp.	Muskgrass
---	Wild Celery

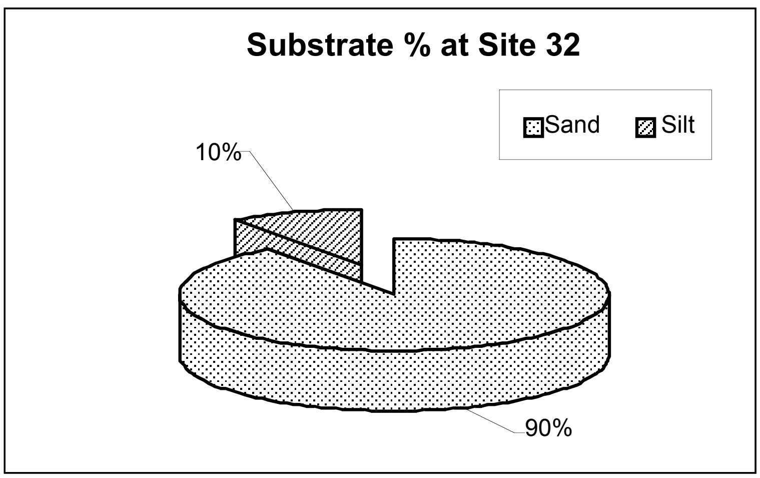

Figure A32. Substrate mixture (%) at site 32

Table A32.3. Weather conditions for each seining event at site 32

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
15-08-07	14:30	16:45	NW	15	<0.5	80	25	22.9
29-08-07	13:45	---	SW	5	<0.5	0	29.9	---

Table A32.4. Water quality parameters for each seining event at site 32

Date dd-mm-yy	Time arrival	Temp. (°C)	pH	Cond. mS/cm	DO %	DO mg/L	ORP
15-08-07	14:30	26.55	8.37	0.287	---	---	166.5
29-08-07	13:45	24.76	---	0.282	121.2	9.99	88.3

Site 33

Table A33.1. List and amounts of fish species caught during the sampling period at site 33

Site 33	Number of Individuals Caught
Species Caught = 16	**15-Aug-07**
Banded Killifish	**300**
Blackchin Shiner	**66**
Blacknose Shiner	**805**
Bluntnose Minnow	**133**
Brook Silverside	**1**
Central Mudminnow	**1**
Golden Shiner	**26**
Johnny Darter	**12**
Largemouth Bass	**74**
Pugnose Shiner	**45**
Pumpkinseed	**80**
Rock Bass	**4**
Spottail Shiner	**4**
Tadpole Madtom	**2**
Yellow Perch	**33**
YOY Lepomis spp.	**6**
Catch Total=	**1592**

Table A33.2. List of plant species present at site 33

Emergent/Shoreline	Submergent
Bulrush	Common Waterweed
Cattail spp.	Milfoil sp.
---	Muskgrass
---	Pondweed sp.
---	Wild Celery

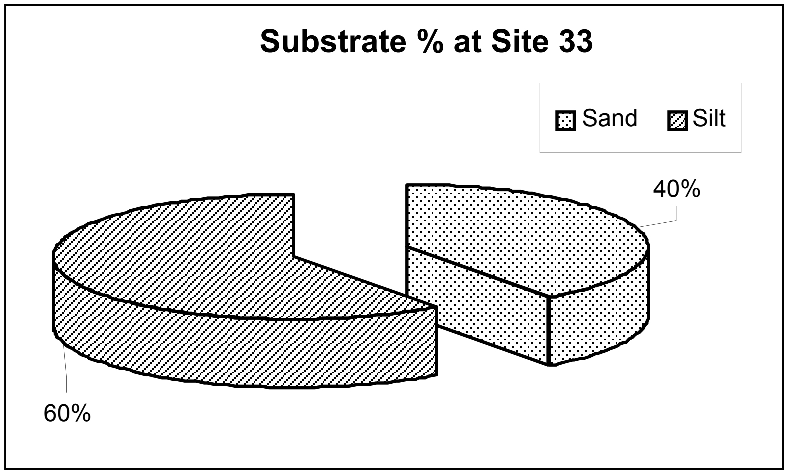

Figure A33. Substrate mixture (%) at site 33

Table A33.3. Weather conditions for each seining event at site 33

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
15-08-07	10:50	13:40	NW	<5	<0.5	10	23.7	25.9

Table A33.4. Water quality parameters for each seining event at site 33

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**
15-08-07	10:50	23.09	9.01	0.256	---	---	162.8

Site 34

Table A34.1. List and amounts of fish species caught during the sampling period at site 34

Site 34 Species Caught = 16	Number of Individuals Caught 16-Aug-07
Banded Killifish	14
Blackchin Shiner	26
Blacknose Shiner	27
Bluntnose Minnow	167
Brook Silverside	7
Golden Shiner	5
Grass Pickerel	2
Johnny Darter	58
Lake Chubsucker (YOY)	1
Largemouth Bass	11
Pumpkinseed	50
Rock Bass	5
Spottail Shiner	1
Tadpole Madtom	1
Yellow Perch	113
YOY Lepomis spp.	61
Catch Total=	**549**

Table A34.2. List of plant species present at site 34

Emergent/Shoreline	Floating Leaf	Submergent
Cattail spp.	Pond Lily sp.	Common Waterweed
---	---	Muskgrass
---	---	Wild Celery

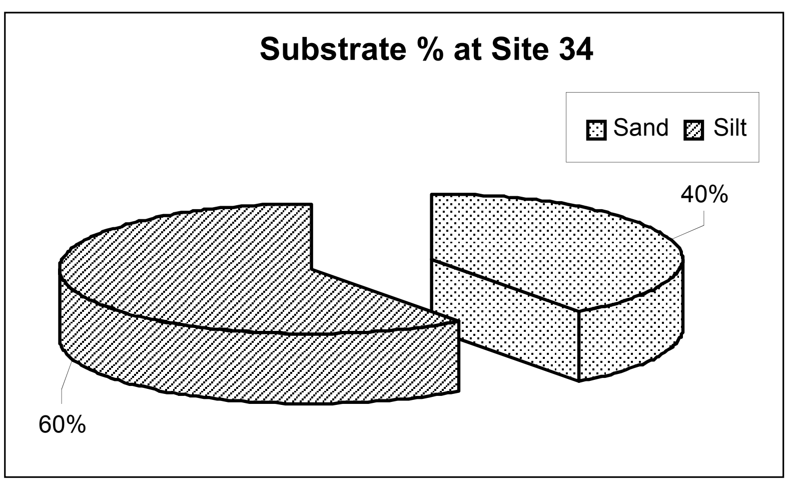

Figure A34. Substrate mixture (%) at site 34

Table A34.3. Weather conditions for each seining event at site 34

Date dd-mm-yy	**Time** arrival	**Time** departure	**Wind** direction	**Wind** speed(kts)	**Waves** (m)	**Cloud** (% cover)	**Air Temp** arrival (°C)	**Air Temp** departure(°C)
16-08-07	10:00	12:00	W	10	<0.5	15	27.6	27.3
30-08-07	14:50	---	NW	<5	<0.5	85	24.9	---

Table A34.4. Water quality parameters for each seining event at site 34

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
16-08-07	10:00	23.76	8.37	0.277	---	---	154.3	---
30-08-07	14:50	25.25	---	0.255	131.4	10.8	68.2	0.181

Site 35

Table A35.1. List and amounts of fish species caught during the sampling period at site 35

Site 35	Number of Individuals Caught
Species Caught = 10	16-Aug-07
Alewife	1
Banded Killifish	9
Bluegill	7
Bluntnose Minnow	1
Brook Silverside	830
Johnny Darter	3
Largemouth Bass	1
Mimic Shiner	1
Pumpkinseed	15
Spotfin Shiner	3
Catch Total=	871

Table A35.2. List of plant species present at site 35

Emergent/Shoreline	Submergent
Bulrush sp.	Common Waterweed
Cattail spp.	Muskgrass
Common Reed	---

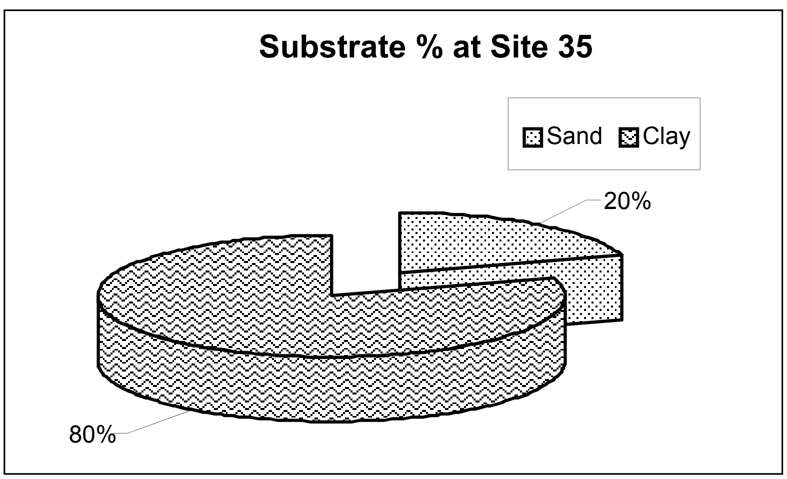

Figure A35. Substrate mixture (%) at site 35

Table A35.3. Weather conditions for each seining event at site 35

Date dd-mm-yy	Time arrival	Time departure	Wind direction	Wind speed(kts)	Waves (m)	Cloud (% cover)	Air Temp arrival (°C)	Air Temp departure(°C)

16-08-07	12:50	14:05	W	15	0.5	20	29.1	27.5
30-08-07	14:45	---	NW	<5	<0.5	90	24.9	---

Table A35.4. Water quality parameters for each seining event at site 35

Date dd-mm-yy	**Time** arrival	**Temp.** (°C)	**pH**	**Cond.** mS/cm	**DO** %	**DO** mg/L	**ORP**	**Depth** (m)
16-08-07	12:50	24.44	8.73	0.243	---	---	168.2	---
30-08-07	14:45	25.1	---	0.246	125.4	10.17	65.5	0.424

RELATIVE ABUNDANCE AND HABITAT ASSOCIATIONS OF LEAST BITTERNS (*Ixobrychus exilis*) AT LONG POINT, LAKE ERIE, ONTARIO

(Spine Title: Relative Abundance and Habitat Associations)

(Thesis Format: Monograph)

by

Nickolas D. Bartok

Graduate Program in Biology

A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science

School of Graduate and Postdoctoral Studies
The University of Western Ontario

ABSTRACT

The Least Bittern is a threatened species in Canada, with an estimated 1500 breeding pairs. I estimated relative abundance and determined habitat associations of Least Bitterns at Long Point, Lake Erie, Ontario. I conducted call-broadcast point counts during 2008 and 2009 with 96 and 197 individual Least Bitterns detected, respectively. I estimated 195 pairs of Least Bitterns at Long Point and 1434 pairs in coastal wetlands of the Canadian lower Great Lakes. Habitat assessments identified percent cover of Cattail and Bulrush, and number of dead Cattail stems as the best predictors of Least Bittern presence. Interspersion and percent cover of Cattail and Bulrush influenced relative abundance at the survey station scale. The estimated number of breeding pairs in Canada is potentially biased low. Point counts should be continued to increase our understanding of Least Bittern ecology. I recommend managing wetlands to increase the amount of Cattail and interspersion.

Keywords: Least Bittern, habitat, interspersion, Long Point, relative abundance

STATEMENT OF CO-AUTHORSHIP

As the first author I was in charge of literature review, study design, fund raising, data collection, analysis, and the monograph. I received draft edits of the monograph from: Benoît Jobin (CWS), Dr. Scott Petrie (LPW), Dr. Michael Schummer (LPW), Dr. Shannon Badzinski (CWS, formally LPW), Dr. Hugh Henry (UWO), and Dr. Chris Guglielmo (UWO).

This monograph will be broken down into two manuscripts for publication. Manuscript one will focus on abundance of Least Bitterns at Long Point, Lake Erie. It will be co-authored by: Dr. Scott Petrie, Dr. Michael Schummer, and Dr. Shannon Badzinski.

The second manuscript will focus on habitat use of Least Bitterns at Long Point, Lake Erie and will have the same authors as the first manuscript. I will be in charge of manuscript revisions and the publication process.

This thesis is dedicated to Ken Cox
A passionate wetland advocate
An uncle of grand proportions and wonderful role model
You are missed
Rest in Peace

ACKNOWLEDGEMENTS

Funding for this research project was provided by Long Point Waterfowl (LPW), Environment Canada (EC) – Canadian Wildlife Service – Ontario Region, Ontario Ministry of Natural Resources (OMNR), Bird Studies Canada (BSC), Nature Canada, Canada-Ontario Agreement, the World Wildlife Fund Canada, and S.C. Johnson and Son Ltd. and the Bluff's Hunt Club.

I would especially like to thank the federal, provincial and private wetland managers for allowing me access to the protected areas to conduct my research. Jeff Robinson and Danny Bernard, Environment Canada, for access to Long Point and Big Creek National Wildlife Areas, providing housing at the tip of Long Point and for the numerous boat rides and logistical support. Dave Richards and Rick Thompson, with the Ontario Ministry of Natural Resources, for access to the Crown Marsh, and Sandy Dobyn, John Marchington and Lyle Harper, with Ontario Parks, for access to Long Point Provincial Park. I would also like to thank Ray Ferris (Turkey Point Hunt Club), Emile Vandommele (Murray Marsh Hunt Club), Kim Brown (Lee Brown Wildlife Management Area) and David Walmsley (Long Point Company) for providing access to these private hunt clubs. Thanks also to Fin & Feather Marina for allowing me to launch canoes from their docks.

I would like to thank my advisor and friend Dr. Scott Petrie for providing support, encouragement, and trying to teach me to hunt turkeys; I have yet to bag one. I look forward to working and collaborating with Scott and LPW for many years to come. I would like to thank Dr. Shannon Badzinski for all of his statistical wizardry and wish him and his family much success in Ottawa. Much thanks to Dr. Michael Schummer for helping me through final revisions. I would also like to thank my scientific advisory committees at Long Point Waterfowl and the University of Western Ontario (UWO). Dr. Ken Abraham, Dr. Dave Ankney, Darrell Dennis, Dr. George Finney, Dr. Mark Gloutney, Shawn Meyer, and Rod Brook with LPW, and Dr. Hugh Henry, Dr. Chris Guglielmo and Dr. Jane Bowles at UWO. Thank you also to Dr. Bob Bailey for some early marsh bird discussions and improving my statistical abilities. Thanks to my fellow lab mates for all their tidbits of help: Rob Baden, Robin Churchill, Caroline Brady, Dave Messmer, Everett Hanna, Katie Stammler, and Sonja Teichert. Thanks to Carol Curtis at UWO for helping me keep my on campus school life organized.

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I received a lot of additional help, guidance and assistance from many people within LPW, BSC, OMNR, and EC. In order by organization: thanks to Ted Barney, Jim Cook (LPW); Stu MacKenzie, Yousif Attia, Ryan Archer, Kathy Jones, Dr. Phil Taylor, Anne Marie Ridout, Liane Varga, Andrew Couturier (BSC); Janice Gilbert, Kurt Olenburg, Silvia Strobl (OMNR); Andrew Taylor, Angela Darwin, Benoît Jobin, and Kim Laird (EC). Thanks also to Owen Steele for early guidance and discussions on waterfowl survey techniques and the possibilities of the relationship between waterfowl and Least Bittern habitat; it is now pretty safe to say there is!

Two people who really deserve a round of applause for all their assistance and guidance are: Jon McCracken and Laurie Maynard. Jon has been an inspiration, a wealth of knowledge and in a round-a-bout way, source of funding. Laurie gave me the ever so gentle nudge towards studying Least Bitterns and offered me work, which helped me to move back to Ontario; for this, my mum also thanks you. I am hugely indebted to the time and energy they put into this project and for all the long discussions on marsh birds, thank you!

I need to thank my fourth year honours undergraduate project advisor, Greg Michalenko. Without his encouragement to publish and present my thesis, I may not be in the situation I am in today; I wish him many fun adventures in his retirement. I would also like to thank Dr. Courtney Conway and Chris Nadeau of the University of Arizona, who put up with me for three fields seasons doing marsh bird point counts along the Colorado River and teaching me everything I know about identifying marsh birds.

I wish to thank all my friends and family for all their moral support and constant nagging for me to finish my thesis. Lastly, yet most importantly, I have to say thanks to my loving wife, of only 7 months, for allowing me to spend my summers away having fun chasing birds. She had to endure not seeing me for long periods of time and short phone calls during the summer months, all of which cut into her beach time, for this I apologize.

I will somehow try and make it up to you. I love you and look forward to growing old with you.

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LIST OF ABBREVIATIONS

BBS	Breeding Bird Surveys
BSC	Bird Studies Canada
CLGL	Canadian Lower Great Lakes
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
EC	Environment Canada
LPW	Long Point Waterfowl
MMP	Marsh Monitoring Program
NLBSP	National Least Bittern Survey Protocol
NWA	National Wildlife Area
OMNR	Ontario Ministry of Natural Resources
PP	Provincial Park
SARA	Species at Risk Act
SWOOP	South Western Ontario Orthophotography Project
UWO	University of Western Ontario
WMA	Wildlife Management Area

1.0 Introduction

1.1 Least Bittern Life History

The Least Bittern (*Ixobrychus exilis*) is the worldôs smallest heron (Poole et al. 2009) and includes 6 subspecies. The body length and mass of a Least Bittern is between 28 ï 36 cm and 36 g respectively (Poole et al. 2009). Males and females are similar in size, but are dimorphic in appearance; males having a contrasting black crown, nape, and back against the lighter coloured body. Use of large emergent wetlands by Least Bitterns and their brown and beige colours make them one of North Americaôs most inconspicuous birds (Weller 1961). Food items used by Least Bitterns include: small fishes, amphibians, insects, small mammals, and vegetable matter (Poole et al. 2009). In Ontario, Least Bitterns arrive on breeding grounds at the end of April (*personal observation*) and begin calling for females using a distinctive ñCoo-cooò call. Nests are built by bending live and dead vegetation around rigid plant stalks, usually 60 ï 90 cm above water (Poole et al. 2009). On average Least Bitterns lay 6 eggs (Ontario range = 3 ï 7 eggs, *personal observation)*. Least Bittern chicks leave the nest Ó6 days after hatch and fledge at 25 ï 27 days (Bogner and Baldassarre 2002, Poole et al. 2009).

1.2 Least Bittern Population Status

Despite the fact that Least Bitterns occur throughout much of North America and many areas of South America (Figure 1.1), little is known about their population dynamics or habitat use. This lack of knowledge can largely be attributed to the secretive nature of Least Bitterns (Weller 1961; Bogner and Baldassarre 2002; Poole et al. 2009), apparent declines in populations throughout North America (James 1999; Poole et al.

2009), and limited monitoring efforts. Least Bittern population declines in Canada led to the species being listed as Special Concern in 1988 and subsequent listing as Threatened in 2001 (COSEWIC 2009). North American Breeding Bird Surveys (BBS) suggest that the North American population of Least Bitterns decreased by 43% during 1984-1993 (Price et al. 1995). Subsequent to that, data from the Great Lakes Marsh Monitoring Program (MMP) suggest annual population declines of 6.7%, 12.8% and 14.4 % for Lakes Ontario, Erie and Huron, respectively, from 1995-2004 (Timmermans et al. 2008). However, population trends for Least Bitterns, derived from BBS and MMP may not be reliable because many of the survey stations are located along roads or shorelines, which may not provide an adequate survey of Least Bittern habitat (Butcher 1989). Also, Least Bitterns are often not detected in large multi-species surveys of bird populations because of their secretive nature; hence data on population trends are contradictory and potentially unreliable (Poole et al. 2009). Based on population data deficiencies, there is limited information on Least Bittern populations and habitat use throughout their range and in particular, Canada.

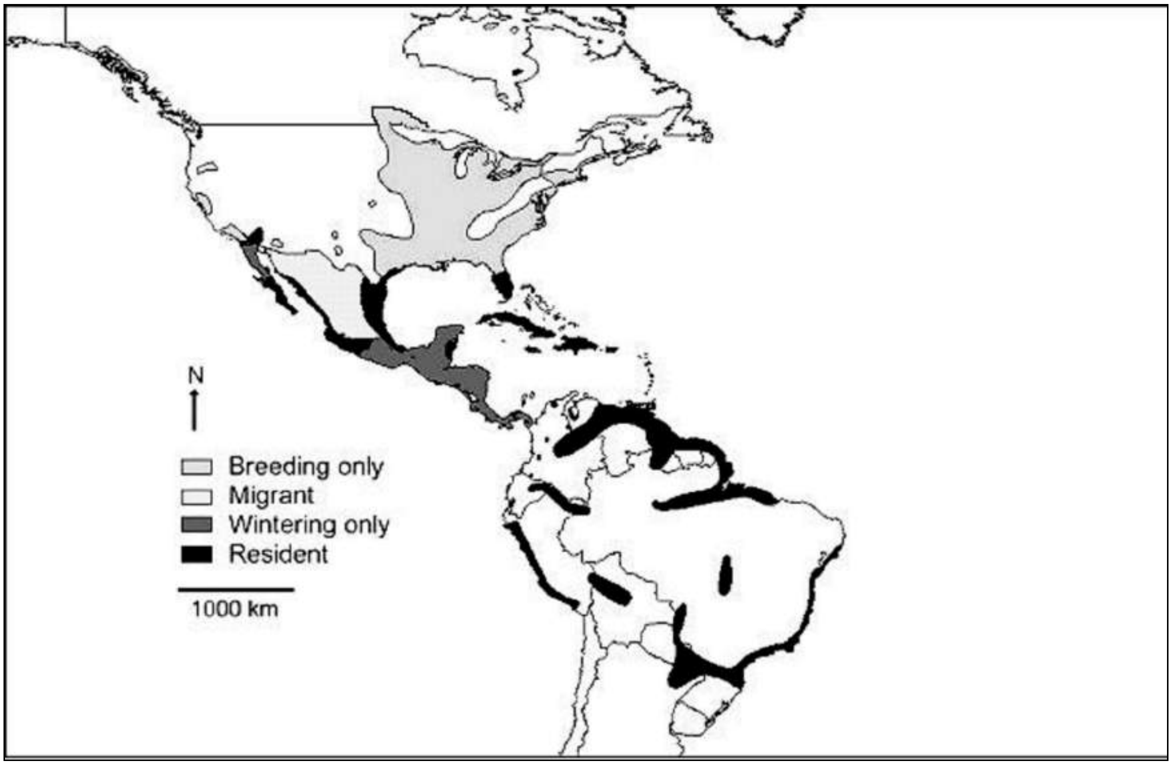

Figure 1.1 ï Global range of Least Bitterns (Committee on the Status of Endangered Wildlife in Canada - COSEWIC 2009).

1.3 Least Bittern Canadian Status

The Canadian breeding range of Least Bitterns (Figure 1.2) is limited to southern Manitoba, Ontario, Quebec, New Brunswick, and Nova Scotia. The first Ontario Breeding Bird Atlas in the mid-1980s (Cadman et al. 1987) and the Ontario Rare Bird Breeding Program (Austen et al. 1994) suggested a provincial population estimate of 555 - 2360 breeding pairs. However, too few point counts were conducted during the second Ontario Breeding Bird Atlas (2001 - 2005) to provide a reliable abundance estimate of Least Bittern breeding pairs (Cadman et al. 2007), although frequency of occurrence was similar to the first atlas project (Woodliffe 2007). Based on limited knowledge of Least Bittern abundance, distribution, and the Species at Risk listing in Canada, a Least Bittern

Recovery Team was established in 2004, as a requirement of the Species at Risk Act (SARA), to identify and address recovery issues. Since 2004, surveys targeted at estimating Least Bittern abundance were conducted in Manitoba and Quebec using the methodology outlined in draft versions of the National Least Bittern Survey Protocol (NLBSP; Jobin et al. In press), but surveys did not begin in Ontario until 2007. Using abundance data from Breeding Bird Surveys (BBS), Marsh Monitoring Program (MMP), Provincial Atlas data, and targeted surveys, the Least Bittern Status Report (COSEWIC 2009) estimated the population of Least Bitterns in Canada at 1500 breeding pairs.

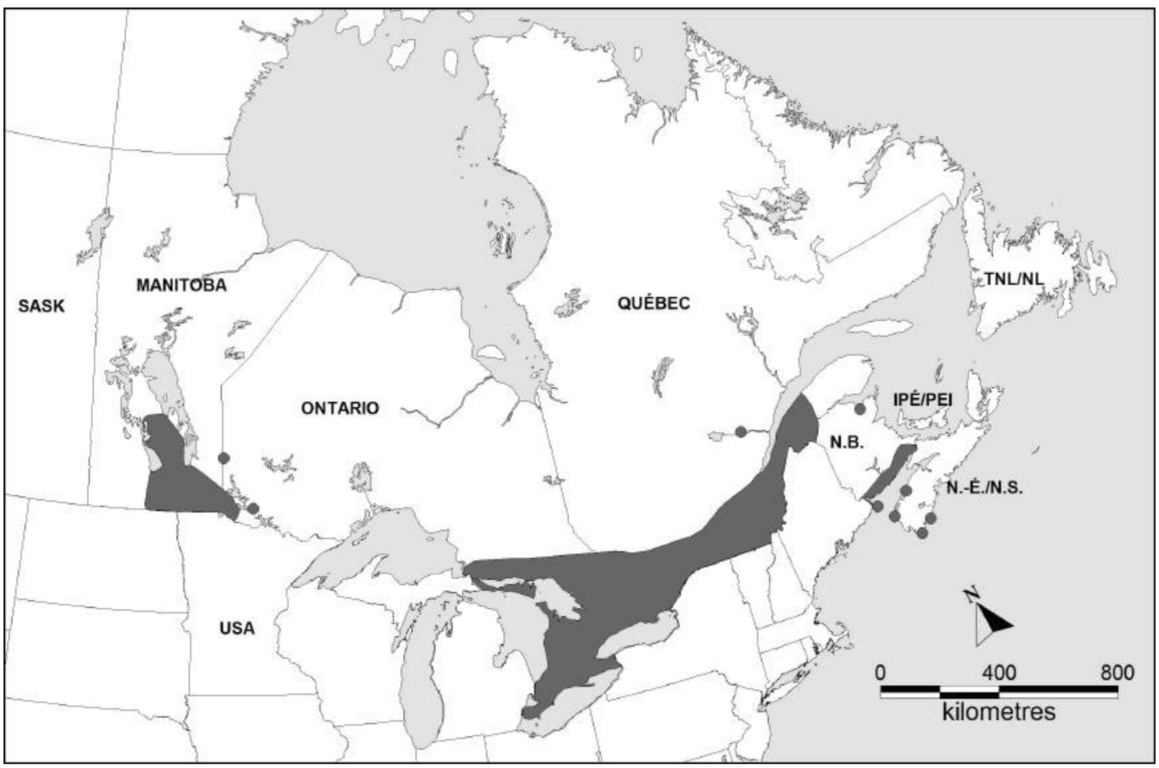

Figure 1.2 - Known distribution of the Least Bittern in Canada as of 2008; points indicate locations isolated from the known breeding range, where birds have been found during the breeding season (COSEWIC 2009).

1.4 Least Bittern Habitat

The Least Bittern is a migratory bird species listed under Schedule 1 of the federal Species at Risk Act because of its threatened status under COSEWIC, due to apparent historical declines throughout its Canadian range, potentially caused by the loss and degradation of wetland habitat. Least Bitterns require large patches of emergent wetland habitat (Poole et al. 2009), but many of these large wetlands have been drained or filled in the past century (Natural Resources Canada 2011; United States Environmental Protection Agency 2011). More than 90% of the original wetlands in southwestern Ontario are now gone (Ducks Unlimited Canada 2010) and less than 5% of western Lake Erieȏs original coastal wetlands remain (Herdendorf 1987). Anthropogenic influences are also impacting remaining wetland habitat in Ontario, including introduction of invasive species, channelization and water management, each with a myriad of effects that may or may not affect Least Bitterns.

Decreases in water levels in the lower Great Lakes are of concern because of potential wetland loss, degradation, and introduction of invasive species (Steen et al. 2006). Lake Erie in particular had a wide range of water level fluctuations from 1860 ï 2010 and stable levels during this study; however, general declining water levels from 1995 - 2002 (National Oceanic and Atmospheric Administration 2011). Least Bittern annual abundance indices from 1995 - 2002 are positively correlated to water levels in Lake Erie (Timmermans et al. 2008). Recent research using general circulation models to couple climate change scenarios with Great Lakes hydrologic models predict continued water level declines (Swartz et al. 2004). Also, Great Lakes coastal wetlands experience frequent changes in vegetation composition from fluctuations in climate and water levels (Leahy et al. 2005). Based on predicted changes in wetland community composition, it is important to identify habitat used by Least Bitterns so researchers can predict how future changes could influence Least Bittern populations and habitat use.

Phragmites australis (Cav.) Trin. ex Steudel *americanus* and *Phragmites australis* subsp. a*ustralis* (hereafter *Phragmites)* are tall cane-like perennial grasses that grow in aquatic, semi-aquatic, and terrestrial habitats (Marks et al. 1994), with the latter species being a non-native genotype. Although both species are similar in appearance and grow in the wetlands around Long Point, Ontario, *Phragmites* has expanded throughout many lower Great Lakes coastal wetlands (Catling and Carbyn 2006), including Long Point (Wilcox et al. 2003). The invasion of *Phragmites* is changing coastal wetland plant communities from diverse emergent marsh habitat to monotypic stands of *Phragmites* that may adversely affect waterbirds (Poole et al. 2009; Meyer et al. 2010). Therefore, wetland managers are concerned about *Phragmites* expansion and the effects it will have on waterbirds (Meyer et al. 2010).

Federal, provincial, and private agencies manage wetlands in an attempt to maintain a ôhemi-marshô state to benefit a diversity of wildlife. Weller and Spatcher (1965) first described hemi-marsh as a wetland with an equal ratio (1:1) of emergent cover and open water (cover-to-water ratios) distributed in an ñinterspersedò pattern. Interspersion is defined as the amount of mixing that occurs between the wetland features of vegetation and water. Interspersion can be measured by the amount (m/ha) of interface between vegetation and water (Rehm and Baldassarre 2007). Vegetation management is occurring on some Lake Erie coastal wetlands, primarily in the form of channelization, which increases interspersion. This management to increase interspersion could benefit Least Bitterns, but has yet to be studied in Canada.

1.5 Overall Study Objectives and Predictions

The Least Bittern population has apparently declined in Canada with the loss and degradation of wetland habitat in the last century; however, the status of the population in Ontario is currently unknown (Cadman et al. 2007). My first objective was to use the NLBSP to estimate the distribution and relative abundance of Least Bitterns in several study wetlands at Long Point (Table 2.1), Lake Erie. A study in 2007 using the NLBSP at 83 survey stations estimated 47 individual Least Bitterns in Big Creek National Wildlife Area and the eastern portion Long Point National Wildlife Area (Environment Canada unpublished data). Because I conducted Least Bittern surveys on the same 83 stations as the 2007 study and added 268 stations for a total of 351 in 2009, I predicted that I would detect over 200 individual Least Bitterns using the new survey protocol.

There is a lack of specific information pertaining to habitat use and wetland selection by Least Bitterns, particularly in Ontario (Environment Canada 2010). Least Bitterns most commonly occur in emergent wetlands with open water where ñhemi-marshò conditions exist and the dominant vegetation is Cattail (*Typha latifolia*; *T. angustifolia*; DesGranges *et al*. 2006; Budd 2007; Rehm and Baldassarre 2007; Poole et al. 2009). However, Least Bittern associations with specific plant community composition, percent cover or height of emergent vegetation, and interspersion values, are unknown. Wetland managers and conservationists need basic information on habitat use and association by wetland obligate wildlife to manage wetlands properly so that they support, maintain, and increase species diversity. My second objective was to determine habitat associations of Least Bitterns. I predicted that Least Bitterns would mainly use Cattail dominated habitats, because Cattail is the dominant emergent vegetation at Long Point and is commonly used by Least Bitterns (Weller 1961; Post and Seals 1993; Rodgers and Schwikert 1999; Bogner 2001). I also predicted locations used by Least Bitterns would be 50% Cattail and 50% open water (Hay 2006). I predicted Least Bitterns would use habitat with an equal mix of live and dead Cattail stems and a water depth of 20-80 cm (Weller 1961; Reid 1989; Post and Seals 1993; Bogner 2001). I predicted a negative relationship between relative abundance of Least Bitterns during the breeding season and *Phragmites* (Meyer et al 2010), as Least Bitterns do not typically associate with this invasive species. I also predicted that relative abundance of Least Bitterns would be related with interspersion at the wetland and survey station scales as Least Bitterns may be responding to interspersion at different scales (*sensu* Rehm and Baldassarre 2007). Results from this project will be used to identify Best Management Practices and help meet two of the priorities in the National Least Bittern Recovery Strategy: 1) estimate distribution and relative abundance of Least Bitterns in Long Point area wetlands and 2) identify habitat associations of Least Bitterns (Environment Canada 2010).

2.0 Methods and Experimental Design

2.1 Study Area

The Long Point region of northern Lake Erie (Figure 2.1) has been designated a World Biosphere Reserve, an Important Bird Area, and a Provincially Significant Wetland complex. The Long Point region comprises 26,250 ha of coastal wetlands and is an example of a Great Lakes coastal ecosystem with several habitats, including long uninterrupted beaches, undisturbed sand dunes, grass ridges, wet meadows, woods, emergent wetlands and ponds, cold water streams, and the shallow Inner Bay.

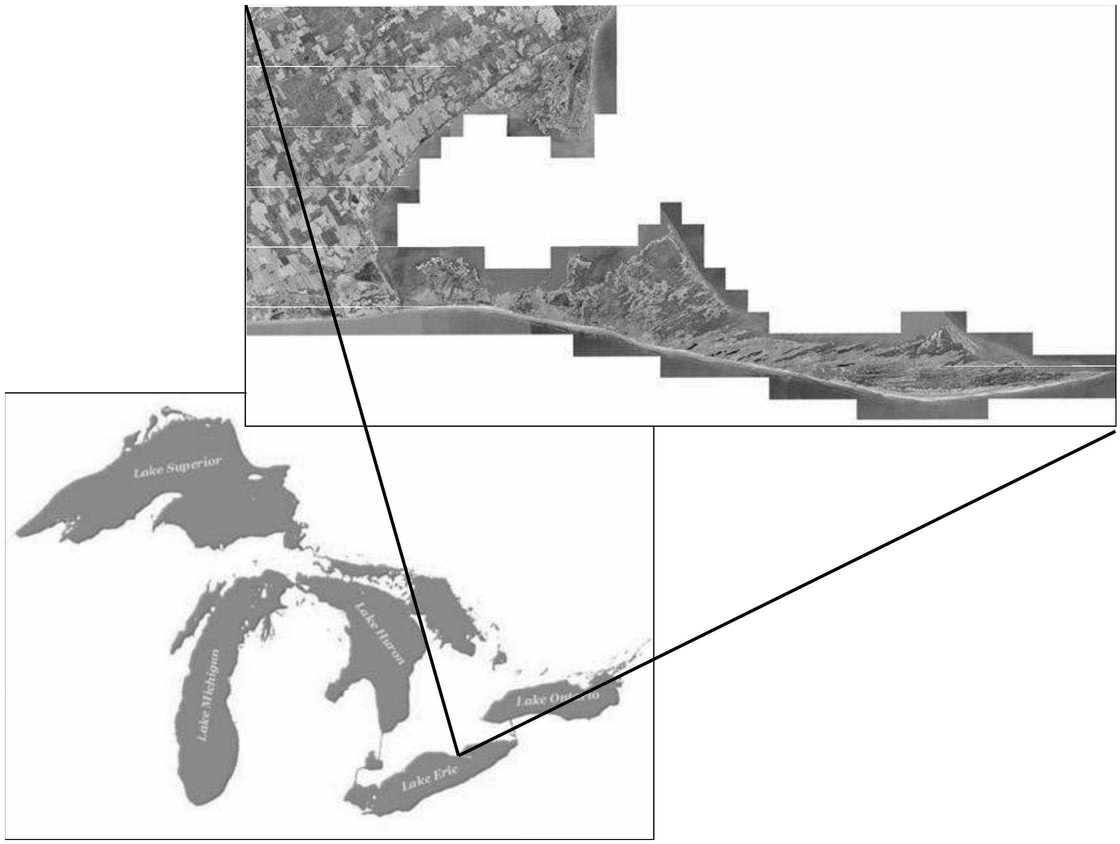

Figure 2.1 – Map of the Great Lakes Region (lower) and the Long Point Region (upper - Ontario Ministry of Natural Resources 2006) of Lake Erie, Ontario, Canada.

I sampled emergent wetlands within 6 independently managed properties in the Long Point Region for Least Bitterns in 2008 and 8 in 2009 (Figure 2.2, Table 2.1) and performed point counts at 193 and 351 survey stations in 2008 and 2009, respectively. The study wetlands are protected by federal, provincial, or private entities, which have resulted in limited overall loss of wetland size and function; however, levels and types of management vary by wetland (See Appendices 1 ï 8). Wetlands surveyed in 2008 included Turkey Point, Murray Marsh, Long Point Company (only a small portion, approximately 4%, of Long Point Company Marsh was surveyed due to limited access), Crown Marsh, Long Point Provincial Park and Long Point National Wildlife Area. In 2009, I added two study sites in the Big Creek National Wildlife Area, the Lee Brown Waterfowl Management Area and 4 additional study sites in Long Point National Wildlife Area to increase area surveyed. All of the surveyed wetlands have historical evidence of Least Bittern activity and/or breeding (Woodliffe 2007). Wetland size was approximated using air photos imported into ArcGIS (ESRI 2011). Air photos were taken as part of the South Western Ontario Orthophotography Project (SWOOP; Ontario Ministry of Natural Resources 2006).

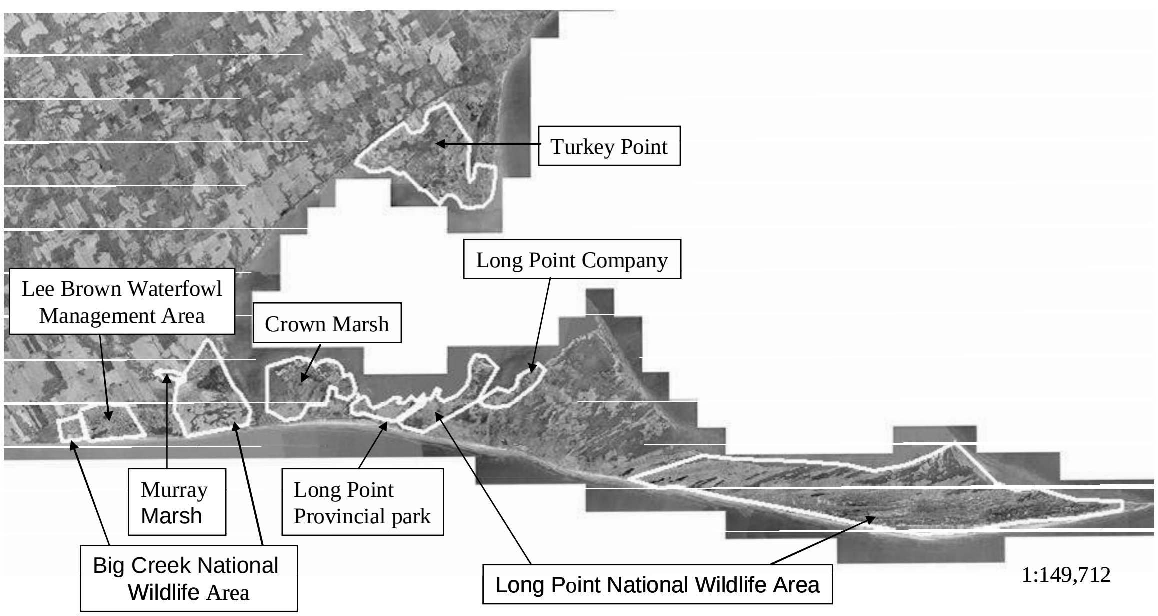

Figure 2.2 ï Map of Long Point region showing the eight independently managed properties. The non-bordered area in the centre of the Figure is also part of Long Point Company; I only had access to a small northwest portion.

Table 2.1 - Number of survey stations, number of routes, and size of the study wetlands in the Long Point Region of northern Lake Erie, Ontario, Canada.

	# of Stations 2008	# of Stations 2009	# of Routes	Area Surveyed (ha)[d]
Big Creek NWA[a]	N/A	38	5	665
Crown Marsh	54	55	6	518
Lee Brown WMA[b]	N/A	31	3	221
Long Point NWA	32	102	11	1013
Long Point PP[c]	15	15	2	111
Long Point Company	9	9	1	90[e]
Murray Marsh	12	12	1	22
Turkey Point	71	89	9	924

Notes

[a]NWA = National Wildlife Area

[b]WMA = Wildlife Management Area

[c]PP = Provincial Park

[d]Size is an approximation based on mapping used for interspersion analysis

[e]Long Point Company encompases roughly 2300 ha; I only had access to a small portion

2.2 Survey Station Setup and Call-broadcast

I visually inspected satellite images (Google Earth) and air photos (SWOOP data) to obtain information on wetland characteristics (i.e. channels and site access) and confirmed these characteristics by visiting wetlands. I established survey stations in each wetland at 250 m intervals (Jobin et al. In Press). Survey stations were positioned along routes, with a maximum of 12 stations per route, the number of survey stations that could be completed in one morning between 30 min prior to sunrise and 1000 hrs. One to nine survey routes were established depending on wetland size resulting in 20 and 38 routes during 2008 and 2009, respectively. Survey stations and routes were visited prior to conducting surveys to validate access and identify potential problems with station positioning. Survey stations and routes were positioned along wetland-open water interfaces and within stands of emergent vegetation (e.g. Cattail and *Phragmites*). If coverage of habitats could not be obtained using wetland-open water interfaces, survey stations were established and accessed by walking through wetland habitat (for example in the middle of a *Phragmites* stand). In some cases there were relatively large distances between survey stations (see Appendices 1 - 8), where non-emergent habitat (e.g. Grass and Sedge) allowed for detection of Least Bitterns at greater distances (Ribic et al. 1999). Survey stations were located using a Garmin Rhino® 130 handheld GPS unit with accuracy of 3-5 m. The number of survey stations per wetland also was dependent on the size of the wetland (range = 6 ï 89 stations). Co-ordinates were recorded for each survey station and stations were marked with flagging tape to ensure survey locations were standard among visits. Maps showing survey stations were created in Google Earth to assist surveyors with locating stations and accessing sites. Survey routes were travelled by foot, canoe, and motorized boat.

Call broadcasts following the NLBSP were conducted at each survey station and were full circular plots. Call broadcasts were unlimited-radius point counts (i.e. all Least Bitterns heard or seen, regardless of distance, were recorded), utilizing call response broadcasts to elicit responses from Least Bitterns. I provided pre-season training of survey protocol methods to technicians. Surveys were conducted from 5 June to 15 July 2008 and 20 May to 22 July 2009. A minimum of 2 visits were made to each survey station in 2008 (47 of 193 survey stations were completed three times), and 3 visits were made to each station in 2009. At least 3 surveys are needed to confirm with 90% certainty seasonal presence/absence of some wetland birds (Gibbs and Melvin 1993). Visits were Ó10 days apart to decrease frequency of disturbance to nesting birds. Surveys were not conducted in rain, fog, extreme heat (>35 degrees Celsius) or winds exceeding 15 km/h (Conway 2009). Wind and temperature were measured using a Kestrel 2500 meter (Nielsen-Kellerman, Inc., Boothwyn, PA, USA).

Surveys were 13 min in length and consisted of 5 min of passive listening, 5 min of call broadcast (each minute included 30 sec of the Least Bittern óCooô call and 30 sec of silence), and 3 minutes of passive listening (Jobin et al. In Press). Least Bittern calls were broadcast at a sound pressure of 90 decibels measured with a portable sound meter at 1 m in front of the speakers and were played at or just above water level from a portable MP3 player and óclamô speakers. Surveyors worked in pairs to increase the likelihood of Least Bittern detection (Conway 2009). Because call types have been suggested as a way to differentiate among mate attraction (óCooô call), mate communication/alarm (óKakô call); and alarm (óErtô call; Conway 2009) surveyors noted calls heard during survey broadcasts and type of call.

<u>2.3 Habitat Assessments and Interspersion</u>

2.3.1 Circular Plots (Macrohabitat)

In 2009, at each survey station (*n* = 351), I visually estimated percent cover of 8 vegetation types and 3 non-vegetative features within 50 m of the centre of the survey station (i.e. 100 m diameter plots). I designated the 8 dominant vegetation types as Cattails (*Typha* spp.), Sedges and Grasses (*Carex* spp.; Poaceae), Burreeds (*Sparganium* spp.), Bulrushes (*Scirpus* spp.), Common Reeds (*Phragmites* spp.), Shrubs and Trees, Floating Vegetation and Other species. The dominant shrub encountered was Alder (*Alnus* spp.), the dominant tree was Willow (*Salix* spp.), and the dominant floating vegetation was Yellow Pond Lily (*Nuphar lutea*) and White Water Lily (*Nymphaea odorata*). The 3 non-vegetative features were Bare Soil, Open Water, and Man-made Structure. I estimated percent cover of habitat features (Conway and Sulzman 2007) for areas with boat access by standing on the bow of a boat. For land based survey stations, I estimated percent cover of habitat features by standing at the middle of the survey station or from a nearby elevated location (i.e. walking up a hill or standing on a car).

2.3.2 Quadrats and Water Depth (Microhabitat)

In 2009, microhabitat and water depth assessments were conducted at all survey stations where one or more Least Bitterns were detected within 50 m of the survey station and one additional randomly selected survey station where a bittern was not detected in the same study wetland. I also assessed microhabitat and water depths at 2 randomly selected survey stations along survey routes with no Least Bittern detections.

I assessed habitat along four 50 m transects at each selected survey station. I selected a random transect direction for each quarter of a circle, for a total of 4 transects per circle (i.e. 0-90, 91-180 181-270, and 271-360 degrees). I measured water depth every 10 m (0, 10, 20, 30, 40 and 50 m) along transects (n = 21 water depths per habitat assessment). I placed a 1 m^2 quadrat randomly at 1-25 m and another at 26-50 m along each transect (n = 9 quadrats per habitat assessment). I counted the number of stems and maximum stem height of all live and dead vegetation types within each quadrat.

2.3.3 Interspersion

Air photos were acquired from SWOOP, which flew air photo transects in 2006 to produce 1 km^2 tiles for all of southwestern Ontario with a 0.3 m × 0.3 m resolution. To acquire a measure of interspersion at the wetland scale I created an air photo mosaic or orthophoto for each study site using PCI Geomatica 10 (PCI Geomatics Enterprises Inc. 2007). I extracted the study sites from the orthophotos using the ArcMap 9.3 extract function and performed a supervised image classification by setting training sites for water and vegetation using PCI Geomatica 10. To test the accuracy of the image classification I performed a post-classification analysis by selecting 200 random pixels and determined whether each pixel was classified correctly. Lastly, I filtered the image in IDRISI Kilimanjaro (Eastman 2003) to remove scattering of individually associated water or vegetation pixels and used the PERIM function to get a measure of edge length (m).

To determine interspersion at the survey station scale, I first imported the survey stations into ArcMap 9.3 and converted them from vector to raster format. Second, I created a uniquely identified 50 m buffer around each survey station. Third, I combined (or overlaid) the resulting buffer image and the classified wetland scale image. Lastly, I used the PERIM function to get a measure of edge length (m) for each survey station in each wetland. At the survey station scale, I used IDRISI Kilimanjaro to obtain edge length (m) for each survey station. Interspersion values are expressed as m / ha (Rehm and Baldassarre 2007).

2.4 Data Analysis

2.4.1 Relative Abundance of Least Bitterns

Relative abundance of Least Bitterns at the wetlands scale was determined as the maximum number of Least Bitterns detected for each survey route across the 3 route visits and summing all routes within a wetland (Ralph et al. 1995). Relative abundance is presented as the number of Least Bitterns per survey station (birds / survey station). I chose this method of estimating relative abundance because it takes into account temporal variation in detection and ensures 90% confidence in abundance estimates (Gibbs and Melvin 1993). Detection of bitterns may not have been independent among stations (i.e. the same individual Least Bittern may be detected at multiple survey stations); thus, surveyors used directional spot mapping to identify when detections of Least Bittern were likely unique (Conway 2009). Estimated relative abundance was determined for the survey station scale as the maximum number of Least Bitterns detected within 50 m for each survey station for each visit.

To estimate the number of Least Bittern pairs at Long Point, Lake Erie and in the CLGL coastal wetlands, I first used the maximum number of detections using the ćCooô call for each survey station and summed all the stations. Second, I assumed each male detected had a mate, giving a number of pairs / ha in wetlands surveyed. Thirdly, I determined how much wetland habitat at Long Point was not surveyed during this study and extrapolated to provide an estimate of pairs at Long Point. Lastly, I used the number of Least Bittern pairs / ha at Long Point, assumed Least Bittern densities at Long Point were representative of all CLGL coastal wetlands, and extrapolated to an estimated number of pairs in all CLGL coastal wetlands. I estimated the Least Bittern population in the CLGL using 2009 data only, as greater area was surveyed and was surveyed more thoroughly (n = 3 visits per station; *sensu* Gibbs and Melvin 1993).

2.4.2 Presence / Absence Macrohabitat

I used stepwise binary logistic regression to identify vegetation types influencing Least Bittern presence within macrohabitat circular plots. I designated Least Bittern presence or absence as my response variable and the percent cover of the 11 vegetation and non-vegetation features were the explanatory variables. All 11 vegetation and non-vegetation independent variables were included in initial models and removed in a stepwise manner until only significant variables remained (Ŭ= 0.10; SPSS 18.0). Second, I used independent sample t-tests to compare the percent coverage by each vegetation type or non-vegetative feature between stations at which we detected Least Bitterns and those lacking Least Bitterns (Ŭ= 0.10; SPSS 18.0).

2.4.3 Presence / Absence Microhabitat

To determine if presence / absence of Least Bitterns was influenced by microhabitat features I first averaged the results of the 9 quadrats and 21 water depth measurements for each 50 m radius habitat assessment. I removed inter-correlated habitat variables prior to the stepwise binary logistic regression process by inspecting pair-wise scatterplots and correlation matrices. Where habitat variables were correlated ($r > 0.6$), I kept the variable with the greatest correlation to the response variable (Green 1979). I then subjected microhabitat variables associated with vegetation types retained in the macrohabitat analysis to a stepwise binary logistic regression (Ŭ= 0.10; SPSS 18.0). Each vegetation variable had 5 associated explanatory variables: percent cover, number of stems live, number of stems dead, maximum height of live stems and maximum height of dead stems. Whether a Least Bittern was detected or not (within 50 m of the survey station) was the response variable.

2.4.4 Relative Abundance, Macrohabitat, and Interspersion

To analyze the relationship between relative abundance of Least Bitterns and interspersion at the wetland scale, I performed a linear regression (Ŭ= 0.10; SPSS 18.0), using interspersion of the study wetland as the response variable and relative abundance of Least Bitterns as the explanatory variable. Outliers were determined by creating a box plot in SPSS 18.0.

At the survey station scale, I applied generalized linear mixed models to relative abundance data, incorporating habitat variables identified as influencing presence of Least Bitterns and interspersion (PROC GLIMMIX; SAS Institute Inc. 2008) Because data were skewed, I modeled the data as a Poisson distribution function using the Log Link function. I blocked by wetland (random effect) and designated habitat variables as fixed effects. My initial model included linear and quadratic relationships, interspersion, and the interaction between habitat variables and interspersion. Type 3 sum of squares were evaluated and the initial models were reduced using backwards elimination (Ŭ= 0.10). I assessed over dispersion using the ratio of the generalized chi-square statistic and its degrees of freedom (SAS Institute Inc. 2008). A ratio close to 1 indicates variability in data has been properly modeled and little residual over dispersion (Schabenberger 2007). To ensure no statistical redundancy, I inspected correlation matrices before running models.

3.0 Results

3.1 Relative Abundance

In 2008, I conducted 433 point count surveys at 193 survey stations within 6 individually managed properties and detected Least Bitterns on 272 occasions. I estimated that 96 unique Least Bitterns were detected. The Turkey Point Marsh had the greatest relative abundance (0.62 birds / survey station), whereas the Murray Marsh had the least (0 birds / survey station - Figure 3.1). Mean relative abundance in 2008 for all study wetlands was 0.51 birds / survey station.

In 2009, I conducted 1026 point count surveys at 351 survey stations in 8 individually managed properties and recorded 712 detections of Least Bitterns. I estimate that 197 unique Least Bitterns were detected of which 118 or 61% were detected by the óCooô call, 32 were detected by the óKakô call (16%), 22 by the óErtô call (11%) and 24 by sight only (12%). The Crown Marsh had the greatest relative abundance (0.98 birds / survey station), whereas the Lee Brown Waterfowl Management Area had the least (0.07 birds / survey station ï Figure 3.1). Mean relative abundance in 2009 for all study wetlands was 0.58 birds / survey station.

Using the estimated number of male Least Bitterns detected (using the óCooô call and not including birds detected by sight only) and assuming a mate accompanied each male, I estimate 118 pairs in the Long Point study wetlands in 2009. Because I only surveyed 90 of the available 2300 ha in Long Point Company, and assuming that the 3 male Least Bitterns detected at the 9 survey stations in 2009 in Long Point Company were representative of the entire wetland, I estimate 77 males (or pairs) within the Long Point Company. Thus, the Long Point Region contains 195 pairs of Least Bitterns or

13% (195 of 1500) of the COSEWIC estimated Canadian population. Extrapolating from the 195 pairs of Least Bitterns in the Long Point Region, I estimate that the 42259 ha of coastal wetland (Environment Canada 2003) in the CLGL may contain 1434 pairs of Least Bitterns.

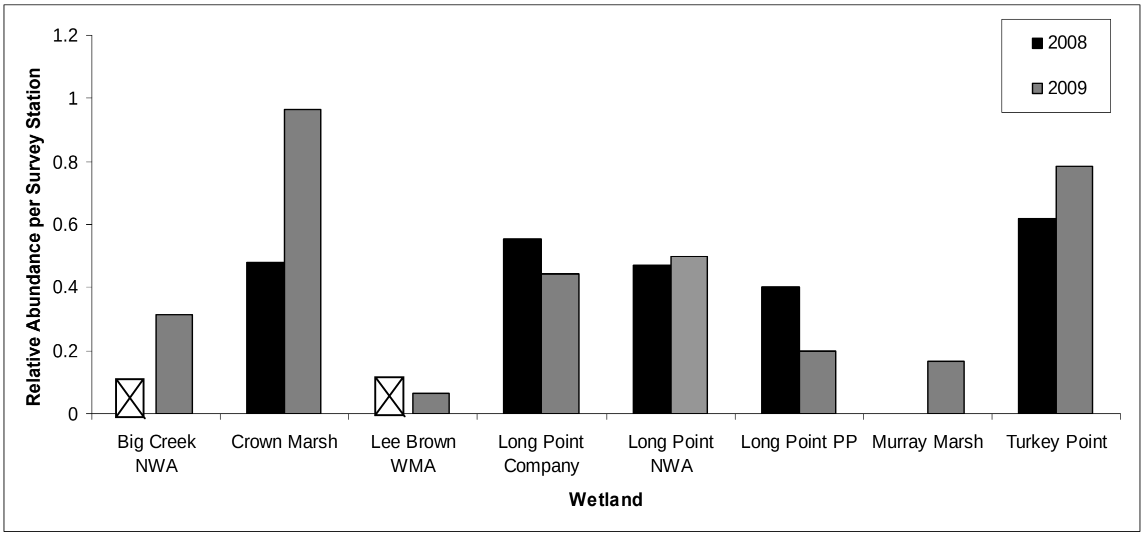

Figure 3.1 – Estimated relative abundance per survey station of Least Bittern by wetland and year. Big Creek National Wildlife Area (NWA) and Lee Brown Waterfowl Management Area were not surveyed in 2008 ï denoted by a box with an X. Least Bitterns were not detected in Murray Marsh in 2008.

3.2 Presence / Absence Macrohabitat

I conducted 1053 point counts and recorded 712 detections (sight or aural) of Least Bitterns of which 197 were determined to be unique individuals. I assessed macrohabitat percent cover at 351 survey stations using a 50 m radius circular plot buffer. I used 344 50 m radius circular plots in analyses because 7 plots contained areas where not all habitat types could be determined because they were not visible. Probability of detecting a Least Bittern varied positively with Cattail (Table 3.1), Bulrush and Open Water. For each 10% increase in Cattail cover from 10 ï 70%, the average predicted likelihood of detecting a Least Bittern increased by 10.2% (Figure 3.2), assuming mean percent cover values for Bulrush ($\bar{x}$ = 2.6%) and Open Water ($\bar{x}$ = 24.2%). Survey stations where I detected Least Bitterns within 50 m differed in vegetation composition compared to survey stations where I did not (Table 3.2).

Table 3.1 – Results of the stepwise binary logistic regression of the 50 m circular plot macrohabitat percent cover data. Least Bittern presence or absence was the response variable and the percent cover of the 11 vegetation and non-vegetation features were the explanatory variables (*n* = 344).

Effect	Estimate	Error	DF	*P*	X^2	Lower CI	Upper CI
Intercept	-2.653	0.467	1	<0.001	32.205		
Cattail	2.887	0.663	1	<0.001	18.970	0.780	1.727
Bulrush	4.291	1.897	1	0.024	5.117	0.509	3.219
Open Water	1.371	0.686	1	0.046	3.988	0.105	1.085

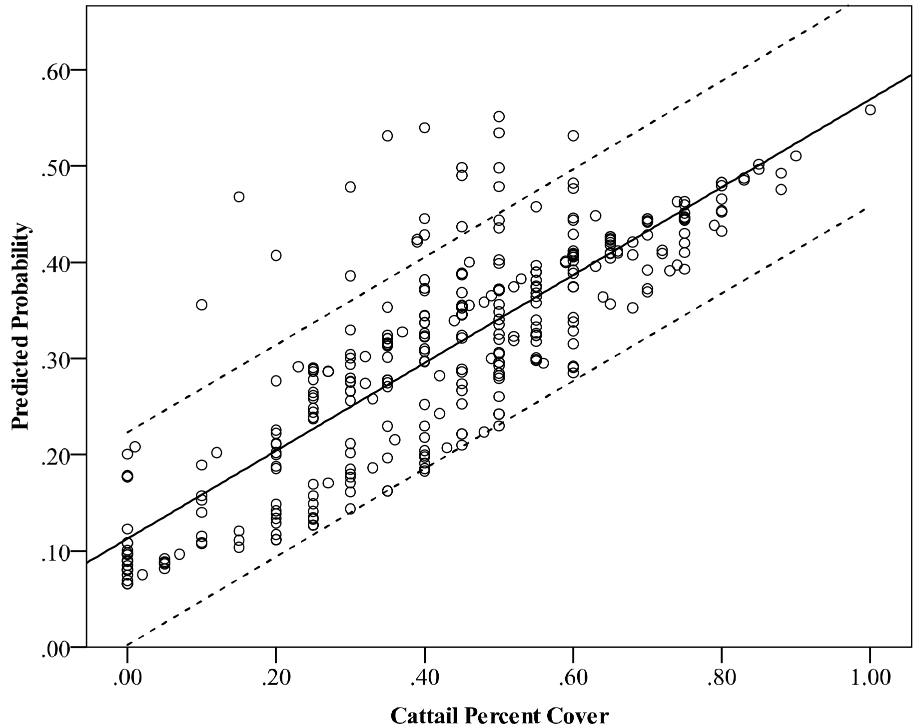

Figure 3.2 – Relationship between the predicted probability of Least Bittern presence and the observed proportion of Cattail percent cover (n = 344, u = 49.2%) using the 50 m Circular Plot data. Confidence intervals (90%) represented by dashed lines.

Table 3.2 – Results of the independent sample t-test of the 50 m circular plot data showing mean percent cover compared to presence / absence of Least Bitterns within 50 m of the survey station using 11 explanatory variables (n = 344).

All Stations		Survey Stations with Least Bitterns n = 105					Survey Stations without Least Bitterns n = 239						
					Range (%)					Range (%)			
Cover Type	Cover (%)	Cover (%)		SE	Low	High	Cover (%)		SE	Low	High	t	*P*
Cattail	42.1	49.2	±	2.0	0.0	100.0	39.1	±	1.4	0.0	88.0	4.085	<0.001
Trees and Shrubs	3.9	1.9	±	0.5	0.0	25.0	4.8	±	0.7	0.0	60.0	3.533	<0.001
Sedge and Grass	6.0	3.3	±	0.9	0.0	50.0	7.2	±	1.0	0.0	75.0	2.903	0.004
Phragmites	9.2	6.1	±	1.2	0.0	65.0	10.6	±	1.1	0.0	75.0	2.726	0.007
Other	0.8	0.4	±	0.1	0.0	10.0	1.0	±	0.3	0.0	29.0	2.072	0.039
Floating Vegetation	4.4	3.4	±	0.6	0.0	28.0	4.9	±	0.5	0.0	45.0	1.939	0.054
Bulrush	2.6	3.3	±	0.7	0.0	35.0	2.3	±	0.4	0.0	30.0	1.258	0.210
Open Water	24.2	25.7	±	2.2	0.0	76.0	23.6	±	1.5	0.0	75.0	1.079	0.281
Man-made Structure	0.3	0.2	±	0.1	0.0	10.0	0.4	±	0.1	0.0	20.0	0.800	0.424
Burreed	0.3	0.3	±	0.2	0.0	10.0	0.3	±	0.1	0.0	10.0	0.379	0.705
Bare Ground	0.3	0.3	±	0.2	0.0	13.0	0.3	±	0.1	0.0	25.0	0.198	0.843

3.3 Presence / Absence Microhabitat

I conducted 211 habitat assessments using quadrats and measured water depth at survey stations where at least one Least Bittern was detected (*n* = 97) and where none were detected (*n* = 114). The range of mean water depths at survey stations where Least Bitterns were detected was 2.96 ï 107.83 cm ($\bar{x}$ = 54.4 cm), and mean water depths at stations were bitterns were not detected ranged from 3.92 ï 111.17 cm ($\bar{x}$ = 49.3 cm). I analyzed Cattail and Bulrush microhabitat variables because they were retained in the macrohabitat assessment of Least Bittern presence / absence (See Section 3.2). Height of dead Cattail was removed due to high correlation with number of dead Cattail stems. The number of dead Cattail stems (Table 3.3, Figure 3.3) was retained in the analysis. Probability of detecting a Least Bittern varied positively with the number of dead Cattail stems (Table 3.3).

Table 3.3 – Results of the stepwise binary logistic regression of the 50 m circular plot microhabitat quadrat data. Least Bittern presence or absence was the response variable and the measurements of the 10 vegetation features were the explanatory variables (*n* = 211).

Effect	Estimate	Error	DF	*P*	X^2	Lower CI	Upper CI
Dead Cattail Stems	0.022	0.007	1	0.001	11.398	0.005	0.014
Intercept	-0.849	0.247	1	0.001	11.857		

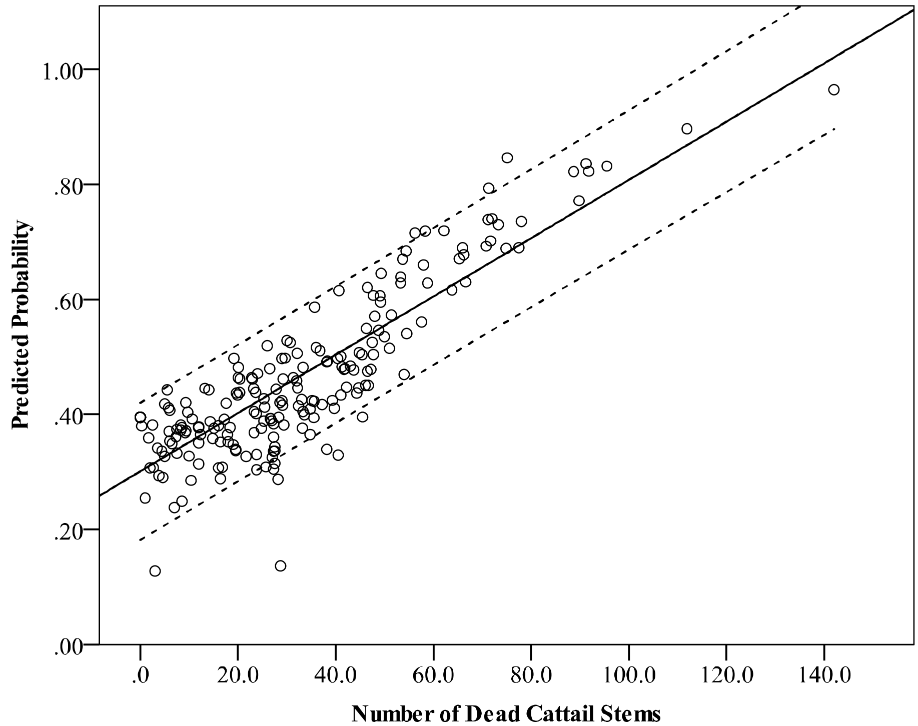

Figure 3.3 – Relationship between the predicted probability of Least Bittern presence and the observed number of dead Cattail stems (*n* = 211, *u* = 31.33, SD = 23.82) using microhabitat quadrat data. Confidence intervals (90%) represented by dashed lines.

3.4 Relative Abundance, Macrohabitat, and Interspersion

3.4.1 Wetland Scale

I determined interspersion values (m / ha) for 12 study sites within the 8 individually managed properties at the wetland scale (Table 3.4). I did not assess interspersion for the eastern portion of Long Point National Wildlife Area due to difficulty in differentiating between wetland area and terrestrial habitats using air photos. There was no influence of interspersion on relative abundance of Least Bitterns at the wetland scale (P = 0.80). To determine if an outlier (Big Creek NWA ï Table 3.4) skewed the results, I removed the outlier from the analysis but the results remained non-significant (P = 0.31).

Table 3.4 – Individually managed properties and study sites indicating relative abundance in 2009 (birds / survey station), size and interspersion values.

Sites/Wetlands	Relative Abundance	Size (ha)	Interspersion (m / ha)
Crown Marsh	0.96	518.4	1658.7
Long Point NWA - Gravelly Land[a]	0.83	36.6	745.4
Turkey Point	0.79	924.3	1729.6
Long Point NWA - Squires Land	0.67	25.0	575.5
Long Point NWA - Thoroughfare Point	0.48	427.2	422.6
Long Point Company	0.44	90.1	804.2
Big Creek NWA	0.35	597.7	4010.5
Long Point NWA - Eastern Portion	0.33	481.8	N/A[b]
Long Point PP[c]	0.20	111.4	1690.7
Murray Marsh	0.17	22.3	1031.3
Big Creek NWA - The Hahn	0.17	67.3	532.6
Long Point NWA - Squires Cabin	0.10	42.7	659.4
Lee Brown WMA[d]	0.07	221.3	756.0

Notes

[a]NWA = National Wildlife Area
[b]Not Determined
[c]PP = Provincial Park
[d]WMA = Wildlife Management Area

3.4.2 Survey Station Scale

At the survey station scale, I determined relative abundance and macrohabitat percent cover data at all survey stations (*n* = 351). I removed survey stations from analysis due to missing macrohabitat data, pond dredging near a survey station after air photos were taken, mapping errors, and indiscernible interspersion values (Crown Marsh *n* = 4, Lee Brown WMA *n* = 3, Turkey Point *n* = 1, Long Point NWA ï Squire Cabin *n* = 2, and Long Point NWA ï Eastern Portion *n* = 42). Thus, I was able to determine interspersion values (m / ha) and conduct analyses using 299 survey stations. I analyzed Cattail and Bulrush macrohabitat variables because they were retained in the macrohabitat assessment of Least Bittern presence / absence. Percent cover of Cattail and Bulrush, and interspersion were retained in the analysis (Table 3.5). Relative abundance of Least Bitterns varied positively with percent cover of Cattail (range = 0 ï 90%) and Bulrush (range = 0 ï 35%), as well as interspersion (range = 0 - 12208 m / ha). An increase of 0.68 Least Bitterns / station is predicted by the model when Cattail is increased from 0 to 90% with Bulrush ($\bar{x}$ = 2.6%) and interspersion ($\bar{x}$ = 1667.1 m / ha) are held constant. When interspersion is varied from 0 to 12208 and Cattail ($\bar{x}$ = 42.1%) and Bulrush are held constant an increase of 0.64 least bitterns / station is predicted. However, if cattail and interspersion are both maximized (i.e. 90% and 12208 m / ha, respectively) the model predicts an increase of 2.15 least bitterns / station from mean conditions (i.e. 42.1% cattail and 1667.1 m / ha interspersion).

Table 3.5 – Results of the Generalized Linear Mixed Model of Relative Abundance, Cattail, Bulrush, and Interspersion. Data modeled as a Poisson distribution function using the Log Link function of Proc GLIMMIX in SAS 9.2. Wetland was blocked as a random effect and all other variables as fixed. The initial model included linear and quadratic relationships and the interaction between habitat variables and interspersion. Type 3 sum of squares were evaluated and the initial models were reduced using backwards elimination (Ŭ= 0.10).

Effect	Estimate	Error	DF	*P*	Lower CI	Upper CI
Intercept	-2.363	0.3449	9	<0.001	-2.407	-2.318
Cattail	2.101	0.4967	286	<0.001	2.039	2.164
Bulrush	3.247	1.4960	286	0.031	3.058	3.435
Interspersion	0.000	0.0001	286	0.096	0.000	0.000

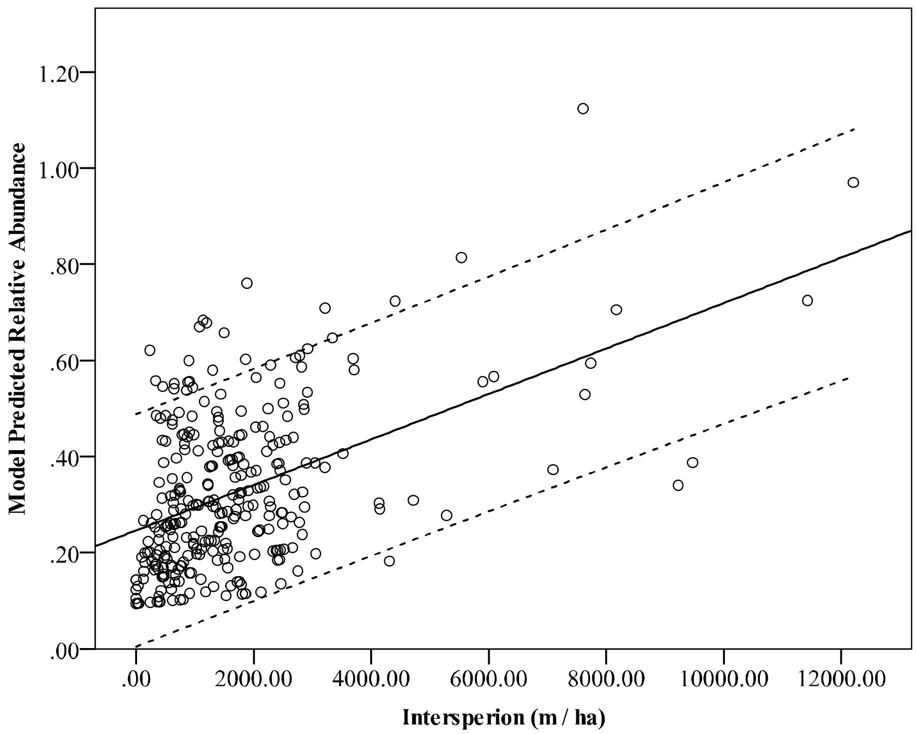

Figure 3.5 – Relationship between the model predicted relative abundance of Least Bittern and the calculated interspersion value (n = 299, u = 1667.10). Confidence intervals (90%) represented by dashed lines.

4.0 Discussion

4.1 Relative Abundance and Population

Historical surveys for Least Bitterns (i.e. BBS and MMP) do not provide reliable estimates of abundance, because they do not adequately survey Least Bittern habitat (Butcher 1989; Tozer 2007). Greater understanding of Least Bittern distribution and abundance would facilitate well-informed SARA policy and species designation decisions. In addition to information on distribution and abundance, an understanding of wetland habitat-Least Bittern associations would facilitate effective management of wetlands for Least Bitterns breeding in Canada. The NLBSP was created to increase precision of distribution and abundance estimates for Least Bitterns. In this study I used the NLBSP at Long Point, Lake Erie and demonstrated that use of the survey protocol resulted in substantial increases in detection when compared to MMP, which also conducted surveys at Long Point in 2008 and 2009 (0.12 birds / station and 0.08 birds / station in 2008 and 2009 respectively; Bird Studies Canada 2008). Results from my study supports previous suggestions that detections of Least Bitterns using the MMP may have been biased low because MMP does not survey appropriate Least Bittern habitat (Butcher 1989) and uses a different call broadcast technique from the NLBSP. The NLBSP protocol is designed to target Least Bitterns and increase detection probability compared to traditional methods such as passive listening (i.e. BBS) and multi-species call broadcasts (i.e. MMP) . For example, Least Bitterns may remain undetected with use of call-broadcasts < 30 sec, even if pairs of these birds nested within 25 m of call-broadcast locations (Tozer et al. 2007). The NLBSP methodology appears useful in detecting a greater number of Least Bitterns and should provide more accurate estimates of Least Bittern abundance.

The estimated population of Least Bitterns in Canada was recently increased from 1000 pairs to 1500 pairs based on additional abundance data from use of the NLBSP (COSEWIC 2009). Data from the 2001-2005 Breeding Bird Atlas suggests there were 555 ï 2360 pairs in Ontario (Cadman et al. 2007). My estimated pair value within the CLGL (n = 1434) is within the range of the most recent Breeding Bird Atlas (Cadman et al. 2007); however, my pair estimate of Least Bitterns does not consider inland wetlands or other provinces. Therefore, the estimate of 1500 pairs of Least Bitterns used in SARA designation in Canada is potentially an underestimate. Additional surveys using the NLBSP throughout the Canadian breeding range of Least Bitterns may increase the accuracy of the estimated breeding population of these birds in Canada and in other countries; thus, increased use of the NLBSP is recommended. I also recommend assessing the ability of the NLBSP to detect Least Bitterns by directly comparing it to other marsh bird monitoring protocols such as the MMP or the Standardized North American Marsh Bird Survey Protocol (Conway 2009). Use of several survey methods at the same survey stations would provide a comparison of methodologies, which would help determine the effectiveness and efficiency of using a multi-species approach to surveying Least Bitterns compared to targeted species approaches. A protocol comparison study would help assess the survey intensity needed to monitor Least Bitterns and other wetland obligate species, which would be beneficial to conservationists in terms of budgeting and time constraints.

I detected relatively clumped distributions of Least Bitterns in certain wetland areas (Figure 4.1 and 4.2). Although the term ósemi-colonialismô is not defined clearly in the literature (Meyer and Friis 2008), previous studies in Ontario (Meyer and Friis 2008) and Florida (Kushlan 1973) have suggested that Least Bitterns may nest semi-colonially. Least Bitterns appeared concentrated in central areas of The Crown Marsh and Turkey Point Marsh and seemed to avoid coastal edges, in particular at Turkey Point Marsh (Figure 4.2). These high concentrations may suggest semi-colonialism at Long Point, Lake Erie. Nesting semi-colonially may provide selective advantages for Least Bitterns, such as minimizing predation risk (Burger 1981). Alternatively, clumped distributions of breeding pairs may be facilitated by greater interspersion in habitats selected by Least

Bitterns (Rehm and Baldassarre 2007). Increased interspersion may increase visual barriers leading to smaller; more closely associated and therefore clumped territories. Further study is necessary to determine if clumped distributions confer increased recruitment (i.e. selective advantage) or if the distributions we observed were a product of habitat selection and interspersion.

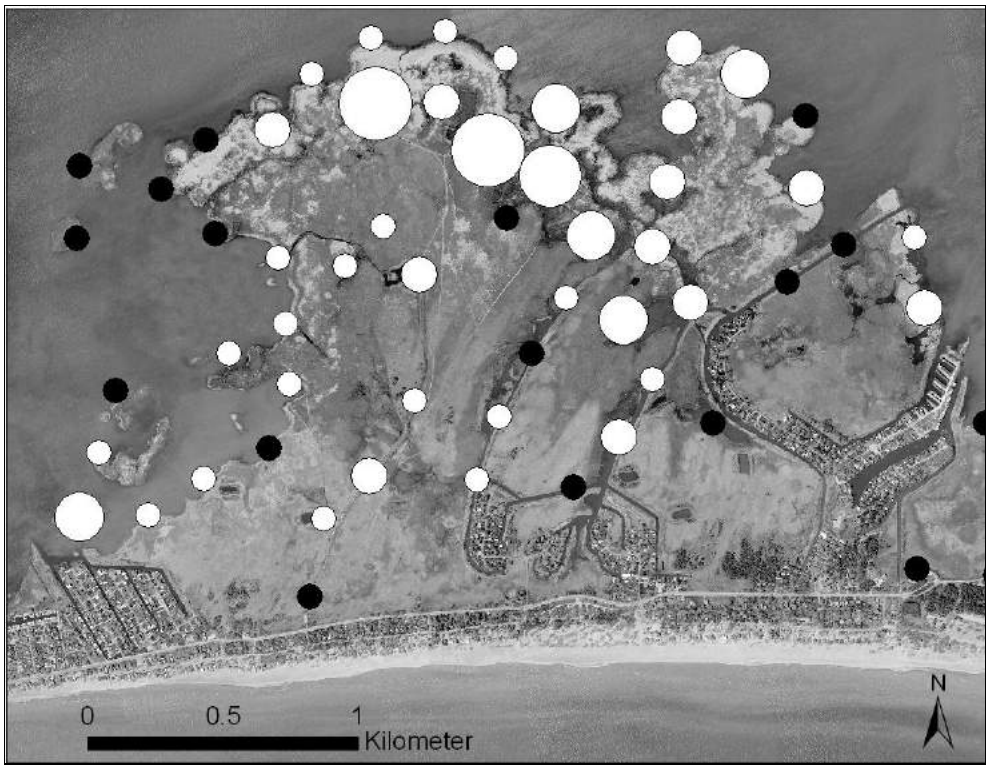

Figure 4.1 - Maximum relative abundance of Least Bitterns in the Crown Marsh by survey station, 2009; white circles represent the number of Least Bitterns detected at a survey station, range 1 (small) to 5 (large), black circles represent no detections.

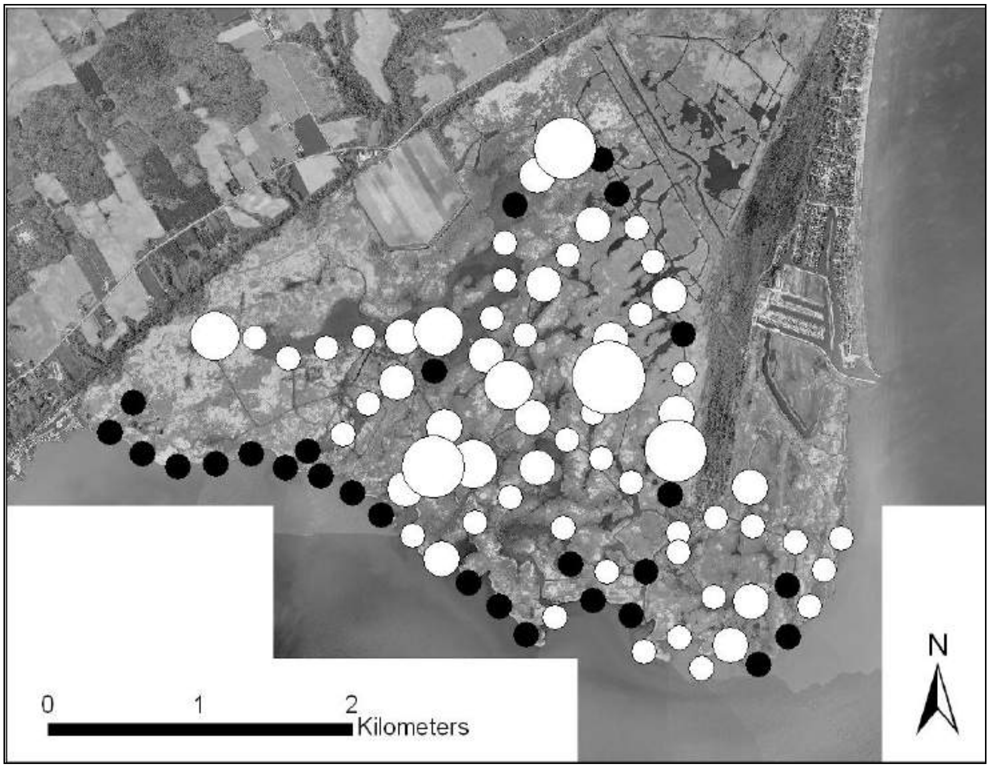

Figure 4.2 - Maximum relative abundance of Least Bitterns in the Turkey Point Marsh by survey station, 2009; white circles represent the number of Least Bitterns detected at a survey station, range 1 (small) to 5 (large), black circles represent no detections.

Survey methods that improve detection of avian species help increase accuracy of population estimates but also may provide a greater understanding of avian-habitat associations (Ralph et al. 1995; Carter et al. 2000). Determining habitat use by Least Bitterns in the CLGL may help increase accuracy of population estimate of these birds. In addition, determining Least Bittern habitat preferences would provide habitat management guidance to conservationists attempting to increase habitat suitability and availability for these secretive marsh birds.

4.2 Habitat Associations

Traditional monitoring programs such as BBS and MMP do not survey Least Bitterns effectively because many of the survey stations are located along roads or shorelines, which may not provide an adequate survey of Least Bittern habitat (Butcher 1989). Thus, determinations of habitat associations of Least Bitterns were previously not possible and knowledge on habitat use and selection by these secretive birds was lacking (Poole et al. 2009). Identifying habitat requirements in Canada is one of the objectives listed in the Recovery Strategy for Least Bitterns (Environment Canada 2010). In this study I identified habitat variables that influenced the presence and relative abundance of Least Bitterns in coastal wetlands at Long Point, Lake Erie. Historical and continued loss and degradation of wetland habitat is thought to be the most severe threat to Least Bitterns (Sandilands and Campbell 1988; James 1999; Poole et al. 2009) with most loss and degradation due to anthropogenic causes (COSEWIC 2009). However, it is possible that current wetland management techniques, such as increasing interspersion (primarily for waterfowl), are beneficial to Least Bitterns on the CLGL. My results could be used to guide protection and management of remaining wetland habitat in Great Lakes coastal habitats to maximize the efficiency and effectiveness of these conservation efforts.

Use and selection of wetlands by Least Bitterns is often associated with presence and abundance of dense, tall stands of emergent vegetation (primarily Cattail and Bulrush; Weller 1961; Post and Seals 1993; Rodgers and Schwikert 1999; Bogner 2001). Similarly, Least Bittern presence and relative abundance in this study were positively influenced by percent cover of Cattail and Bulrush at Long Point. Additionally, my investigation of microhabitat features determined that Least Bitterns were associated with an increased abundance of dead Cattail stems. As far as I am aware, this study is the first to assess specific microhabitat features associated with the presence of Least Bitterns and the first to identify dead Cattail as influencing the presence of Least Bitterns during the breeding season. As dead Cattail is the dominant habitat feature when Least Bitterns return to breeding sites at Long Point, I hypothesize that greater relative abundance of Least Bitterns in areas with dead Cattail was related to rigid stems that they use as habitat cues for nest site selection, settling, and support of a relatively large nest (Poole et al. 2009).

Least Bittern presence has also been associated with dense, tall growths of aquatic vegetation (particularly Cattail and Bulrush and to a lesser extent *Carex* and *Sagittaria*) interspersed with clumps of vegetation and open water (Poole et al. 2009). In this study, Bulrush was associated with Least Bittern presence; however, Bulrush was generally associated with Open Water (i.e. emerging through Open Water areas; *personal observation*; Pearson Correlation = 0.76). Least Bittern nests have been found in Bulrush (Weller 1961); however, Bulrush was not the dominant vegetation type at Long Point, nor were there any Least Bittern nests found in Bulrush in this study (*personal observation*). My results suggest that Cattail is the best predictor of Least Bittern presence and relative abundance, but management of wetlands for increased wetland diversity which includes areas of Bulrush and Open Water may provide habitat for Least Bitterns.

Within the family Ardeidae, species that depend on marsh habitat for breeding, such as Least Bittern, are often associated with sites characterized by interspersion of open water and vegetation (Crewe et al. 2006; Rehm and Baldassarre 2007). In my study, interspersion was not an important predictor of relative abundance of Least Bitterns at the wetland scale but was found to be influential at the survey station scale (i.e. within 50 m of a survey station). Therefore, breeding Least Bitterns likely respond to interspersion within their home range rather than that of the entire wetland. Alternatively, a lack of relationship between relative abundance and interspersion at the wetland scale may be related to reduced statistical power (Coefficient of Variation = 0.81), partially resulting from my small sample of study wetlands (n = 12). Least Bittern response to interspersion at the survey station scale may suggest that interspersion and associated visual barriers facilitates a greater number of territories and foraging areas. It is probable that Least Bitterns select habitat based on both interspersion and vegetation composition as these attributes influence foraging availability and nesting habitat quality (Poole et al. 2009).

Trees, Shrubs, Grass, Sedge, and *Phragmites* were underrepresented in areas occupied by Least Bitterns, but I did not detect an influence of these habitat features on presence of Least Bitterns. In other studies, Least Bittern nests have been found in stands of *Phragmites* (Bent 1926; Dillon 1959; Jobin et al. In press). Least Bitterns may use *Phragmites* for nesting because of similarity in form and rigidness to dead Cattail, but, at Long Point, lack of positive association between *Phragmites* and Least Bittern presence and relative abundance suggests that *Phragmites* is not a functional replacement for Cattail (Meyer et al. 2010). Further, selection for Cattail relative to *Phragmites* may result from the relative availability of these two habitat types, whereby Cattail is selected when available in abundance and *Phragmites* is used secondarily. Nonetheless, encroachment by Trees and Shrubs, as well as rapid expansion of *Phragmites* may reduce availability of Cattail habitat and reduce wetland interspersion (Wilcox et al. 2003). My results suggest that reductions in Cattail coverage and interspersion would negatively influence the relative abundance of Least Bitterns at Long Point coastal wetlands. *Phragmites* may not be a functional replacement for Cattail by Least Bitterns and, given rapid expansion of *Phragmites* in lower Great Lakes coastal wetlands, active control of *Phragmites* would likely benefit Least Bitterns through maintenance of quality habitat (i.e. Cattail and interspersion). Future studies could use radio-telemetry to track habitat use and selection by Least Bitterns and determine nest success of these secretive birds among different habitat types (e.g. Cattail, *Phragmites*).

4.3 Sampling Errors and Assumptions

Results of this study may have been skewed by sampling and mapping errors, limitations or assumptions. Similar to many studies of wetland obligate bird species, Least Bitterns are usually detected aurally instead of visually, which limits the ability to effectively document relative abundance, establish what habitat the birds are using (including water depth), or estimate distance. Gibbs and Melvin (1993) report that marsh bird presence and absence can be determined within 90% accuracy after 3 surveys have been conducted during the breeding season. In this study, I completed 3 surveys on each survey route and used detections of Least Bitterns within the 50 m buffer around survey stations for presence / absence analyzes. I did this to increase the detection probability, as the further away a Least Bittern is from the survey station the less likely it is to be detected (*personal observation*). Additionally, habitat information (i.e. percent cover) was collected by 6 different people and in some cases not all the habitat features were visible when conducting the 50 m buffer percent cover plots. Plots where any amount of area was determined as óNot Visibleô (i.e. habitat could not be seen) were removed from the analysis to eliminate ambiguity in the data.

To estimate the number of Least Bittern pairs in the CLGL I had to make three assumptions: 1) every Least Bittern detected with the óCooô call was a male (Conway 2009), 2) each detected male had a mate, and 3) the number of males detected on one route at Long Point Company was representative of the entire wetland property. As access was only provided to the shoreline of the northwestern portion of Long Point Company, constituting one route, I assumed the route habitat was representative to the entire property; however, Figure 4.1 and 4.2 suggest that Least Bittern relative abundance is quite low along coastal edges. With fewer Least Bitterns found at the coastal edges, it is likely that my estimate for Long Point Company and for Long Point is in fact a conservative estimate.

The methodology of determining interspersion likely provided a low estimate of interspersion due to filtering of the classified wetland images. Filtering was performed to remove independent 0.3 x 0.3 m classified pixels to produce a cleaner image and remove tiny pockets of open water which were deemed as classification errors or were too small to provide Least Bittern habitat. Keeping these pixels within the image would have greatly increased the interspersion value, but likely decreased accuracy of the classified pixels.

5.0 Management Implications

Preservation, protection, and enhancement of wetland habitats, particularly large (>10 ha), shallow wetlands with dense growth of robust, emergent vegetation (particularly Cattail), is the most urgent conservation need for Least Bitterns (Poole et al. 2009). The wetlands used in this study were large, shallow, and emergent wetlands known to have breeding Least Bitterns (Cadman et al. 2007); however, I had poor Least Bittern detection in some of these wetlands (See Chapter 2). Limited detection of Least Bitterns was likely the result of poor habitat quality, habitat characteristics not assessed in this study, or other biological factors (i.e. food availability).

A recently published study on bird use of *Phragmites* at Long Point found that *Phragmites* provides suitable habitat for a diversity of landbirds but only limited habitat for many marsh-nesting birds (Meyer et al. 2010). Other studies (Benoit and Askins 1999; Meyer 2003) also found negative correlations between *Phragmites* and marsh bird obligate species (e.g. *Raillidae*). The majority of *Phragmites* at Long Point is the non-native genotype and has become increasingly abundant in the CLGL over the past three decades (Lynch and Saltonstall 2002; Wilcox et al. 2003; Catling and Carbyn 2006; Frieswyk and Zedler 2007). Survey stations where Least Bitterns were detected had a lower percent cover of *Phragmites* than those where Least Bitterns were not detected; however, I did not detect an influence of *Phragmites* on relative abundance. As *Phragmites* is increasing exponentially in Lake Erie wetlands (Wilcox et al. 2003) by replacing Cattail, which appears to be the most important emergent vegetation for breeding Least Bitterns. There is concern about *Phragmites* reducing interspersion and habitat quality for Least Bitterns and other marsh obligate species; therefore, removal of *Phragmites* to increase interspersion and promote growth of Cattail should provide habitat for Least Bitterns and may benefit other species (Kaminski and Prince 1981; Rehm and Baldassarre 2007; Meyer et al. 2010). Interspersion and Cattail were both habitat features that influenced presence and relative abundance of Least Bitterns in my study.

Active management within Crown Marsh (Appendix 2) in the fall of 2008, between my two field seasons, entailed dredging of 3 ponds Ò5 ha. Reasons for dredging included, increasing the amount of open water and the removal of *Phragmites*. I detected nearly double the relative abundance of Least Bitterns at Crown Marsh in 2009 than in 2008 (Figure 3.1). The change in relative abundance between 2008 and 2009 may be directly related to habitat modifications, considering the other study wetlands had similar relative abundance between years (Figure 3.1).

Many marsh-nesting obligates (e.g. herons and bitterns) require openings within stands of emergent vegetation, as this provides access to nesting and foraging habitats (Manci and Rusch 1988; Gibbs et al. 1991; Benoit and Askins 1999). Openings in stands of Cattail may be created naturally by muskrat (*Ondatra zibethicus*) and beaver (*Castor canadensis*) activities (Edwards and Otis 1999; Rehm and Baldassarre 2007) or through active management for open water habitats and boat channels in Great Lakes coastal wetlands. Management agencies and private land managers, such as hunt clubs, dredge openings in monotypic stands of Cattail and *Phragmites* to maintain or manage wetlands in a óhemi-marshô state to benefit a diversity of wildlife (Murkin et al. 2000) and allow access to wetlands for waterfowl hunting. These natural and anthropogenic openings increase interspersion and thus, benefit Least Bittern populations by providing necessary habitat for breeding and foraging. Interspersion was the best predictor of abundance for Least Bitterns in New York (Rehm and Baldassarre 2007) and was also a good predictor in this study. Therefore, coastal Great Lakes wetlands should be managed to increase interspersion. óHemi-marshô conditions provide the necessary water openings and stands of vegetation that support Least Bitterns so long as the interspersion or edge density (m / ha) remains high. High interspersion in a óhemi-marshô could be achieved by creating many long sinuous channels through wetland habitat, thus providing wetland access and habitat for Least Bitterns, while still maintaining habitat for other marsh species. I strongly recommend managing coastal Great Lakes wetlands by increasing the amount of interspersion.

The Least Bittern is among the most inconspicuous of North American bird species (Poole et al. 2009). Studying Least Bitterns and other secretive marsh birds can be challenging as these birds are rarely seen. However, use of the NLBSP to study habitat use of Least Bitterns should continue and expand in future years, as traditional survey methods may not adequately survey Least Bitterns habitat. Results from this study will help wetland conservationists create, maintain, and manage wetland habitat to benefit Least Bitterns.

6.0 Future Research and Recommendations

My study addressed the lack of knowledge about the relative abundance of Least Bitterns in the Long Point region of Lake Erie; a priority described in the most recent draft of The Least Bittern Recovery Strategy (Environment Canada 2010). My study provided baseline data on relative abundance of Least Bitterns at Long Point for use in assessment of population trends. I encourage use of the NLBSP to assess the distribution, relative abundance and population trends of Least Bitterns throughout Canada. Long-term monitoring programs of breeding populations of Least Bitterns (i.e. NLBSP) are needed to determine trends in populations of these birds with precision.

The NLBSP not only provides data on distribution and relative abundance of Least Bitterns, but for other bird species as well. A knowledge gap not identified in the Recovery Strategy is to assess bird species relationships. For example, are Least Bitterns more commonly found in areas with high Marsh Wren (*Cistothorus palustris*) density? A study in northern Illinois compared the presence / abundance of other marsh birds in relation to Least Bitterns and found an association with Mute Swans (*Cygnus olor*) and Sora (*Porzana Carolina* - Ward et al. 2010). As part of the NLBSP, surveyors record detections and abundances of other marsh birds; therefore, the data are already available for analysis. If relationships can be identified between Least Bitterns and other marsh bird species, this may be an indicator of suitable habitat for Least Bitterns, regardless of if they are present in a wetland or not. Therefore, I recommend studying the habitat relationships of Least Bitterns to other marsh bird species in Canada. This information will provide land managers with an indicator as to whether a wetland is suitable for Least Bitterns.

It also would be valuable to undertake habitat modeling to determine the extent and amount of suitable habitat for Least Bitterns throughout Canada and elsewhere. There now may be enough existing information on habitat use in Canada [this study (2009), Ontario; Hay (2006), Manitoba; and, Jobin (2009), Quebec] to develop habitat models for Least Bitterns. After developing a reliable habitat model it could be combined with remote sensing of Canadian wetlands to assess available habitat in Canada for Least Bitterns. These models could also be applied to wetlands in other countries.

7.0 Best Management Practices for Least Bitterns in Southern Ontario Wetlands

Best Management Practices (BMP) are defined as ñapproaches based on known science that, if followed, should allow the client to meet the required standard(s) or achieve the desired objective(s)ò (Ministry of the Environment 2011). I outline two BMPôs that are necessary to monitor and maintain or increase the population of Least Bitterns in Southern Ontario.

BMP #1 *- Protect, create, maintain, and restore wetlands to promote growth of Cattail and increase interspersion*

- Remove stands of *Phragmites* to promote growth and expansion of Cattail.
- Dredge or channelize wetlands sinuously on an annual basis to promote increased interspersion of open water and emergent vegetation.

BMP #2 *– Assess distribution, relative abundance and population trends*

- Continue and expand use of the National Least Bittern Survey Protocol.
- Conduct long-term monitoring to assess population trends.

8.0 Conclusion

In conclusion, the results of this study supported some but not all of my predictions. I predicted that I would detect over 200 individual Least Bitterns, which was nearly the case in 2009 with 197 unique individuals detected (96 in 2008). Secondly, I predicted that the probability of detecting a Least Bittern would be greatest in areas with live and dead Cattail stems equal in number, a water depth of 20-80 cm and low percent cover of *Phragmites*, and that interspersion would influence relative abundance. My prediction of finding Least Bitterns in areas with an equal number of live and dead Cattail stems was not supported. The number of Cattail dead stems was a significant variable in the probability Least Bittern presence. My prediction of finding Least Bitterns in areas where the range in water depth was 20-80 cm was similar. My prediction of finding Least Bitterns in areas with lower percent cover of *Phragmites* was correct. There was significant difference in the percent cover of *Phragmites* between survey stations where Least Bitterns were present compared to stations where they were not present. My prediction that interspersion at the wetland and survey station scales would be correlated with Least Bittern relative abundance was not correct; there was only a relationship between relative abundance and interspersion at the survey station scale.

Overall, in 2008 (n = 193 survey stations), I recorded 272 Least Bittern detections of which 96 were estimated to be unique (0.49 birds/ survey station), whereas in 2009 (n = 351 survey stations) I had 712 detections estimated as 197 unique Least Bitterns (0.56 birds / survey station). Relative abundance differed substantially among surveyed wetlands and between years with a range of 0 ï 0.62 birds / survey station in 2008 and 0 ï 0.98 birds / survey station in 2009. Based on detections of Least Bitterns responding to the survey protocol with the óCooô call (n = 118) in 2009, wetland area not surveyed, and total area of coastal wetland, I estimate 195 pairs of Least Bitterns at Long Point, Lake Erie and 1434 pairs in coastal wetlands of the CLGL. Thus, the breeding population of Least Bitterns in Canada (n = 1500) is potentially biased low. Use of the

NLBSP should be continued and expanded to increase our understanding of Least Bittern distribution, relative abundance, and habitat use for effective wetland management and species-listing policy. Macrohabitat assessments determined percent cover of Cattail to be the best predictor of Least Bittern presence. Microhabitat assessments determined number of dead Cattail stems as the best predictors of Least Bittern presence. Interspersion of the study wetlands was significant at the survey station scale, but not at the wetland scale. Current wetland management at Long Point (primarily for waterfowl) appears to be beneficial to Least Bitterns. I recommend managing wetlands by increasing interspersion, maintaining the percent cover and density of cattail in wetlands, and minimizing the percent cover of *Phragmites*.

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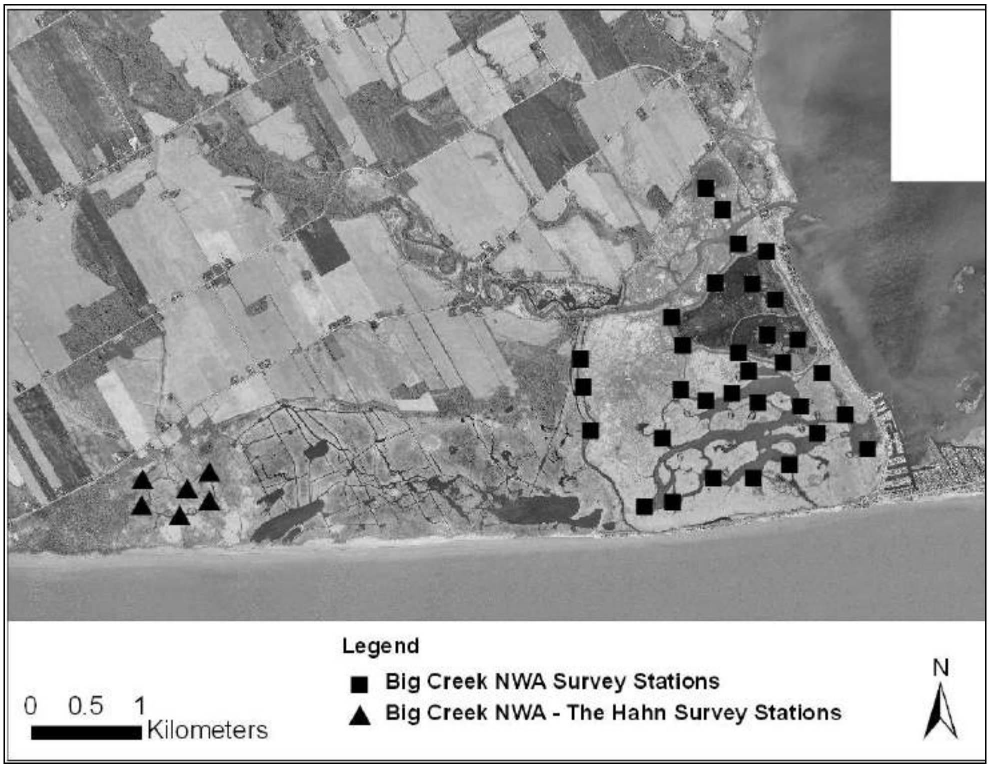
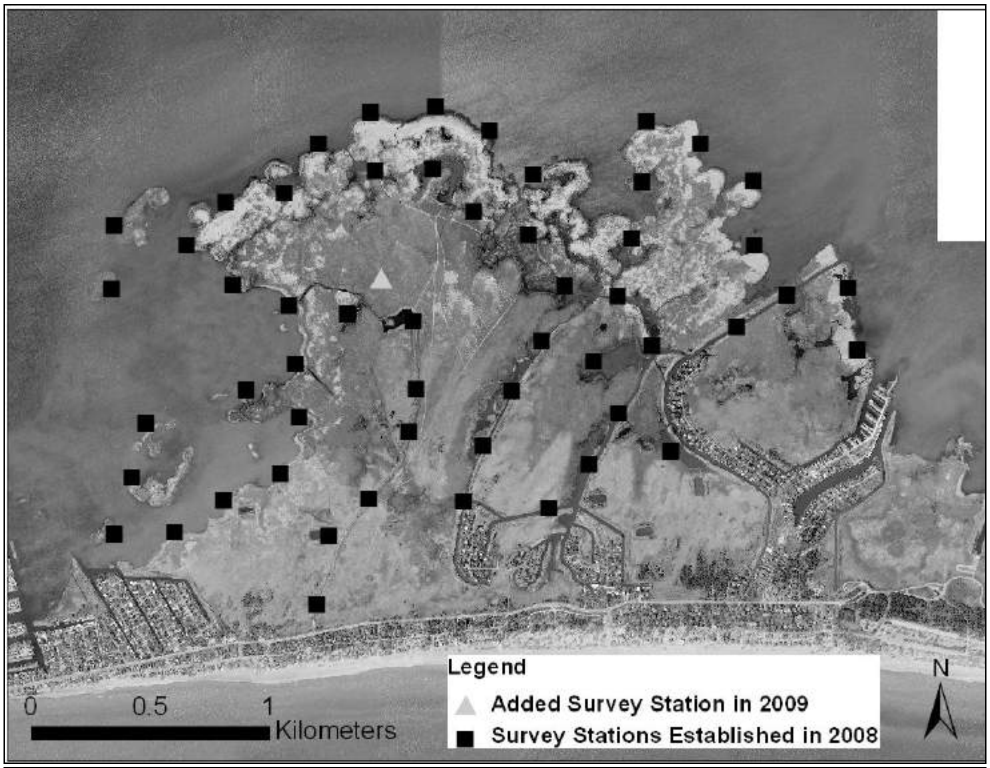
Appendix 1



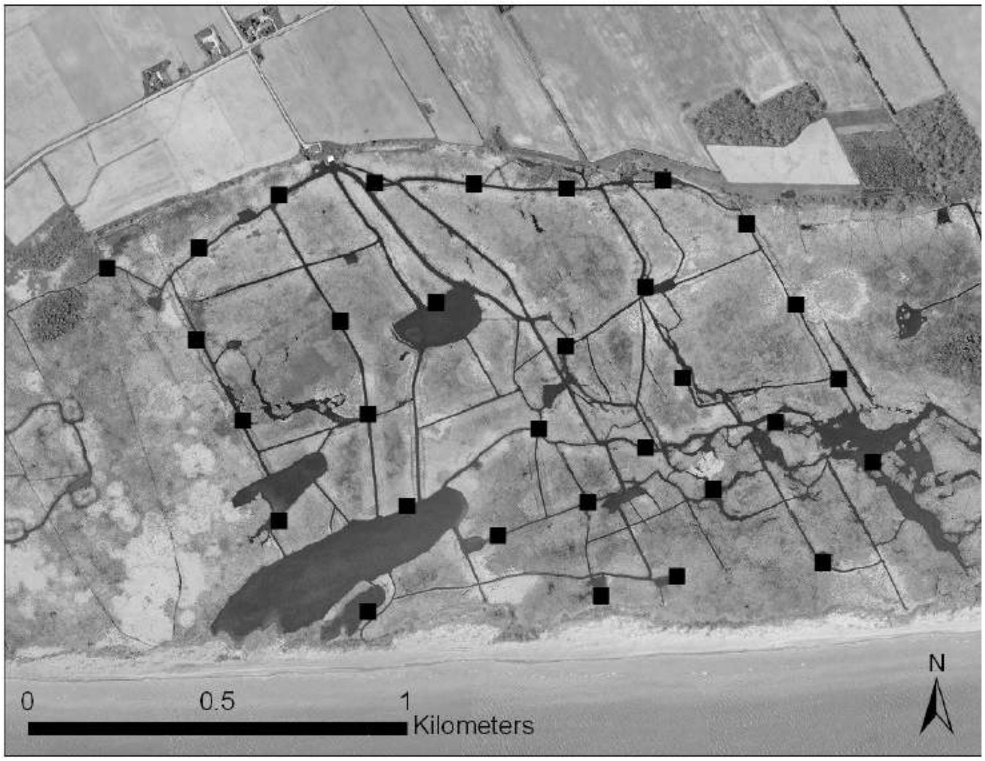
Big Creek National Wildlife Area (BCNWA) was established in 1973 and is comprised of two units. The east unit of BCNWA (598 ha) is situated to the northwest of the Town of Long Point and at the base of Long Point. It is bordered by Big Creek and agriculture in the north, the Inner Bay (Lake Erie) in the east, Lake Erie in the south and a private hunt club in the west. A secondary unit (The Hahn; 67 ha) is located west of the east unit and is bordered by agriculture to the north and west, Lee Brown Waterfowl Management Unit in the east, and Lake Erie to the south. I surveyed 38 stations on 5 routes in BCNWA, 2009. The routes surveyed in BCNWA were established in 2007 during previous Least Bittern research (Environment Canada unpublished data). The BCNWA is managed federally by the Canadian Wildlife Service ï Environment Canada and historically was heavily dredged and channelized, but no physical manipulation of habitat has occurred in the past 5 years.

Appendix 2



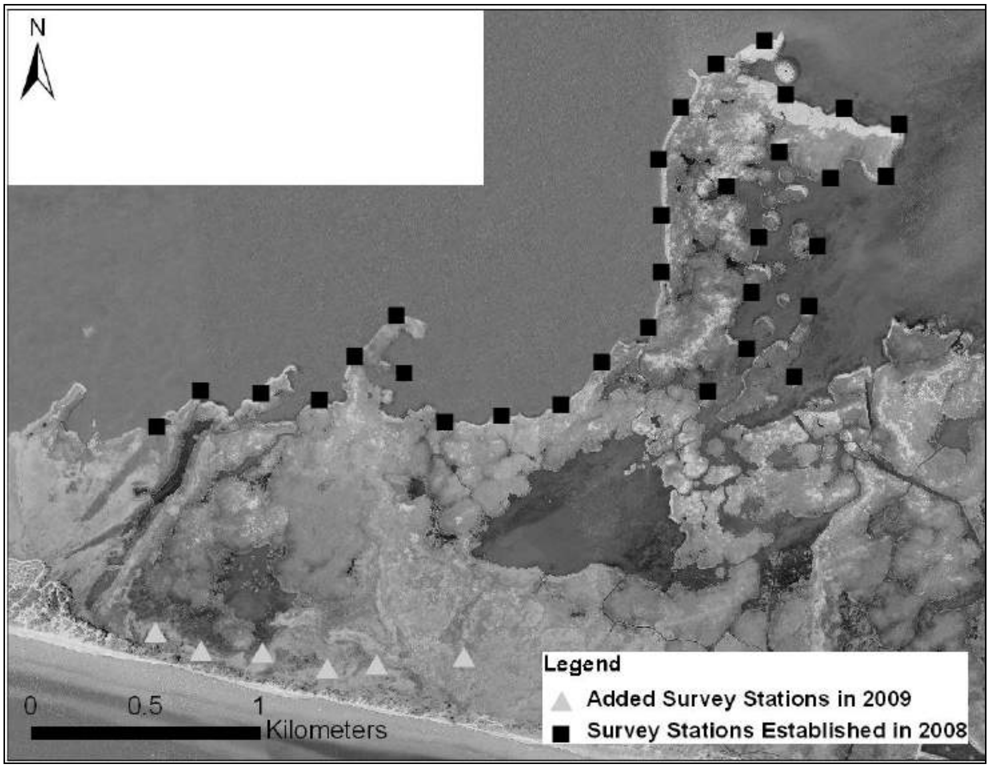
Crown Marsh (518 ha) is owned by the province of Ontario and managed by the Ontario Ministry of Natural Resources. Crown Marsh is located northeast of the Town of Long Point. I surveyed 54 stations on 6 routes in 2008 (one station was added in 2009 to increase area surveyed, thus making 55 survey stations) in the Crown Marsh. Crown Marsh is open to waterfowl hunting, September ï January. The wetland receives periodic management to maintain boat channels for access to hunting locations. During autumn 2008 and 2009 the Ministry of Natural Resources dredged 12 ponds (range = <1 ha to 2 ha) to increase interspersion and remove patches of *Phragmites*. The figure does not show the 12 recently dredged ponds.

Appendix 3



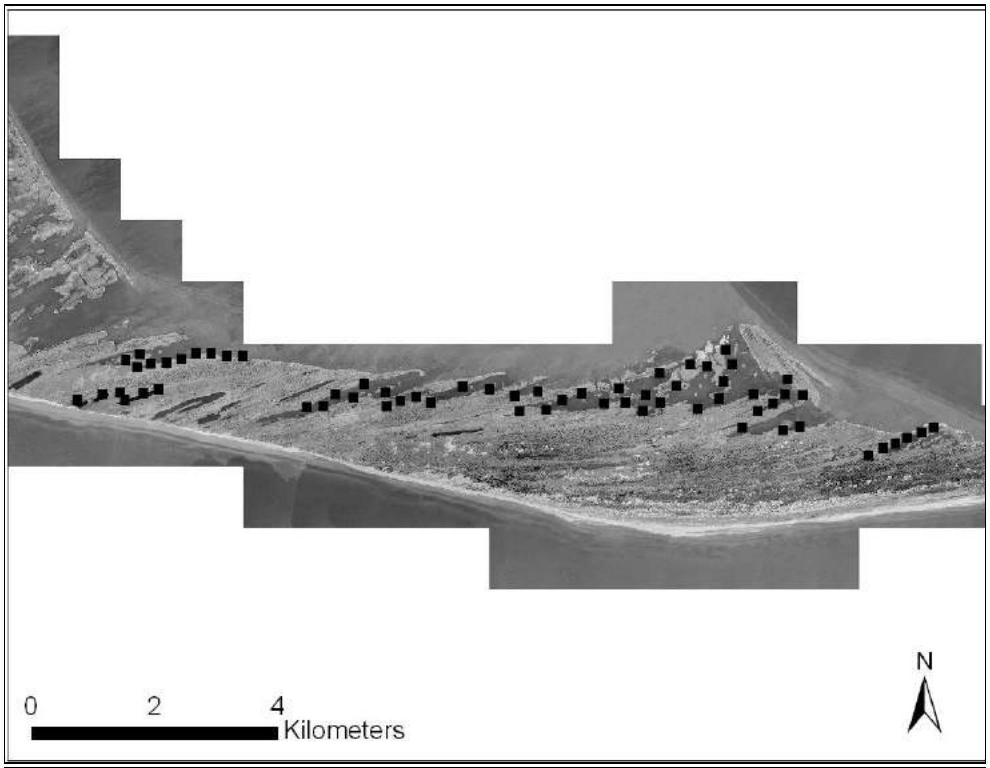
Lee Brown Waterfowl Management Area (221 ha) is managed by the local Conservation Authority and is bordered by a private hunt club in the west, agriculture in the south, The Hahn in the east and Lake Erie in the north. Surveys were conducted at LBWMA in 2009 at 31 survey stations along 3 routes. The boat channels are mechanically dredged each year and removed sediment is piled on the sides of the channels.

Appendix 4a

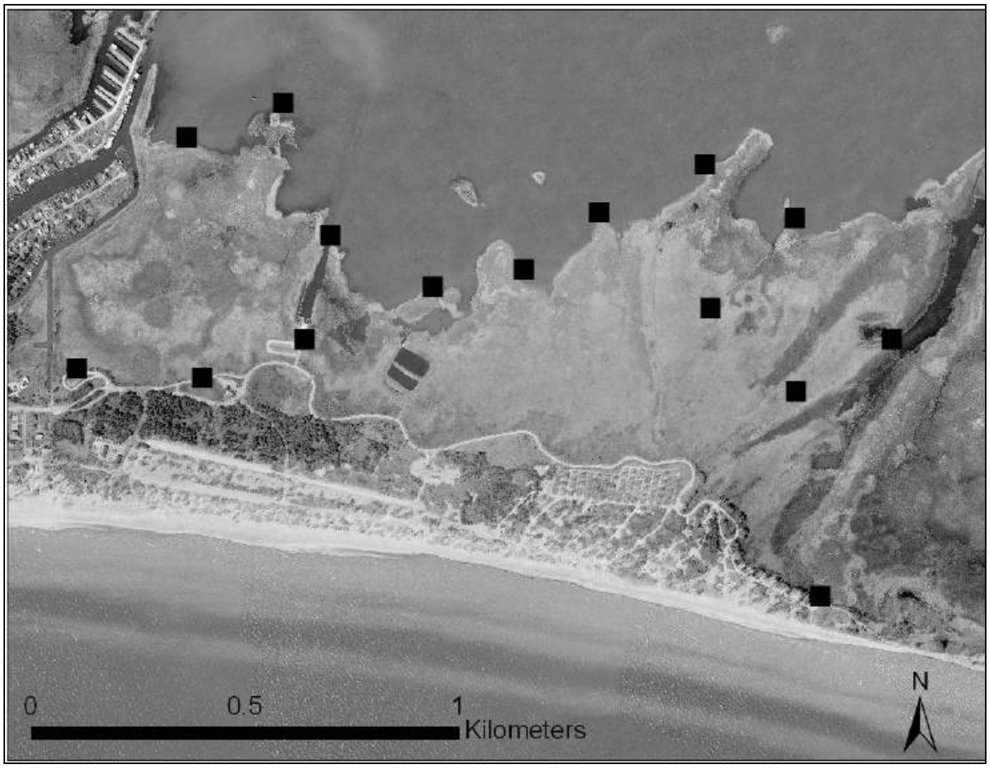


Long Point National Wildlife Area (LPNWA) is managed federally by the Canadian Wildlife Service ï Environment Canada and is comprised of two units. The smaller unit (Thoroughfare Point) is located in the west central portion of Long Point and is bordered by Long Point Company in the east, Crown Marsh in the west and Lake Erie to the north and south. Thoroughfare Point (427 ha) and was surveyed in 2008 and 2009. In 2008, 32 stations were surveyed on 3 routes and I added 6 survey stations in 2009 for a total of 38 survey stations on 4 routes. The larger portion of LPNWA (586 ha ï see Appendix 4b) was surveyed in 2009 with 64 survey stations on 7 routes. This site has not received active management in many years.

Appendix 4b

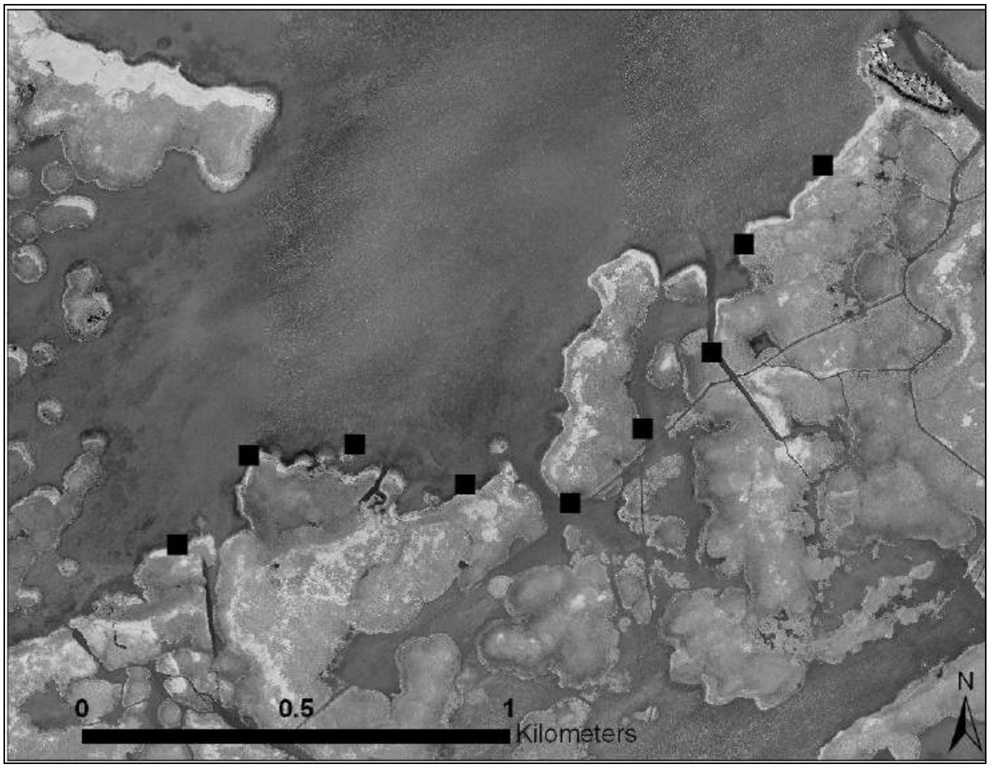


Appendix 5



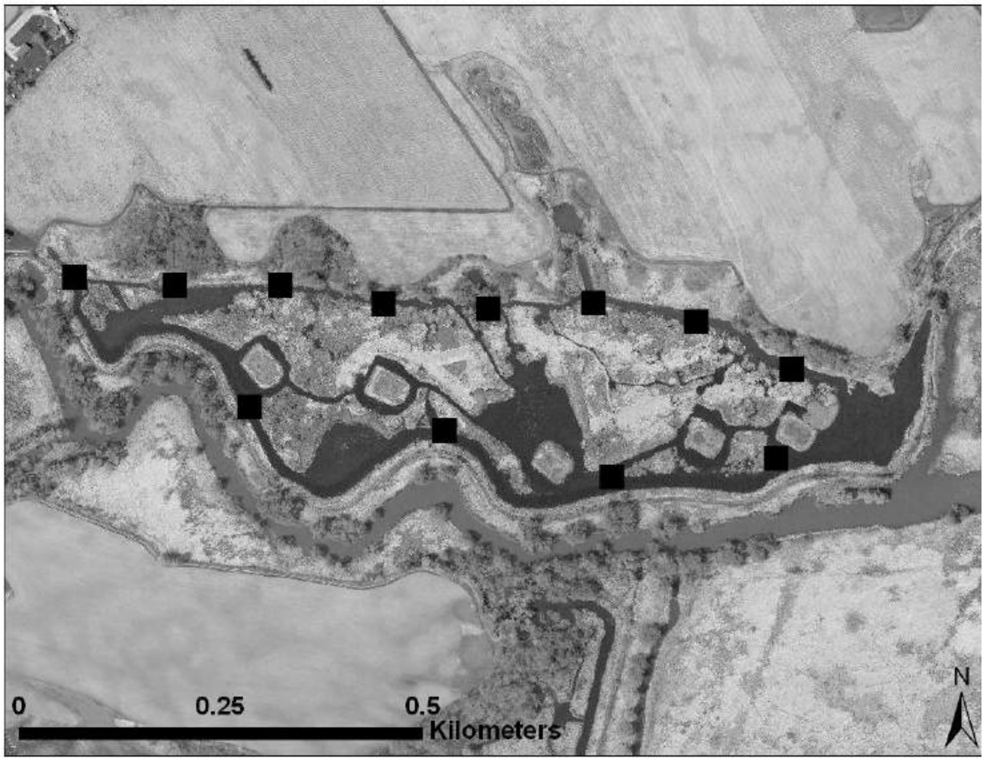
Long Point Provincial Park (LPPP) is managed provincially by Ontario Parks. The wetland portion of LPPP (111 ha) is bordered by Crown Marsh in the west, Thoroughfare Point in the east and Lake Erie in the north and south. Surveys were conducted in 2008 and 2009 at 15 survey stations along 2 routes. With the exception of a small pond dredged by OMNR in the fall of 2008, active management of hydrology and vegetation is limited. The figure does not show the small pond due to how recently the pond was dredged.

Appendix 6



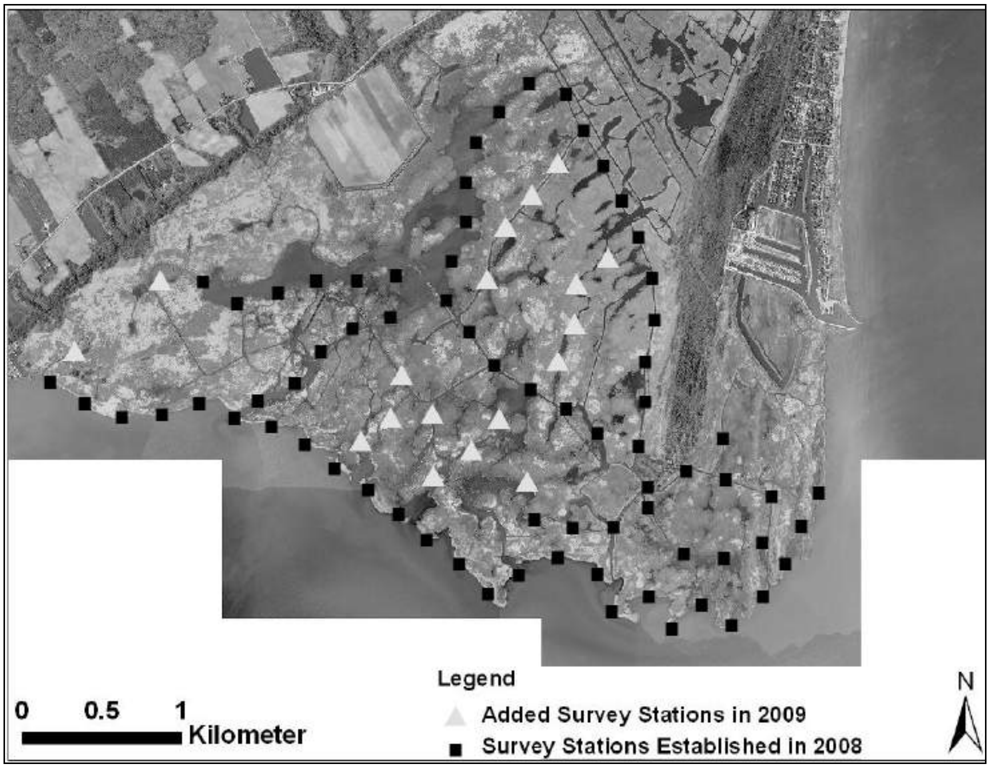
Long Point Company (LPC; 2300 ha) is a private hunt club located in the central portion of Long Point. LPC is bordered in the west by Thoroughfare Point, LPNWA in the east and Lake Erie to the north and south. Surveys were conducted in 2008 and 2009 at 9 survey stations on 1 route. Access to this site was limited and therefore only one route was established in approximately 90 ha. Boat channels are dredged annually.

Appendix 7



Murray Marsh (22 ha) is a private hunt club located southeast of the Town of Port Royal. Murray Marsh is bordered on all sides by agriculture except BCNWA to the southeast. Surveys were conducted in 2008 and 2009 at 12 survey stations on one survey route. Boat channels are dredged annually.

Appendix 8



Turkey Point (924 ha) is intensively managed by the Turkey Point Hunt Club with the exception of the northeast corner, which is managed by 3 smaller, separate hunt clubs, to which I did not have access. In 2008, surveys were conducted at 71 survey stations on 7 routes. In 2009, these same stations and routes were surveyed with the addition of 18 survey stations and 2 routes. Boat channels at Turkey Point are dredged annually.

Volume II Summary and Recommendations

SUMMARY

The Long Point region is an ecological, economic, and cultural resource of local, regional and international importance. The studies contained in this report provide information enabling policy-makers, conservation planners, and fish and wildlife managers to make informed decisions during the conservation planning and delivery process to ensure the continued existence of the regions natural resources. When information was not available for an area of study or it lacked sufficient research to make an informed management recommendation, this report identifies the need for future research. Continued shoreline development and changes in land-use within the Long Point Bay watershed will continue to provide new challenges. Balancing economic and cultural resources with natural resources will entail a combination of conservation, preservation, and management actions in the Long Point region. Climate change and accompanying energy policy (e.g., industrial wind turbine development) also may present new conservation issues and policy-makers and conservation planners would be wise to fund research that will enable adaptation to changes in hydrology, weather, plant and wildlife communities, and land-use. Continued monitoring at Long Point of fish and wildlife populations and their habitats is necessary to identify emerging areas of conservation concern, develop a greater understanding of the life history needs of fish and wildlife, assess Species-at-Risk recovery and de-listing, and make natural resource policy, conservation, preservation, and management decisions. Further, monitoring efforts should attempt to determine mechanisms for changes in distributions and abundance of fish and wildlife. To increase the utility of these studies in the policy, conservation, and management decision-making process, researchers should strive to develop rigorous study designs enabling publication of results in peer-reviewed journals.

RESEARCH AND MANAGEMENT RECOMMENDATIONS

Research – General (GAP analysis)

- Amphibian and reptile research is relatively under-represented and the influences of road mortality and wetland management (e.g., dredging of channels and ponds to increase wetland access and interspersion) on these animals has not been specifically studied. Specifically, peer-reviewed published research on habitat needs of amphibians and reptiles and population dynamics studies are limited and this limits the capacity for developing science-based conservation and management recommendations for these animals. A large-scale, multi-agency collaborative project is needed to reduce information gaps.
- Muskrats are keystone species in Great Lakes coastal wetlands and research on their population dynamics and ecology at Long Point would benefit conservation and management of coastal wetlands in the region.

- Uplands of Long Point, including dunes and forested ridges are unique ecological niches in the Great Lakes region. Additionally, upland habitats adjacent to Long Point greatly influence nutrient input into the bay and birds use these uplands during migration to forage and as nesting habitat in summer. Research on terrestrial vegetation and changes in this vegetation would inform conservation and management policy in the Long Point region. For waterfowl and other waterbirds, understanding vegetation (annual and perennial plants) occurring in seasonal wetlands that are used during migration and breeding would help develop regional carrying capacity estimates that are needed for conservation planning.
- Macroinvertebrates, as well as phytoplankton and zooplankton research is relatively under-represented at Long Point. Considering these invertebrates are forage for a diversity of fish and wildlife, determining factors influencing their abundance and diversity would be beneficial. Also, given the decline in aerial insectivores birds, evaluating relationships between macroinvertebrates and these birds is needed.
- Species-specific studies of fishes, especially Species-at-Risk, are needed to understand influences of water levels, shoreline development, and wetland management activities on population dynamics and for developing conservation strategies for species recovery.
- Climate change may greatly influence annual timing of events such as invertebrate emergence, bird migration, plant leaf-out and flowering, and foraging pressure by migrant waterfowl and other birds. Modeling the influence of these changes will help conservation planners and fish and wildlife managers to develop strategies that incorporate the estimated impacts of changing climates.
- Research on the quantity, quality, and ecology forests in the Long Point region are relatively limited despite the importance of these Carolinian forests for migratory birds and other wildlife, which bring substantial recreational and economic benefit to the region from wildlife watchers.
- Environmental contaminants enter Long Point Bay through the atmosphere and from nearby land-use. Understanding the influence of inorganic contaminants such as Cadmium, Mercury, and Selenium on health, survival and reproduction of fish and wildlife remains important as does understanding input of pesticides into the Long Point Bay watershed and the direct and indirect influence on fish and wildlife resources.

Research – Least Bitterns and Marsh Monitoring Program

- Use the National Least Bittern Survey Protocol to assess the distribution, relative abundance and population trends of Least Bitterns at Long Point (and throughout Canada) and to determine if estimates are precise.
- Assess relationships between Least Bitterns and other, more easily detectable marshbirds to develop a survey protocol that does not rely on detecting Least Bitterns.

- Develop a comprehensive and objective method to assign marshes to categorical human disturbance classes, and statistically assess differences in marsh bird and amphibian community composition among these categories.

Research – Submerged Aquatic Vegetation (SAV)

- Determine the affect of over-wintering waterfowl on SAV in Long Point Bay during winters that the Inner Bay does not freeze to assess the potential influence of changing climates on SAV.
- Determine the influence of disturbance during Autumn (primarily from hunting) that excludes waterfowl from foraging on SAV during this period. Anecdotal evidence suggests that areas hunted during Autumn also have greatest abundance of SAV in Spring and use by waterfowl. Thus, hunting may 'preserve' food and feeding areas for Spring migrating waterfowl that would otherwise be exploited during Autumn migration.
- Determine the nutrient, sediment and water clarity mechanisms influencing abundance and distribution of SAV in Long Point Bay.

Research – Nearshore Fish Assessment

- Use the current report as a baseline to compare the fish community over time and to measure the influences of environmental change, human development, and wetland management and restoration activities.
- Expand the survey to include Autumn, Spring, and Winter surveys and night seining to refine our understanding of seasonal and daily differences in fish community metrics potentially not captured using Summer, diurnal seining.
- Develop a more thorough assessment of freshwater mussels. Declining abundance of zebra mussels in Long Point Bay since the mid-1990s may be facilitating continued existence of freshwater mussels and providing refuge from attachment by zebra mussels which can lead to mortality in freshwater mussels.

Research – Zooplankton communities

- Study indicated that zooplankton community structure is influenced by exposure and hydrological connectivity to the open water, and by determining factors that affect zooplankton communities, could be used to predict prime fish nursery habitat
- Further studies are needed with a goal to develop a tool to assist in predictive capabilities related to zooplankton for restoration work.

Management

- Fund and incorporate monitoring into habitat conservation, restoration and management activities and develop structured decision-making tools based on objective biological thresholds developed from peer-reviewed published research. Specifically, developing an understanding of the positive and negative effects of conservation, restoration and management activities on Species-at Risk fish and wildlife is recommended. Ultimately, ensuring that common species remain common and Species-at-Risk recover and are no longer listed should be the goal of conservation, restoration, and management actions. Monitoring and structured decision-making tools will help ensure this goal is met.

- Management and restoration activities would benefit from a multi-agency/stakeholder decision analysis of actions that incorporate developed structured decision-making tools and clearly defined objectives that are based on published science.
- To increase the abundance of Least Bitterns, remove stands of *Phragmites* to promote growth and expansion of Cattail.
- Dredge or channelize wetlands sinuously on an annual basis to promote increased interspersion of open water and emergent vegetation. Open water to emergent vegetation at a 1:1 ratio is considered ideal for promoting an abundance and diversity of wetland plants and wildlife.
- Managed cells at Big Creek National Wildlife Area had greater abundances of some species of wetland-dependent birds and amphibians than unmanaged areas suggesting that activities, including water level management, may increase habitat diversity and availability for these animals. Continued management, including maintenance of berms (e.g., tree/shrub removal, mowing, muskrat damage control), pump maintenance, invasive species control, water level management, and wetland plant monitoring are recommended at Big Creek National Wildlife Area.
- Ensure a diversity of wetland habitats exist to meet the life-cycle needs of a diversity of fish and wetland-dependent wildlife. The diversity of habitats provides a complex for animals moving among habitats daily and seasonally, whereas no single locale or habitat type provides for all fish and wildlife all the time.
- Conserve and manage the diversity of nearshore habitats, rather than solely the most productive to provide a diversity of fish habitats. Management, planning and restoration strategies for fish habitat should incorporate and address both local and large scale, and immediate and cumulative impacts.
- Ensure that coastal marshes have connectivity to the Inner Bay for nutrient cycling and movement of fish, amphibians, and wetland mammals. Hydrological connectivity of the Big Creek Marsh and other coastal marsh to the Inner Bay is recommended.
- Recent surveys of SAV that were compared to the 1970s and 1990s suggest that the Inner Bay of Long Point is becoming increasingly eutrophic. Monitoring and managing nutrient and sediment loading into Long Point Bay from agricultural areas in the Big Creek watershed and other smaller watersheds should be a priority of conservation planners. Nutrient and sediment reduction could include field buffers, fertilizer management, soil erosion control techniques, and habitat incentive programs for agriculture.

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