PLANNING FOR WATERFOWL
IN LONG POINT INNER BAY

by

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thesis requirement for the degree of
Master of Environmental Studies
in
Geography

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ABSTRACT

This thesis assesses Long Point's Inner Bay as a critical staging area for waterfowl. The results are interpreted in terms of their significance and constraints for planning and managing staging waterfowl. The first and second levels of the ABC Resource Survey approach were used to collect, analyze and interpret data. In the first level of this approach, the Inner Bay was divided into areas to provide a framework for the study of waterfowl food resources and refuge areas. Submerged aquatic plants and invertebrates were collected, identified and mapped to determine what foods were available to waterfowl in each of the areas. Stomach analysis of waterfowl showed what foods waterfowl were selecting. Aerial surveys of waterfowl gave an indication of what areas were being used for waterfowl refuge. In the second level of the ABC approach, information on food resources and refuge areas was interpreted in terms of significance and constraints. Strategic planning priorities and research needs were then identified.

The findings indicate that different areas of the Inner Bay play different and complementary roles for waterfowl and that some areas may be of particular importance for food or refuge. The Open Water area of the Inner Bay is considered to be important because of the high numbers of waterfowl recorded as using the area. The North Shore area is considered as important due to its high productivity of waterfowl plant foods, high diversity of plant foods and high numbers of molluscs. The Big Creek area is considered important due to its high productivity of plant foods and because it has a high abundance of wild celery (*Vallisneria americana*), a critical food source for canvasbacks (*Aythya valisineria*), a species identified by the Canadian Wildlife Service as a concern for management and research. Major management recommendations are: the development of a conservation strategy for the Inner Bay and the development of a system of monitoring and mapping boat traffic. Major research recommendations are: determining the effects of disturbance on waterfowl at Long Point; discovering factors affecting food resources; and, ascertaining foraging and food habits of waterfowl at night and in spring.

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CWS	Canadian Wildlife Service
FON	Federation of Ontario Naturalists
LPBO	Long Point Bird Observatory
LPRCA	Long Point Region Conservation Authority
LPWWRF	Long Point Waterfowl and Wetlands Research Fund
NAWMP	North American Waterfowl Management Plan
NEC	Nanticoke Environmental Committee
NEMP	Nanticoke Environmental Management Program
OFAH	Ontario Federation of Anglers and Hunters
OMNR	Ontario Ministry of Natural Resources
RAMSAR Sites	Sites designated under the Convention on Wetlands of International Importance especially as Waterfowl Habitat
RMHN	Regional Municipality of Haldimand Norfolk
USFWS	United States Fish and Wildlife Service

CHAPTER 1

STUDY CONTEXT AND APPROACH

1.0 Introduction

Loss and degradation of habitat are the major waterfowl management problems in North America (North American Waterfowl Management Plan, NAWMP 1986). The impacts of agriculture, urban sprawl, industry, flood control, navigation and recreational use have reduced the quantity and quality of waterfowl habitat in many parts of Canada and the United States. Habitat degradation has been particularly severe throughout southern Ontario and along the Great Lakes. Snell (1987) estimated that 61% of southern Ontario's original wetlands have been converted to other land uses since settlement times. Reviews of past efforts for waterfowl conservation and research, however, indicate that studies on waterfowl habitat and its management have received little investigation (Smith, *et al.,* 1989).

The Migratory Bird Convention Act of 1916 between Canada and the United States and the subsequent treaty with Mexico (1936) set the foundation for co-operative waterfowl management and research programs in North America. They were established out of concern for declining numbers of birds, particularly waterfowl. These declines were generally attributed to uncontrolled hunting and habitat destruction. The convention established closed hunting seasons during waterfowl breeding and wintering seasons and established 'bag' limits on the numbers of migratory game birds that could be taken by each hunter. Although the convention effectively controlled hunting across North America, it did not address the issue of habitat destruction.

Food habit studies were the earliest focus of research on waterfowl in North America (Krapu and Reinecke, 1992). This early commitment to the study of food relationships of waterfowl resulted in the publication of several comprehensive studies of food habits of many popular game species (e.g., Cottam, 1938; Martin and Uhler, 1939). These studies focused on the identification of food items contained in the esophagi and gizzards of waterfowl and described propagation of food plants for preferred game species. Again, the issue of habitat destruction was not addressed.

Breeding waterfowl studies in North America were conducted as early as the 1960s. As with earlier studies, habitat was not a major emphasis and generally was not addressed until after many studies on the birds themselves were completed (Smith *et al.,* 1989). Research focused on the collection of breeding waterfowl and comparison between foods contained in the esophagus and gizzard. In the late 1970s and early 1980s breeding waterfowl studies continued, with some work on wintering waterfowl as well. Once again the emphasis was placed on waterfowl biology and feeding ecology rather than on habitat and its management for waterfowl (Smith *et al.,* 1989).

At the same time, Ducks Unlimited (DU), a non-government organization, was instrumental in increasing awareness about the loss of wetlands and its impact on waterfowl. This group, however, focused their efforts on duck production areas in Canada, mainly in the prairie provinces. Staging habitat and wintering habitat loss/degradation were not a major focus of DU efforts.

In 1986, a new era in waterfowl management began with the adoption of the North American Waterfowl Management Plan (NAWMP, 1986) by Canada and the United States. The plan called for integrated efforts of those working directly with waterfowl and sought to enlist the support of those impacting on waterfowl habitat indirectly such as agriculturists, foresters, and developers (Hawkins, 1989). The plan stated that "in all waterfowl management decisions and actions, first priority should be given to perpetuate waterfowl populations and their supporting habitats" (NAWMP, 1986).

Like the Migratory Bird Convention, the NAWMP recognized that international co-operation is essential for waterfowl conservation, as 37 out of 44 of the North American waterfowl species occur in both Canada and the United States and cross international boundaries during their annual life cycle (NAWMP, 1986). The NAWMP set population goals for each species and set minimum habitat needs to accomplish these goals. The plan, however, lacked the details that administrators and managers needed to support and conduct successful management programs. More specifically, the plan identified habitats of importance to North American waterfowl, but left the details of management to be worked out (Smith *et al.,* 1989).

One area identified in the North American Waterfowl Management Plan as a priority for waterfowl habitat management is the Lower Great Lakes-St. Lawrence Basin. This area is important because some of its major wetland areas function as critical staging habitat for migrating waterfowl. The plan called for the acquisition of areas in this region for long term waterfowl use. The plan recommended that these areas should be managed to improve habitat quality and minimize risk of disease. Long Point, Ontario, the focus of this thesis, has been identified in the plan as an area of critical importance to waterfowl.

Long Point, and particularly Long Point's Inner Bay, (Figure 1.0) is recognized internationally as an area of critical importance for migrating waterfowl with its designation as a RAMSAR site (a wetland of International Significance) (IUCN Conservation Monitoring Center, 1987). Each year hundreds of thousands of waterfowl stop over at Long Point to rest and feed during spring and fall migration on their way to and from wintering grounds on the Gulf of Mexico and on the Atlantic Coast (Figure 1.1). Dennis *et al.,* (1984) reported Long Point as having the greatest waterfowl use of any area on the Great Lakes in the late 1970s.

Figure 1.0 Long Point's Regional Context (adapted from the Long Point Environmental Folio Series)

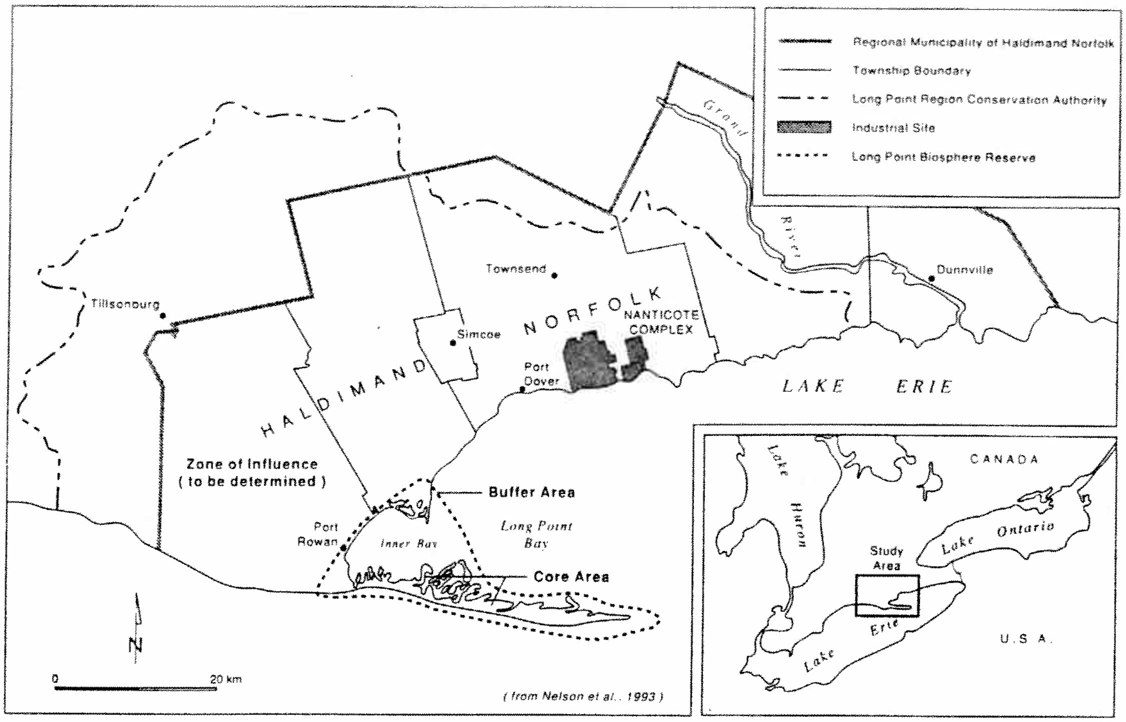
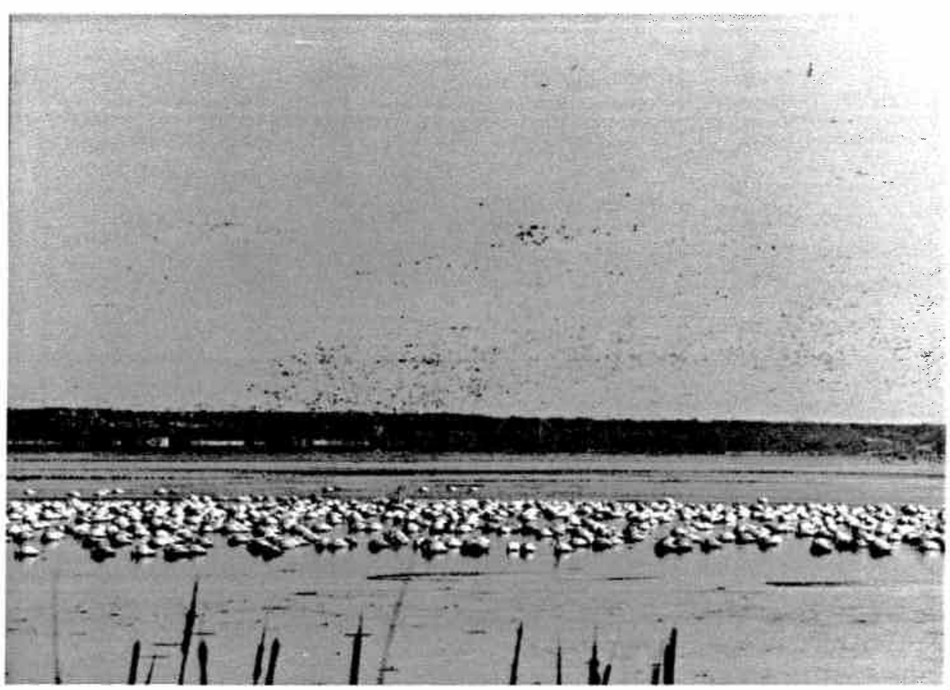


Figure 1.1 Waterfowl at Long Point, Spring 1992 (Photograph by J. McCracken)



In the past decade, concerns have been expressed regarding the numbers of waterfowl using the Long Point area (Bookhout *et al.*, 1989). Aerial surveys conducted by the Canadian Wildlife Service from 1968-1988 indicated an overall decline in waterfowl numbers with a severe decline in canvasback *(Aythya valisineria)* and redhead *(Aythya americana)* numbers in the mid 1980's (Dennis and North, unpublished data). Overall declines in waterfowl numbers at Long Point have been attributed to a list of reasons ranging from food supplies (i.e., less grain put out by hunting groups, less waste grain in fields, less wildrice in the marshes) to poor breeding seasons in the prairies, to increased boat traffic in Long Point's Inner Bay. Bookhout *et al.* (1989) also indicated that powerboats disturb staging waterfowl at Long Point.

Staging areas, like Long Point, play an important role in the life-cycle of migratory waterfowl. Although used for short periods, staging areas are essential to the breeding strategy of these migrants (Stroud *et al.*, 1990). The high productivity of staging areas and generally low disturbance experienced by birds feeding there enable them to gain weight very rapidly. The fat reserves obtained on staging areas are needed not only to store 'fuel' for their long migrations, but in spring also for the success of breeding efforts. These reserves of fat and protein are used for egg production and to sustain the incubating waterfowl during a period of low-food availability on Arctic breeding grounds (Ankney and MacInnes, 1978; Ankney, 1984; Thompson and Raveling, 1987). These staging areas can be additionally important as areas where large flocks come together for social needs such as pairing (Stroud, *et al.*, 1990). Thus, the conservation of staging areas is critically important for populations of migrating waterfowl.

As waterfowl habitat continues to decline in North America, and particularly in southern Ontario, staging habitat has become limited (Kahl, 1991). Reliance on limited staging habitat has led to high concentrations of waterfowl in small areas, leaving some species, such as canvasbacks, susceptible to catastrophic events that may affect entire populations (Kahl, 1991b). Long Point is one of the largest wetland complexes left in southern Ontario and historically has been an important area for staging waterfowl.

Over the last few decades, patterns in farming and other land based activities have been changing at Long Point (Wilcox, 1993). There has been a continuing trend of decreasing numbers of farms and increasing average size of farms over the past thirty-five years, and there has been an overall decline in agriculture as part of the local economy (Wilcox, 1993). At the same time, manufacturing and resource extraction have remained as minimal components of the economies of Long Point. Tourism, however, has been steadily increasing. With a stagnant economy in the Long Point region, tourism has been promoted as a method of bringing money into the area (Wilcox, 1993). Tourism and related boating, swimming, and cottaging activities at Long Point's Inner Bay, however, are impacting on this critical waterfowl staging area. The processes of eutrophication, organic pollution and increased sedimentation associated with development and tourism in other areas such as Chesapeake Bay, and New York Finger Lakes (Bloomfield, 1978) and the Norfolk Broads on the east coast of England (Moss, 1983) have been detrimental for waterfowl, resulting in decreased numbers (Crowder and Bristow, 1988). The experience gained from these sites can be used as a general basis for predicting what is likely to occur at Long Point's Inner Bay if current trends continue. The first phase generally experienced in these areas was an initial increase in food plants, followed by a gradual replacement of preferred species by less desirable (exotic) plants and finally a total loss of submerged and floating-leafed plants (Crowder and Bristow, 1988). Long Point's Inner Bay has been described by Crowder and Bristow (1988) as being in the first phase of the nutrient enrichment process.

Dennis and North (unpublished data) suggested that increased pleasure boat traffic in the Inner Bay may have contributed to reduced use of this area by redheads and canvasbacks. The Regional Municipality of Haldimand-Norfolk, in which Long Point lies, has lost between 60-80% of its wetlands in the last hundred years, and continues to lose marshes valuable to waterfowl; Lawrence and Beazley (1994) estimated that 1/3 of the marshes around the Inner Bay have been lost since 1955. Their study area included the emergent wetlands between Turkey Point/Thoroughfare Point to the east and an arbitrary boundary in-line with the 3rd Concession road to the west. Failure to maintain or restore the food resources for the thousands of migrant waterfowl could cause their populations to crash. Waterfowl require both food resources and refuge from disturbance in staging areas (Kahl, 1991b). Thus, in planning for staging waterfowl at Long Point's Inner Bay, it is essential to know what waterfowl are eating during their stay at Long Point, where these food resources are located within the Inner Bay, and what areas waterfowl are using as refuge sites, i.e., areas where large numbers of waterfowl rest and are not actively feeding. This information is essential to make informed management and planning decisions.

In light of the foregoing concerns, this study involves both an ecological and planning study of waterfowl at Long Point's Inner Bay. The focus is on what waterfowl are eating, where waterfowl are feeding, and where waterfowl are resting during their stay in Long Point's Inner Bay. The intent is to use such information as a basis for identifying protection or other planning measures needed for the Bay. The study is both a synthesis of existing information on waterfowl and waterfowl habitat in different areas of Long Point's Inner Bay, and an assessment of the relative importance of each area and the factors affecting them.

1.1 Motivation for Research

Long Point, Ontario, is a particularly important area to protect for waterfowl because it hosts significant proportions of the total eastern population of several waterfowl species. For example, the IUCN Conservation Monitoring Centre (1987) indicated that the marshes and adjacent waters of Long Point Bay can contain at one time at least 43 000 or 14% of the eastern population of canvasbacks during migration, and 100 000 or 11% of the total population of redheads. Tundra swans (*Cygnus c. columbianus)* also have traditionally used the Long Point marshes extensively during spring migration with about 50% of the population east of the Rocky Mountain passing through southern Ontario in spring and a lesser number in autumn (IUCN Conservation Monitoring Centre, 1987). Dabbling ducks and other species of divers also use the region in large numbers. Thus, degradation or loss of staging habitat at Long Point could have devastating impacts on several species of waterfowl.

The loss of staging habitat in southern Ontario has been severe. Its loss has been attributed to a number of influences ranging from the impacts of agriculture to those of development, recreation and industry. This loss, however, has not received much attention until recently. While Ducks Unlimited, a non-government organization founded in 1937, was instrumental in increasing awareness about the loss of wetlands and its impact on waterfowl, this group focused their efforts on duck production areas mainly in the prairie provinces in Canada. It was much later, after a great deal of campaigning by interest groups such as the Federation of Ontario Naturalists and Wildlife Habitat Canada, that the loss of waterfowl habitat in southern Ontario received attention. The RAMSAR Convention (IUCN Conservation Monitoring Centre, 1987) has designated several sites in Canada as areas of critical importance to waterfowl and has been extremely successful in focusing attention on the need for wetland conservation, especially as habitat for waterfowl (Stroud *et al.,* 1990). The North American Waterfowl Management Plan (1986) outlined the Lower Great-Lakes St. Lawrence Basin area as a priority for future waterfowl management efforts due to the huge loss of wetlands in this area and its vast importance to staging waterfowl. The New Wetland Policy Statement (Ontario Ministry of Natural Resources, 1991) recognized the vast wetland loss in Ontario and offers protection for waterfowl habitat through regulation of development near or within wetland or marsh areas. UNESCO has recognized Long Point's wetlands and ecosystem as significant internationally. Most recently, the report on *New Planning for Ontario* (Sewell *et al.,* 1993) recognises the extensive destruction of wetland habitat in Ontario and supports the regulation of development in wetland areas through the use of provincial policy statement such as the Ontario Wetlands Policy Statement.

The great importance of Long Point's Inner Bay and coastal wetlands has been shown by its international recognition as a World Biosphere Reserve and by designation as a RAMSAR Site under the RAMSAR Convention. Long Point has also been designated as a Class 1 wetland in the Wetlands Policy Statement and as a priority area for waterfowl management efforts in the North American Waterfowl Management Plan. Even with all this recognition of its important ecological qualities, little is known about where waterfowl are resting and feeding at Long Point, what they are eating during their stay, and how they and their food resources are affected by disturbance, by cottage and marina developments, fishing, pleasure boating, and hunting.

Table 1.0. Important Institutional Arrangements for Long Point

Date	Regulatory	Description
1976	RAMSAR Convention	An international network of protected sites recognized as being wetlands of international importance especially to waterfowl. Their goal is to stem the progressive encroachment on and loss of wetlands now and in the future (Stroud *et al.*, 1990)
1985	North American Waterfowl Management Plan	Sets the foundation for waterfowl management efforts in Canada and the United States by setting goals by species and by habitat.
1986	Biosphere Reserve	A worldwide selection of the earth's ecosystems. The goal of the Biosphere program is to conserve distinct ecosystems, demonstrate ecologically sustainable land use, and to provide logistic support for research, monitoring education and training.
1987	Ontario Wetlands Policy Statement	The goal of this policy statement by OMNR is to prevent further encroachment destruction of wetlands

The motivation for this study therefore arises from: 1) a desire to provide information to help fill the foregoing gaps, 2) the desire to conserve waterfowl populations through the protection of internationally significant sites, such as Long Point, 3) my involvement in studying food habits of waterfowl at Long Point, in vegetation surveys of the Inner Bay, and in aerial censusing of waterfowl at Long Point with the Long Point Waterfowl and Wetlands Research Fund (LPWWRF), and 4) the desire to bring this information together as part of the Long Point Environmental Folio Project in co-operation with the Long Point Waterfowl and Wetlands Research Fund (LPWWRF) and 5) an interest in Long Point in general; its vast wetlands, forests, and wildlife.

1.1a The Long Point Waterfowl and Wetlands Research Fund

The Long Point Waterfowl and Wetlands Research Fund (LPWWRF) was established in December 1987 under the auspices of the Nature Conservancy of Canada. The research program focuses on the development of a comprehensive body of knowledge on waterfowl and wetlands at Long Point. The research program is directed at determining the distribution and abundance of waterfowl, and at understanding their use of the Long Point area. The research plan involves 1) long-term monitoring of waterfowl numbers during migration, 2) determining what waterfowl are feeding on, 3) habitat monitoring, especially determining the distribution and density of aquatic vegetation and other food sources, 4) determining the impact of human disturbance on waterfowl, 5) assessing the impact of abiotic factors, and 6) predicting the impact of changes in water level fluctuations on wetland health. The LPWWRF is also involved in other projects such as the influence of zebra mussels on the Long Point ecosystem, the mallard - black duck hybridization process, and behavioral and molting studies of waterfowl.

1.1b The Long Point Environmental Folio

The Environmental Folio of the Long Point Biosphere is a project being undertaken by a study team at the Heritage Resources Centre, University of Waterloo. It is an attempt to provide information on waterfowl and wetlands, other key resources and the environment for use by citizens, planners and managers in the Long Point area. This project involves the collaborative efforts of graduate students, faculty and others interested in the Long Point region. The goal of the project is to gain an understanding of the natural and cultural processes and ecosystems in the Long Point Area for planning and management purposes (Nelson *et al.*, 1993). The project developed in response to issues such as land cover change and stresses resulting from increasing land use activities related to population growth, tourism and industrial and economic pressures (Beazley, 1993). The folio will consist of a series of background reports with maps and text synthesizing and graphically displaying important land use, resource and environmental information determined largely through public meetings, interviews with local people, and meetings with planners and public officials as well as library and some field research. It is hoped that the successful development of a folio process at Long Point will make it possible to use this system in other important areas.

The environmental folio is being presented in a series of technical reports, working papers, and working notes outlining key information on various important criteria and processes of the Long Point area; Beazley (1993) focused on landscape history, Wilcox (1993, 1994) on the economies, Skibicki (1993) on institutional and land tenure history, Chesky (1994) on passerine birds, Zammit (1994) on herpetofauna, Craig (1994) on fisheries, Stenson (1993) on geology and hydrology, and this study examines waterfowl and wetlands at Long Point. The ultimate aim is to summarize the information for each of the foci of study into two or three key maps and supporting text for inclusion in a summary document or folio.

The completion of a folio for the Long Point area required a comprehensive approach. A broad assessment framework was also needed for the collection and interpretation of data. The folio project is therefore organized through the Abiotic, Biotic, and Cultural (ABC) Resource Survey Approach (Nelson *et al.*, 1993). This approach provides an organizational framework for the collection of information on abiotic, biotic, and cultural features and processes of the region. The ABC Approach is also useful in providing a means of identifying significance and constraints related to the various natural and cultural characteristics of the area.

Research for this study on waterfowl and wetlands at Long Point evolved as part of the biotic component of the Long Point Environmental Folio Project. It is the third in a series of background reports prepared in co-operation with the Long Point Waterfowl and Wetlands Research Fund. The first, (Pauls and Knapton, 1993) outlined the distribution of submerged macrophytes in Long Point's Inner Bay and their value to waterfowl . The second, (Wilcox and Knapton, 1994) outlined waterfowl at Long Point, their numbers and distribution and a preliminary assessment of areas of significance and constraints of waterfowl use in Long Point's Inner Bay. This study builds on the work of these two earlier reports in order to assess the importance of the different areas in the Inner Bay for waterfowl and identify the stresses acting upon these areas. The information in this report may provide assistance for planners and land use managers at Long Point; it may also be of interest to scientists and scholars, and to generally concerned and informed citizens.

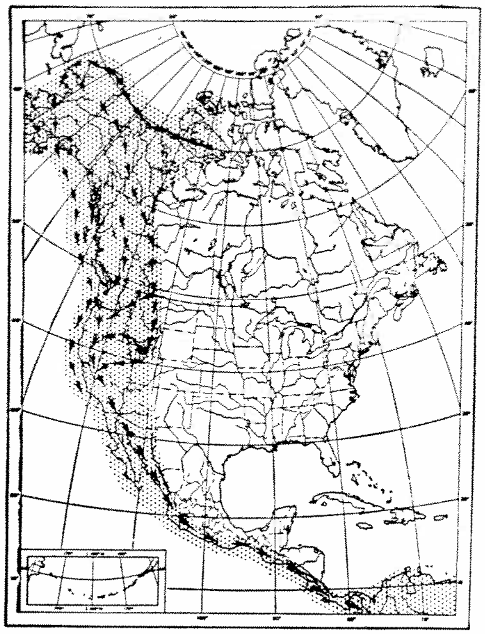
1.2 Study Area

The study area can be described at three levels: 1) its international position in relation to North American waterfowl flyways, 2) its regional setting, and 3) specific study areas within the Inner Long Point Bay.

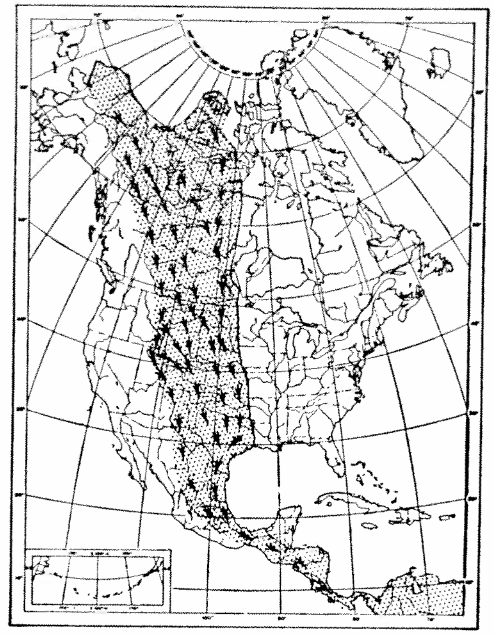
1.2a International

On an international scale, Long Point is located in southern Ontario along the north shore of Lake Erie. Its location on the Great Lakes puts Long Point on the path a major waterfowl flyway, the Atlantic flyway (Figure 1.2). Long Point's position on this flyway can be conceptualized as a stepping stone or a stop over area for waterfowl on flights between wintering areas along the east coast of the United States and the Gulf of Mexico, and summering areas in the prairies and in the Arctic. It has been estimated that three million waterfowl migrate annually through the Great Lakes region (Great Lakes Basin Commission, 1975), and that Long Point has the greatest waterfowl use of any area on the Great Lakes (Bookhout *et al.*, 1989; Dennis and Chandler, 1974).

Figure 1.2 North American Flyways (Source: Kortright, 1967)

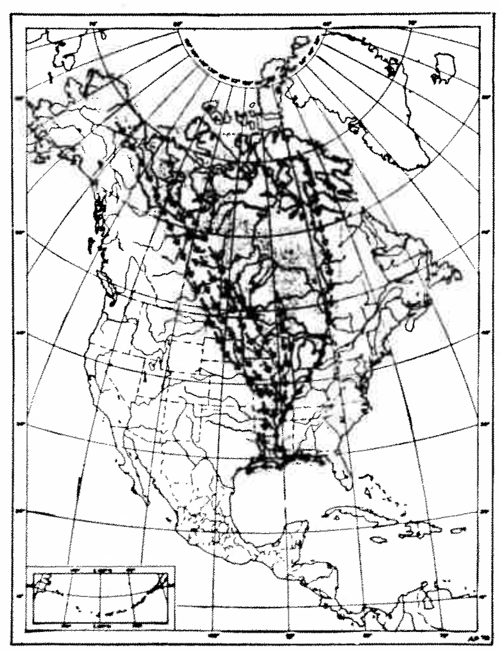


The Pacific Flyway



The Central Flyway

The Atlantic Flyway



The Mississippi Flyway

1.2b Regional

At a regional level, Long Point is located within the Regional Municipality of Haldimand-Norfolk which includes the Townships of Norfolk and Delhi and the City of Nanticoke (Figure 1.3). The Long Point region is situated within three distinct physiographic regions; the Norfolk Sand Plain, the Haldimand Clay Plain and the Long Point Spit (Chapman and Putnam, 1984) (Figure 1.4). The Norfolk sand plain consists of dune complexes, till moraines and ancient beach sandlines; the Haldimand Clay Plain is characterized by drumlin fields, eroding shore bluffs and shallow stream networks; the Long Point Spit is a dynamic combination of dune complexes and wetland marshes and is the largest sediment peninsula on the Great Lakes (Beazley, 1993).

Figure 1.3 Regional Map of Long Point (Adapted from the Long Point Environmental Folio series, Nelson *et al.,* 1993)

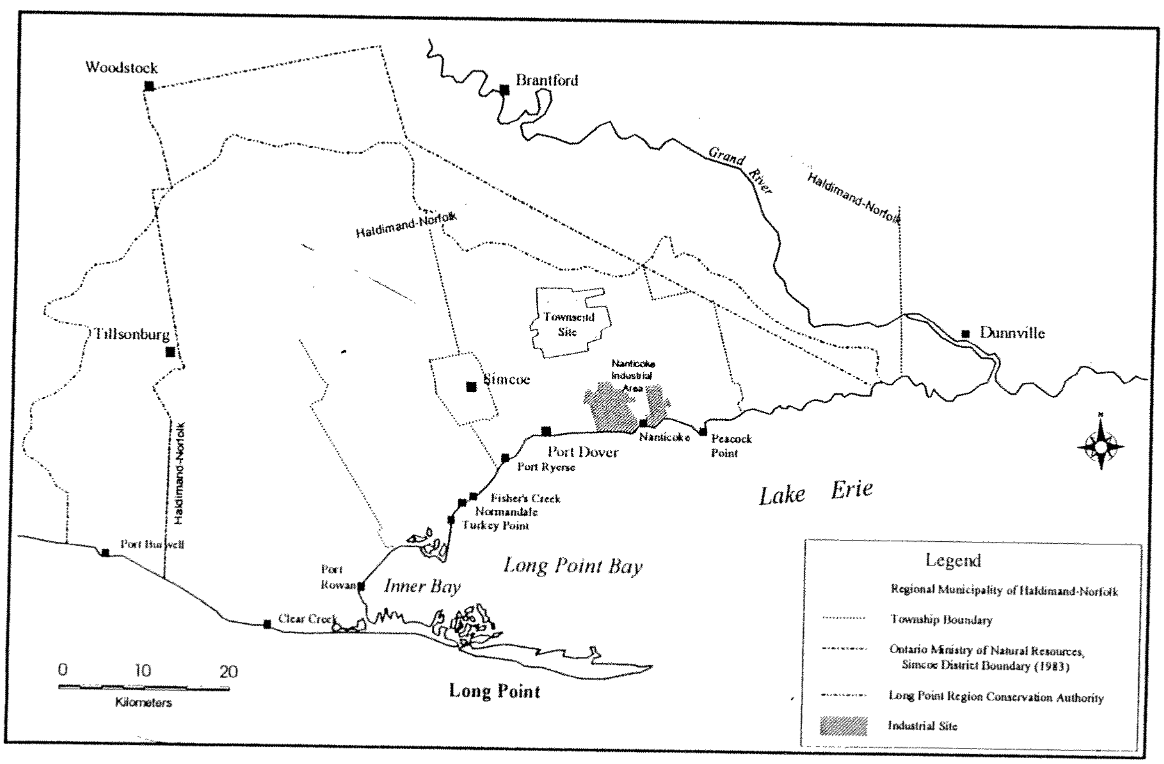
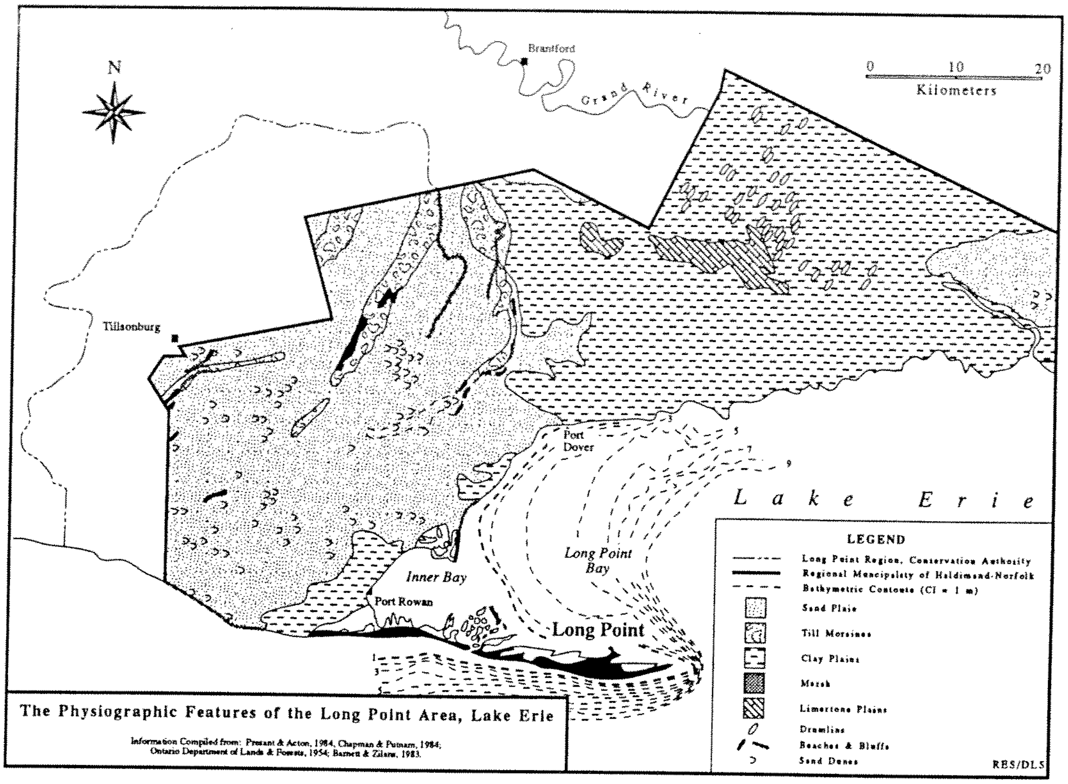


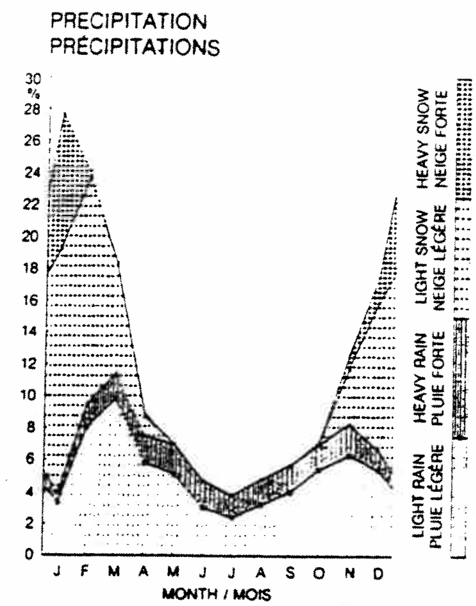
Figure 1.4 Physiographic Features of the Long Point Area (Adapted from the Long Point Environmental Folio Series, Stenson, 1993)



The climate of the Long Point region is characterized by hot, humid summers and mild winters (Wickware and Rubec, 1989) (Figure 1.5). The average temperature is 20°C in July and -6°C in January (Stenson, 1993). Usually, precipitation varies across the region from 60-80mm for July and from 64 to 82mm for January (Stenson, 1993).

The region is predominantly a rural agricultural landscape with scattered patches of remnant natural areas. Agricultural land comprises approximately 73 per cent of the total land area in the Regional Municipality of Haldimand Norfolk, with tobacco, grain, ginseng, and market vegetables comprising the major crops (RMHN, 1989). The steel, hydro-electric and oil refinery industries of the Nanticoke Industrial Complex exists at the northeast edge of Long Point's Outer Bay. Marina and cottage developments are concentrated on the north shore, along the causeway and in the community of Long Point itself (Skibicki, 1993; Beazley, 1993) (Figures 1.6 and 1.7). The Inner Bay supports a substantial fisheries industry (Whillans, 1979) with the entire shoreline of the Inner Bay licensed for commercial fishing (Craig, 1994). Sport fishing takes place primarily in July and August and occurs throughout the Inner Bay. Small settlements exist along the coast and inland. Simcoe and Delhi are larger regional centers.

Figure 1.5 Lake Erie Region Climate (Adapted from Saulesleja, 1986, for the Long Point Environment Folio Series, Staples, 1993)



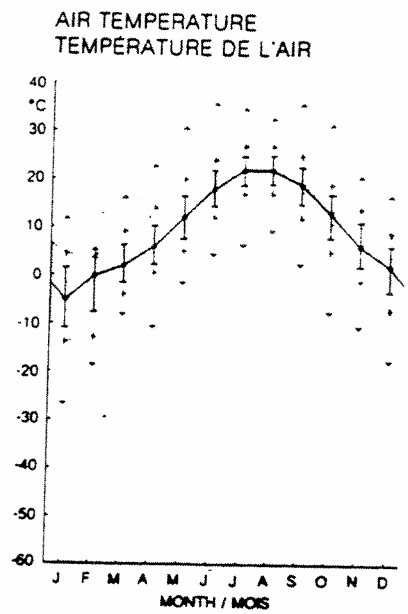


Figure 1.6 Marina and Cottage Developments Around the Inner Bay (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

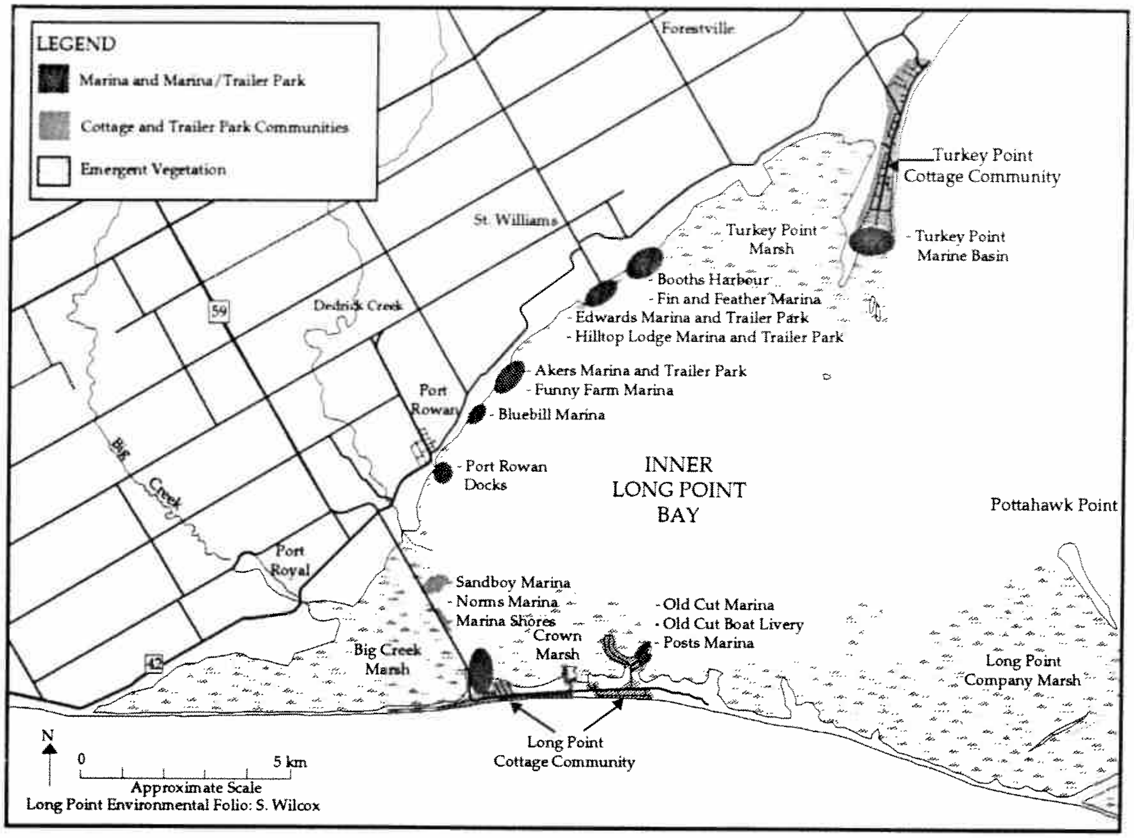


Figure 1.7 Cottage and Marina Developments at Long Point's Inner Bay (Photograph by P. Lawrence)

1.2c Specific Study Area

Long Point's Inner Bay has been defined as the area enclosed by the Long Point sand spit, the north shore of Lake Erie, and an imaginary line between Turkey Point and Pottahawk Point (Whillans, 1985). Three of the four sides of the Inner Bay are marshland (Figure 1.8). The Inner Bay is approximately 28km^2 in surface area, has a mean depth of one meter and a maximum depth that has exceeded three meters (Leech, 1981). Figure 1.9 shows depths recorded in the Inner Bay (Wilcox and Knapton, 1994).

Figure 1.8 Inner Bay (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

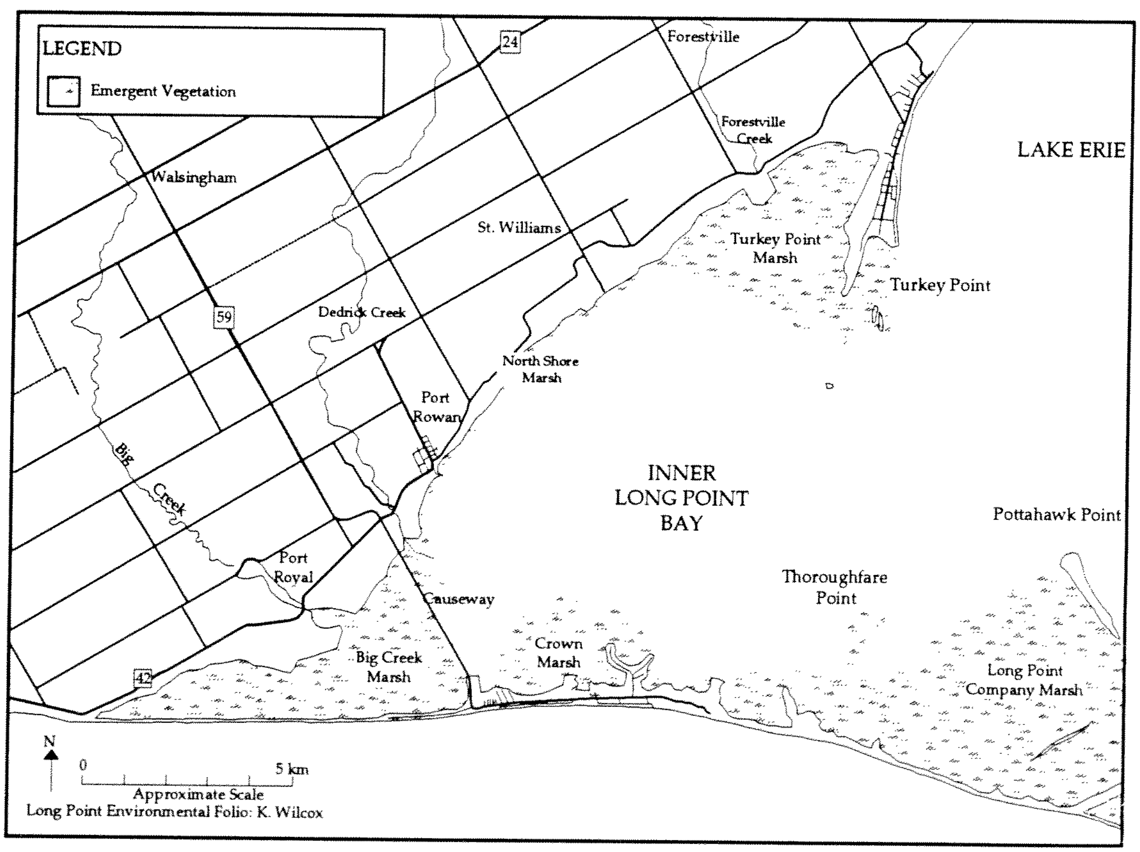
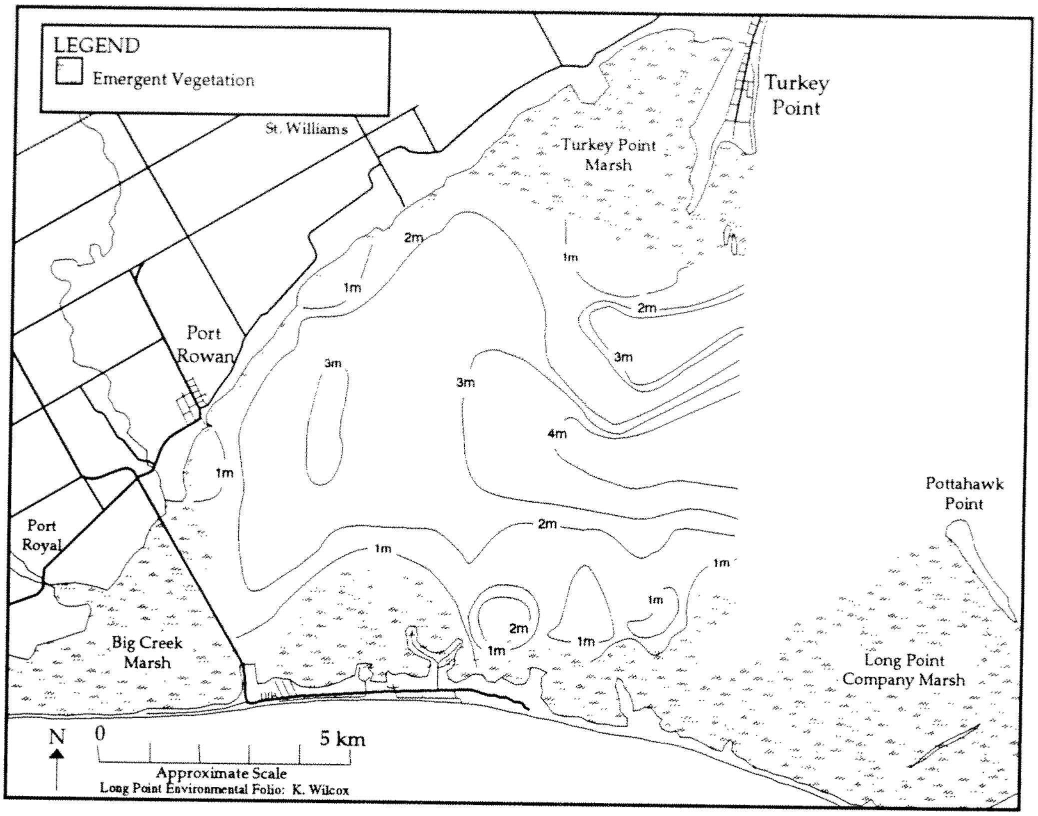


Figure 1.9 Bathymetry of the Inner Bay (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)



Big Creek is the only major tributary to the Inner Bay. It has a watershed of 72 526 hectares and drains the agricultural fields of Norfolk, Oxford, and Brant Counties into the Inner Bay. It is a major source of nutrients and suspended materials entering the Bay (Berst and McCrimmon, 1966, Downey *et al.,* 1994). Other streams flowing into the Inner Bay are Dedrick Creek and Forestville Creek.

Smith (1979) found that the bottom of the Inner Bay from the western shoreline to about 2km offshore was primarily mud. Sandy sediments existed along the south shore adjacent to Long Point and in a large triangular area extending into the Inner Bay south of Turkey Point. Sediments in the central area consist of a sandy loam mixture. Figure 1.10 shows general sediment types in the Inner Bay.

For the purposes of assessing the Inner Bay for migrating waterfowl in this study, the Inner Bay was divided into six separate units or areas: Turkey Point; North Shore; Big Creek; Crown Marsh; Thoroughfare Point; and, Open Water (Figure 1.11). The division of areas is based on some evidence of differences in plant communities identified in an earlier study of *Long Term Trends of Fish and Vegetation Ecology in Long Point's Inner Bay* (Whillans, 1985). Approximate boundaries have been applied to areas and these divisions have been used as a framework for analysis in this study. A statistical test (Canonical Correspondence Analysis) ideally should be applied to test the validity of these boundaries based on gradients of change in species (Posmyk, 1993), but this was beyond the scope of this thesis.

Figure 1.10 Substrates of Long Point's Inner Bay (Adapted from Smith, 1979 for the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

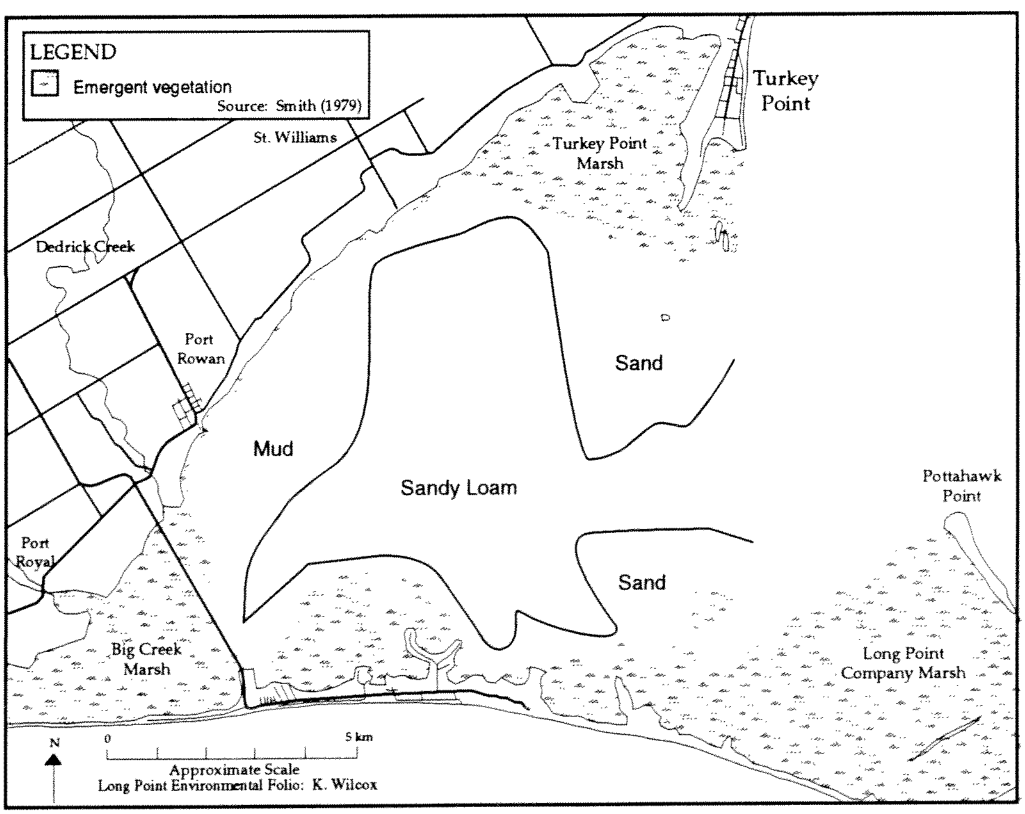
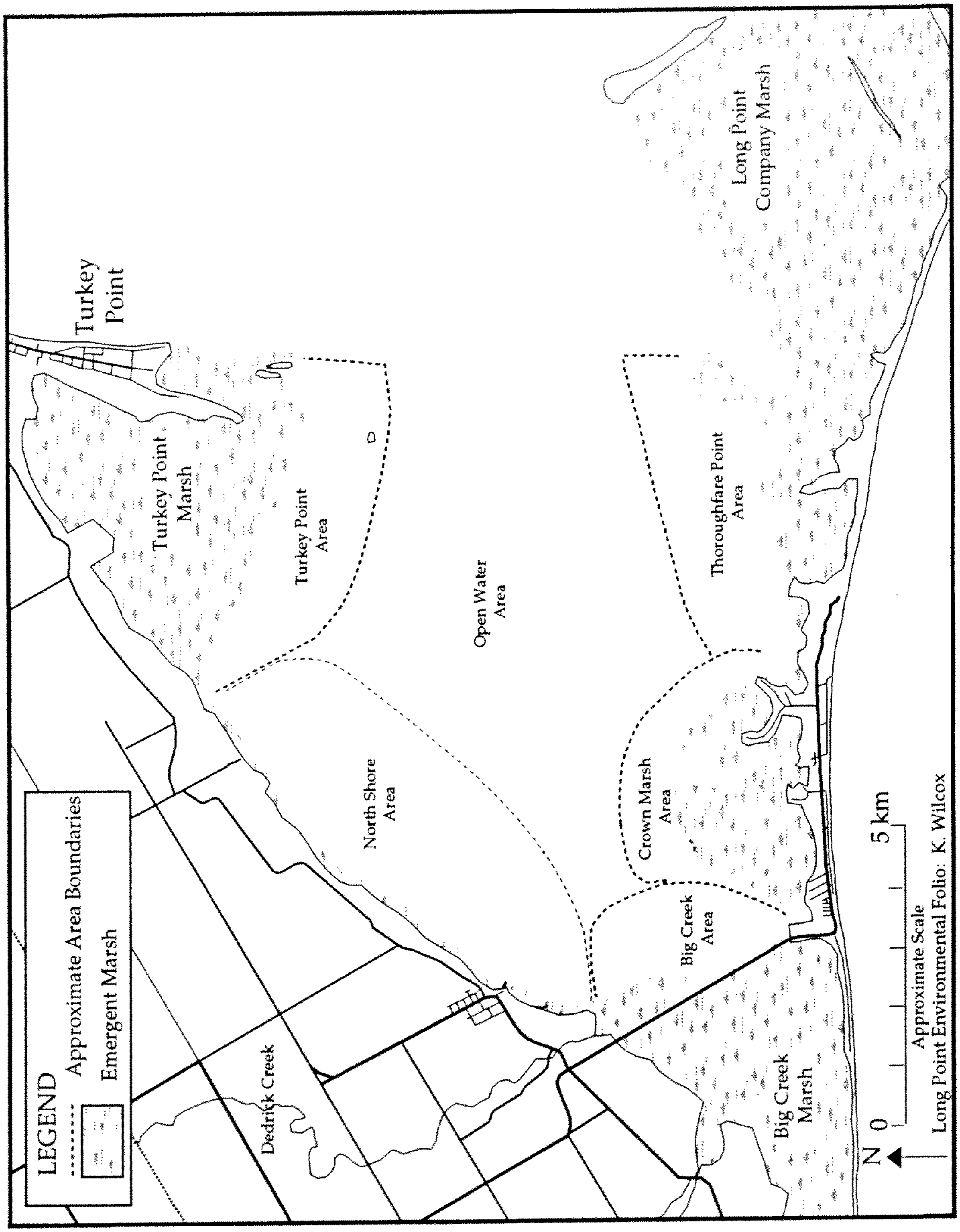


Figure 1.11 Areas in Long Point's Inner Bay



*The area boundaries are approximate and for purposes of this study focus on open water and submerged vegetation and not on the adjacent emergent marshes

For the purposes of this study, the Turkey Point area begins at the edge of Turkey Point Marsh and extends approximately 1200m into the open water. It does not include emergent vegetation although it is recognized that the boundary between submerged and emergent vegetation fluctuates with changing water levels in the Bay. The area of submerged vegetation currently ranges in depth from 1 to 2m with sand as its main substrate. The North Shore area is located along the north shore of the Inner Bay, stretching from the western edge of the Turkey Point area to Port Rowan. This area is quite shallow, generally averaging between 1 and 2 m in depth and has with a mud bottom. It extends out from shore about 2500m into the Inner Bay. The Big Creek area encompasses the shoreline and causeway area extending from Port Rowan to the Crown Marsh and out 2000m into the Inner Bay. It has an average depth between 1 and 2 m, with mud substrate. The Crown marsh area extends outward from the emergent vegetation of the Crown marsh into the Inner Bay approximately 2000m. It has mostly sandy loam substrate and ranges between 1 and 2 meters deep. The Thoroughfare Point area extends outward from the emergent vegetation into the Bay including Little Rice Bay and extending to Thoroughfare Point. This area has sand substrate and ranges between 1 and 2 meters in depth. The Open Water area refers to the central part of the Inner Bay, beyond the boundaries of the other areas. It has sandy loam substrate and ranges in depth from 2 to 4m. The plant communities in each of the areas consist of various submerged and floating-leafed aquatics, including musk grass *(Chara vulgaris)*, Eurasian milfoil *(Myriophyllum spicatum)*, naiads *(Najas guadalupensis* and *N. flexilis)*, wild celery *(Vallisneria americana)*, sago pondweed *(Potamogeton pectinatus)*, variable pondweed *(P. gramineus)* , Richardson's pondweed *(P. richardsonii)*, and Canadian waterweed *(Elodea canadensis)*. More details on the distribution of aquatic plants in each of the areas will be given in chapter 2.0.

1.3. Purpose of the Thesis

The purpose of this thesis is to assess Long Point's Inner Bay from the perspective of its importance as a critical staging area for waterfowl migration and to interpret the results in terms of their significance and constraints for planning and management of staging waterfowl. More specifically, the results are interpreted in terms of their implications for sustaining significant food resources and resting areas for waterfowl.

This thesis is designed to make several contributions. One is towards sustainable development, providing information of use in conserving the Inner Bay's resources and providing access to both the Inner Bay and waterfowl for present and future generations (IUCN, 1980; World Commission on Environment and Development, 1987). This study also contributes to the protection of biological diversity and productivity through recommendations to protect staging waterfowl in an internationally significant staging area.

On a more local level, this study contributes to planning around Long Point's Inner Bay by synthesizing existing ecological information on waterfowl (numbers and distribution, food resources and food habits) and interpreting this information in the context of significance and constraints for planning. This involves the development of a framework or system of mapping, analyzing, synthesizing and assessing various existing sources of information and offers a means of identifying areas of importance for planning in the Long Point area which should be of value to local governments, citizen and supporters of the Long Point Biosphere. It is hoped that these contributions will initiate discussion and understanding, inspire research and monitoring and provide information for strategic planning. Beyond the foregoing more direct applied contribution, this study contributes to the development of a research and planning method that links ecology and planning for areas such as Long Point. The core of this method is the ABC method with its capacity to synthesize diverse information in terms of significance and constraints for planning and management.

1.4 Approach

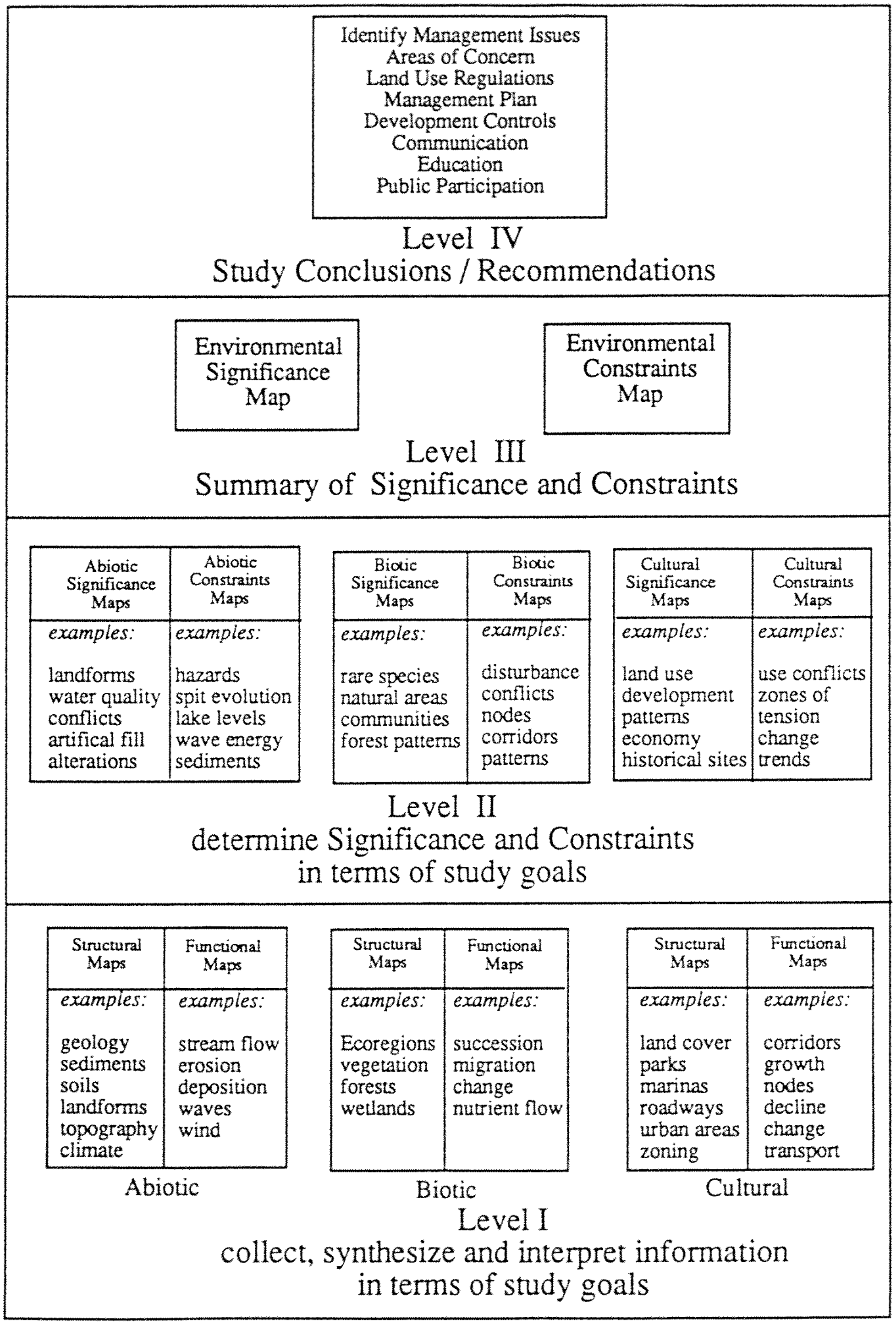
To assess Long Point's Inner Bay as a staging area for waterfowl, the Inner Bay was divided into six areas and the ABC Resource Survey approach was applied. The ABC approach uses several levels of information in order to assess an area for planning (Figure 1.12). The emphasis in this study was on the first and second levels of the ABC approach i.e., on collecting, analyzing and interpreting existing information for strategic planning and identifying research needs.

For the first level, submerged vegetation and invertebrate surveys (Pauls and Knapton, 1993) were used to determine what plant and invertebrate food resources are available for migrating waterfowl and where they are located. Waterfowl aerial survey data from 1969 till 1988 were used to analyze trends in duck numbers in Long Points Inner Bay (Canadian Wildlife Service data). Waterfowl surveys by the Long Point Waterfowl and Wetlands Research Fund (Wilcox and Knapton, 1994) were used to map the distribution of resting waterfowl in Long Point's Inner Bay. Although water quality data were collected by Environment Canada during the summers of 1991 and 1992, it was not available for analysis in this thesis.

For the second level, the information on food resources and refuge areas was interpreted in terms of significance and constraints. Priority areas were then identified for strategic planning.

Chapter 2 presents the baseline information on food resources and refuge areas in Long Point's Inner Bay. Chapter 3 outlines the assessment of significance and constraints for staging waterfowl at Long Point's Inner Bay, with the results being used for the defining of priority areas for planning and management in Chapter 4. Chapter 4 provides a synthesis of the findings and provides recommendations for planning and management.

Figure 1.12 The ABC Resource Survey Method (Adapted from the Long Point Environmental Folio Series Nelson *et al.* 1993)



CHAPTER 2

WATERFOWL FOOD RESOURCES AND REFUGE AREAS

2.0 Introduction and Approach

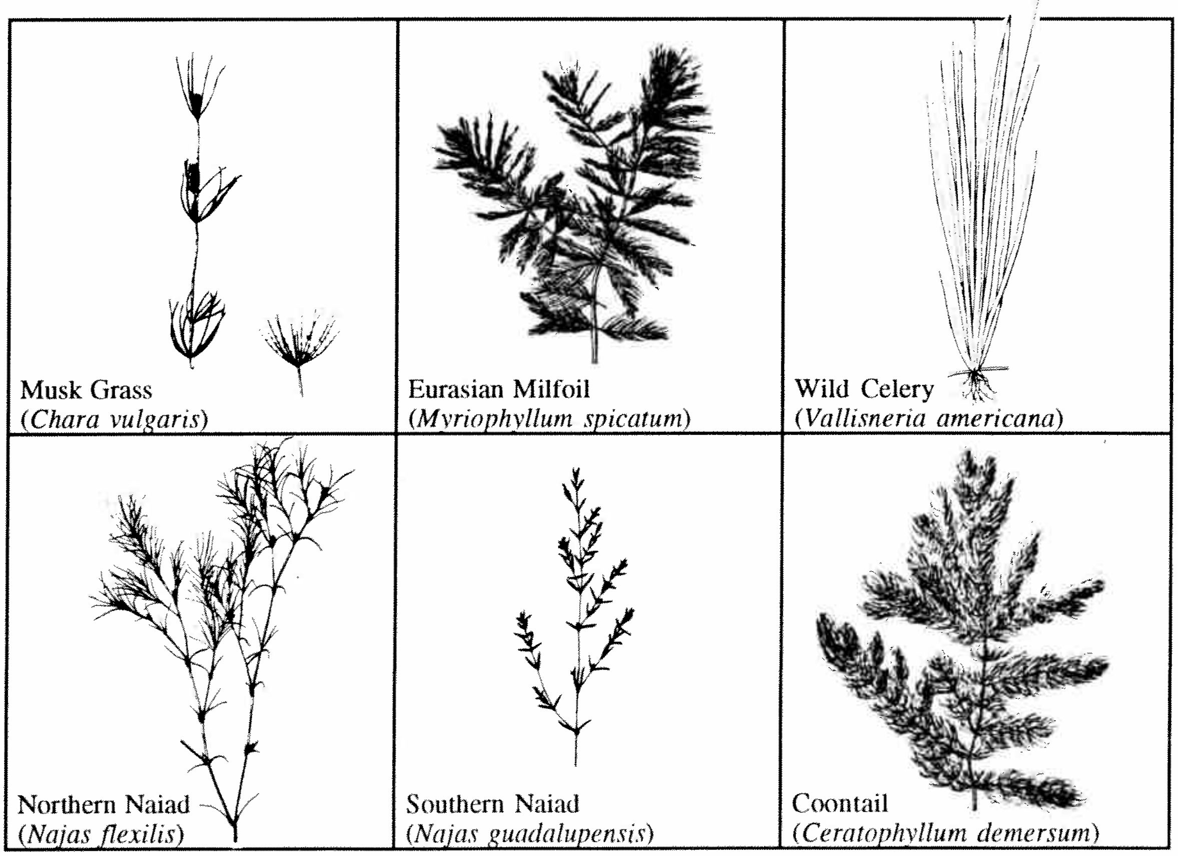
The purpose of this chapter is to describe the food resources and refuge areas in Long Point's Inner Bay and to discuss their importance for waterfowl. The information in this chapter is largely a synthesis of work that the author was involved in while working for the Long Point Waterfowl and Wetlands Fund during 1991 and 1992 and is summarized in Technical Reports #1 and #5 of the Long Point Folio Series. This chapter is divided into two parts: food resources and refuge areas. Part I describes the distribution of submerged macrophytes and macroinvertebrates in the Inner Bay and describes waterfowl food habits which were determined through studies at Long Point. Part II provides information on refuge areas through a description of waterfowl numbers and their distribution at Long Point during aerial surveys conducted in spring and fall, 1992. The maps produced for the foregoing purposes constitute theme or level I maps in accordance with the ABC Resource Survey approach. The results of this chapter provide a basis for interpretation of significance and constraints for planning in Chapter 3.

2.1 PART I Food Resources

Plant foods, such as wild celery (*Vallisneria americana*), and animal foods, such as snails (*Gastopoda*), have been identified as principal food sources for waterfowl during migration (Bookhout *et al.*, 1989). While waterfowl can obtain the required calories needed for migration from grain or corn, they miss some of the essential nutrients that can only be obtained through these natural foods in migration staging areas (Frederickson and Taylor, 1982). Submerged macrophyte distributions, macroinvertebrate distributions (for analysis purposes, macroinvertebrates have been divided into non-mollusc invertebrates and molluscs), and stomach analysis results for Long Point's Inner Bay are included in this section to indicate which foods are available and to give an indication of what foods are being consumed by waterfowl.

In particular, large aquatic plants i.e., submerged macrophytes, are included because of their well recognised importance as a food resource for migrating waterfowl (Bellrose, 1980; Martin and Uhler, 1935). In fact entire shifts in migrational patterns have been directly attributed to changes in the availability of this food resource (Bellrose, 1980). Dependence of migratory waterfowl on submerged macrophytes was demonstrated in Rondeau Bay by a dramatic drop in their numbers after a die-off of plants had occurred (Crowder and Bristow, 1988; Dennis *et al.*, 1984). Common submerged macrophytes of Long Point's Inner Bay are shown in Figure 2.0.

Figure 2.0 Common Submerged Macrophytes of Long Point's Inner Bay (Adapted from Hotchkiss, 1972)



Invertebrate distributions are also included here because of their importance as a possible food resource for waterfowl at Long Point. During migration, invertebrates are usually considered to comprise a small proportion of waterfowl foods (<5%, Korschgen, 1989). If declines in other food sources occur, however, invertebrates may become far more important. At Chesapeake Bay and in North Carolina, for example, where submerged macrophyte beds have declined, canvasbacks adapted to alternate food sources and now feed predominantly on molluscs (Perry *et al.*, 1981). The recent invasion by Zebra mussels *(Dreissena polymorpha)* and Quagga mussels *(D. bugensis)* of Long Point may result in food 'switching' in some species of waterfowl. In Lake Ontario, there is considerable speculation among biologists that the invasion of Zebra mussels may be responsible for the large congregations of waterfowl, particularly scoters (*Melanitta* spp.), during the past few winters (Ridout, 1993). Common invertebrates of Long Point's Inner Bay are shown in Figures 2.1 and 2.2.

Figure 2.1 Common Non-mollusc Invertebrates in Long Point's Inner Bay (Adapted from Ministry of Natural Resources, 1989)

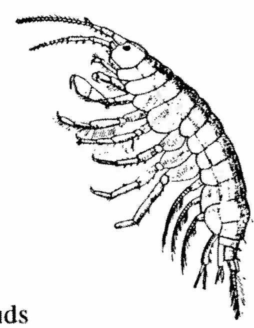
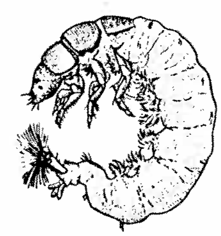
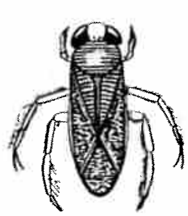
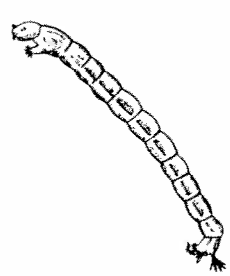
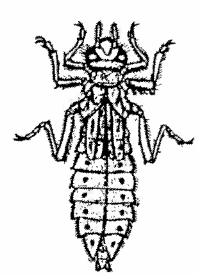
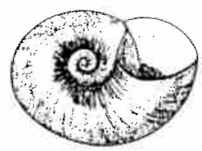
Size Range: 5-20mm	Size Range: 5-20mm	Size Range: 2-50mm
		
Scuds (*Amphipoda*)	Sow bugs (*Isopoda*)	Caddisfly (*Tricoptera*)
Size Range: 14-45mm	Size Range: 2-20mm	Size Range: 15-40mm
		
True Bugs (*Hemiptera*)	Chironomids (*Diptera*)	Dragonfly (*Odonata*)

Figure 2.2 Common Molluscs in Long Point's Inner Bay (Adapted from Ministry of Natural Resources, 1989)

Size Range: 2-70mm	Size Range: 2-250mm
	
Snails (*Gastropoda*)	Clams (*Pelecepoda*)

Finally, food habits of waterfowl at Long Point are included because very little is known about what waterfowl are consuming at Long Point. While Martin and Uhler (1935) studied waterfowl food habits in the Great Lakes area as part of a North American wide study, the food resources available at Long Point may be site specific and may have changed since that study was completed.

2.1a. Submerged Macrophyte Surveys of Long Point's Inner Bay

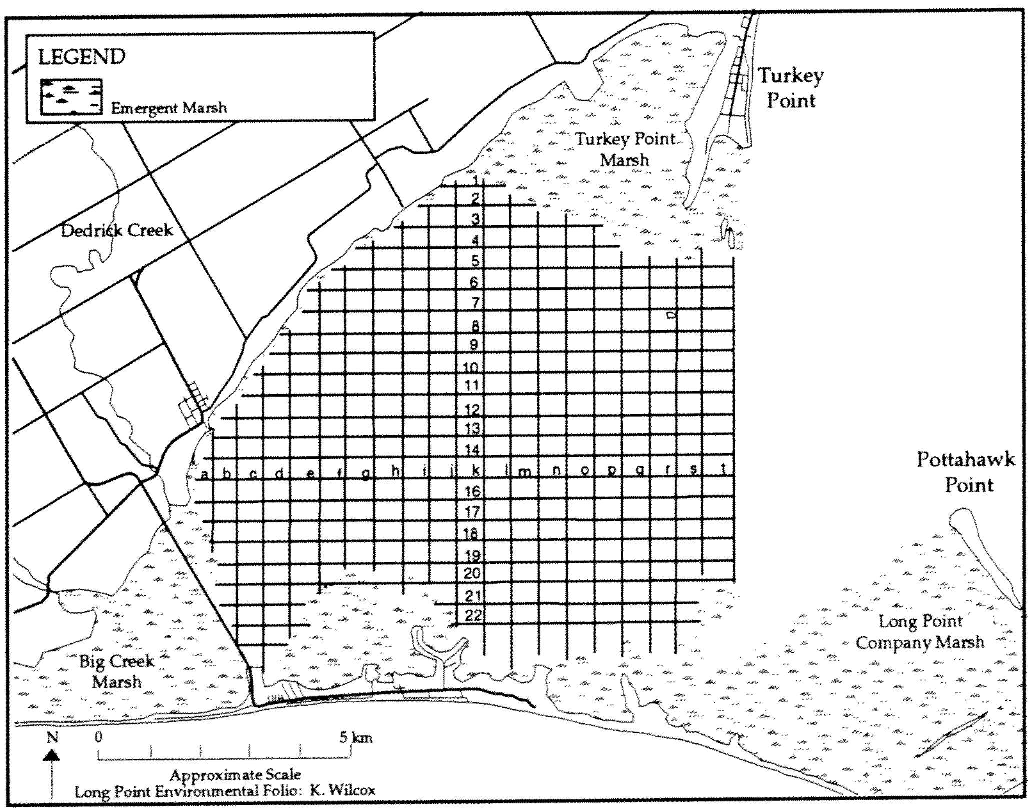
The abundance, distribution, and species of submerged macrophytes of Long Point's Inner Bay were recorded in 1976 by Smith (1979), and in 1991 and 1992 by the Long Point Waterfowl and Wetland's Research Fund (Pauls and Knapton, 1993). In all three years surveys were completed during the months of July and August. The results of these surveys were compared in an earlier folio report, *Submerged Macrophytes of Long Point's Inner Bay, their Distribution and Value for Waterfowl* (Pauls and Knapton, 1993). The results of this report suggested that few significant changes in plant distribution and abundance had occurred over this sixteen year time span.

Although data are available for all three years, only results of the 1991 and 1992 surveys will be used to generally describe the Inner Bay. Only the results of the 1992 data are applied to compare areas, since the 1991 survey grouped subdominant plants (14.5% of the plants) into families of plants (i.e., pondweeds, *Potamogeton* spp.) and not individual species as in 1992.

Methods

The methods used by the Long Point Waterfowl and Wetland's Research Fund to survey the submerged macrophytes of the Inner Bay in 1991 and in 1992 were similar to Smith's (1979) methods in 1976. A grid system was set up across the Inner Bay at 400m intervals on a north (magnetic) -south axis, and at 500m intervals on an east-west axis, with samples being taken at each point (Pauls and Knapton, 1993). Sample stations are shown in Figure 2.3.

Figure 2.3 Sample Stations (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)



Distance between sample stations was determined by averaging the time needed to travel between stations 400m apart, with this initial distance being determined using a LORAN-C navigational system. The boat was then operated at full throttle for the determined length of time along a transect line. Transect lines were determined using two fixed shoreline points approximately 500m apart (Pauls and Knapton, 1993).

Four samples of bottom sediments and plants were taken at each station using an Eckman Dredge, two on opposite sides of the bow, and two on opposite sides of the stern. Plants were identified using Britton and Brown (1976) with an estimation being made of percent abundance for each plant species i.e., the Braun Blanquet method (Mueller-Dombois and Ellenberg, 1974). Average percent abundance from the four samples was used to determine the percent composition of plants for each site. The plant species comprising the highest percentage of the plants sampled at each site was recognised as the dominant plant.

Findings

Overall, the findings of the 1991 and 1992 surveys indicate that the bottom of the Inner Bay is almost completely covered in submerged aquatic vegetation and that the distribution of plant types in the Inner Bay is not uniform. Seventeen different species of submerged macrophytes were identified in the Inner Bay. Table 2.0 shows the percent composition of all the submerged aquatic vegetation in the Inner Bay in 1992. Musk grass, along with Eurasian milfoil (*Myriophyllum spicatum*), wild celery, and naiads (*Najas* spp.) comprised 91.7% of the plant composition in 1992 and 85.5% in 1991 (Pauls and Knapton, 1993). Each of the dominant plants was mapped individually using SPANS-a computerized Geographic Information System by Intera Tydac- with a single map being produced to provide a general picture of the Inner Bay macrophyte distribution in 1992 (Wilcox and Knapton, 1994) (Figure 2.4).

For the purposes of comparing the six areas in Long Point's Inner Bay in the following chapter, the Long Point Waterfowl and Wetland's Research Fund 1992 survey is used to describe each of the individual areas. The plant composition for each of these general areas is provided in Figure 2.5 and shown in Table 2.0

Figure 2.4 Dominant Plant Distributions in Long Point's Inner Bay 1992. (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

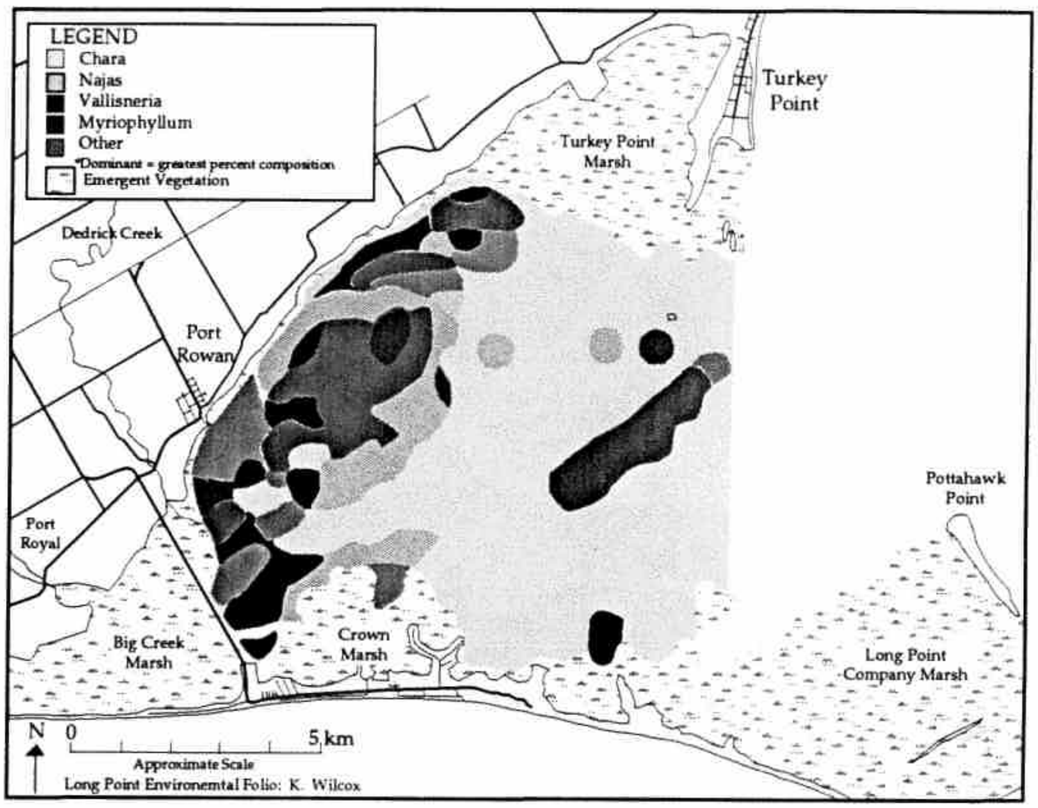


Figure 2.5 Inner Bay Plant Composition

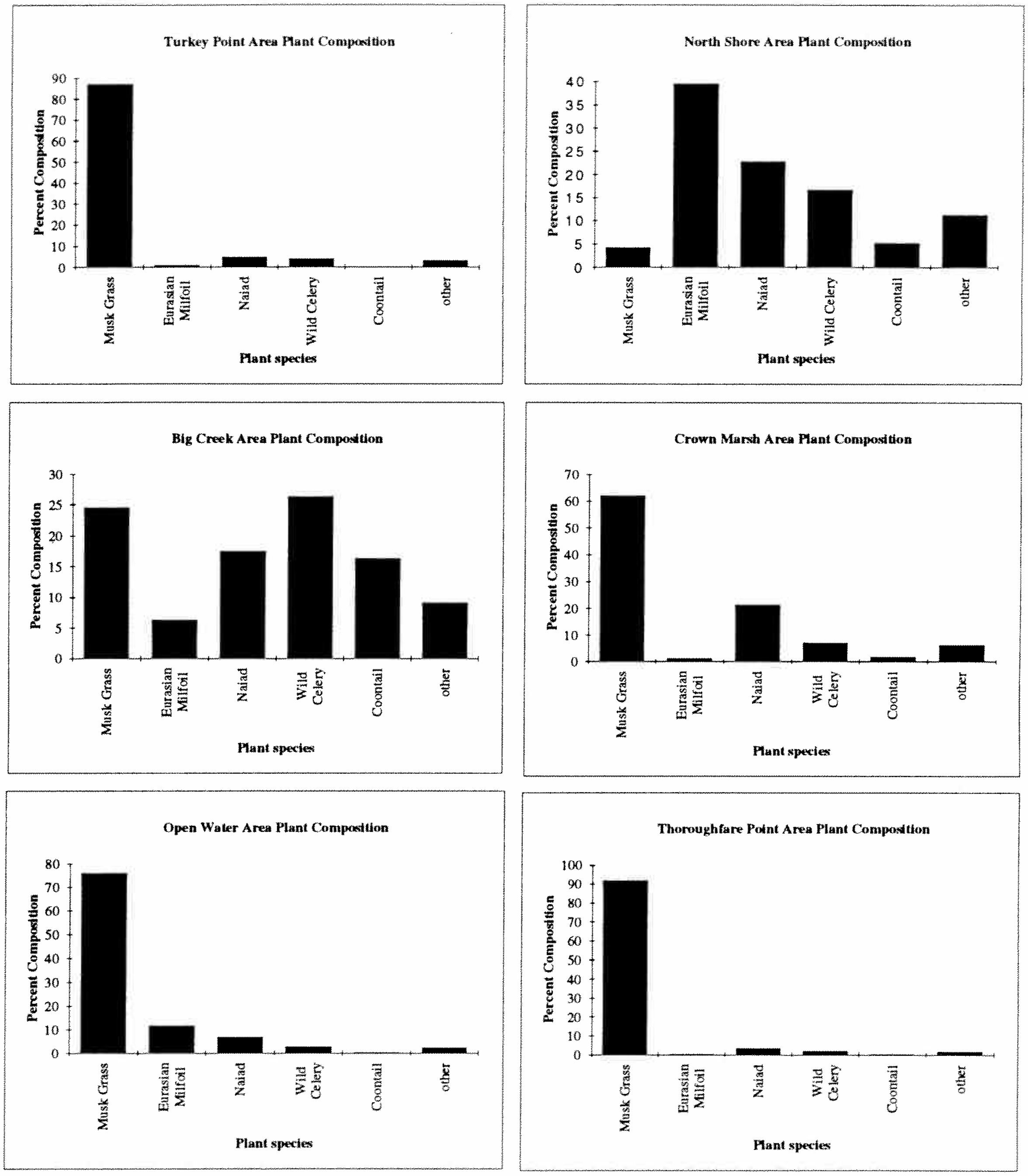


Table 2.0 1992 Plant Composition in each Area of Long Point's Inner Bay (shown as a % of the total plants in each area)

Submerged Macrophytes		Entire Inner Bay	Turkey Point	North Shore	Big Creek	Crown Marsh	Thorough-fare Point	Open Water
Common Name	Scientific Name							
Musk Grass	*Chara vulgaris*	57.4	87.0	4.3	24.5	62.1	91.7	75.9
Eurasian Milfoil	*Myriophyllum spicatum*	13.4	0.8	39.6	6.3	1.2	0.5	11.7
Naiad	*Najas spp.*	12.1	4.9	22.9	17.5	21.3	3.6	6.9
Wild Celery	*Vallisneria americana*	8.8	4.2	16.7	26.3	7.15	2.2	3.0
Coontail	*Ceratophyllum demersum*	3.1	0	5.3	16.3	2.0	0.1	0.1
Variable Pondweed	*Potamogeton gramineus*	0.8	1.0	1.2	0.2	0.2	2.4	1.0
Richardson's Pondweed	*P. richardsonii*	0.9	0.9	3.3	2.5	1.9	0.5	0.4
Canadian Waterweed	*Elodea canadensis*	0.4	0	1.2	1.7	3.4	0.1	0.4
Sago Pondweed	*P. pectinatus*	0.2	0.3	0.3	2.2	0	0	0.3
Slender pondweed	*P. pusillus*	0.1	0.1	0.7	0.1	0	0	0.2
Curly-leaved Pondweed	*P. crispus*	0.1	0	0.2	.02	0.3	0	0.1
Illinois Pondweed	*P. illinoensis*	0.1	0	0	0	0	0	0
Mud Plantain	*Heteranthera dubia*	0.1	0	1.9	2.2	1.3	0	0.1
Flat-stem Pondweed	*P. zosteriformis*	0.1	0	0.3	0	0	0	0
Slender Pondweed	*P. strictifolius*	tr*	0	0.3	0	1.0	0	0
Floating-leaf Pondweed	*P. nodosus*	tr	0	0.1	0	0	0	0
No. of Sample Stations		322	30	66	37	25	44	120

***tr=trace**

While the validity of distinction among areas is not of primary importance to this study of waterfowl food sources, statistical tests were performed to ascertain if there were significant statistical differences among them. Student Newman-Keuls (Statistical Analysis Software, Version 6.0) was used to compare the distribution of the five most abundant plant species among areas. The results are shown on Table 2.1. Areas with the same letter were found not to be significantly different.

Table 2.1 Plant Species Correlations: Significant at 5% level

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point	Open Water Area
Musk Grass	A	B	C	A	A	A
Wild Celery	B	C	C	B	A	A
Eurasian Milfoil	A	B	C	A	A	A
Naiad	A	B	C	B	A	A
Coontail	A	B	C	A	A	A

Note: Areas with the same letter are not significantly different.

Summary

Results suggest that in terms of the occurrence of submerged plant species, several different areas occur in the Inner Bay. The findings mean that planners can begin to think of the Bay in terms of different geographical or ecological areas, although more work is needed to define such areas more fully. In terms of the findings of the study, each area appears to have a distinct plant community. The North Shore and Big Creek areas in particular, both seem to have distinct plant communities.

2.1b. Macroinvertebrate Survey of Long Point's Inner Bay

Prior to Wilcox and Knapton (1994), no studies had been completed on the invertebrates of Long Point's Inner Bay. With no comprehensive assessments of macroinvertebrate densities and distributions across the entire Inner Bay in the past, it is difficult to know how representative the 1992 data are. Nevertheless, for the purposes of this study, the Long Point Waterfowl and Wetland's Research Fund survey of macroinvertebrates in 1992 is used to describe the macroinvertebrate food resources of the Inner Bay.

Methods

The methods used by the Long Point Waterfowl and Wetland's Research Fund to survey the macroinvertebrates of the Inner Bay in 1992 were similar to the submerged macrophyte surveys previously described, in that the same grid system was used for collecting samples. The macroinvertebrates were also collected simultaneously with the submerged macrophytes. The only difference between the submerged macrophyte survey and the macroinvertebrate survey is that only the fourth sample taken at every other station was bottled and brought back to the lab for invertebrate analysis. Invertebrates were identified according to taxonomic order using Pennak (1978) and counted. Later, their abundance per meter square was calculated and they were grouped into two categories; non-mollusc invertebrates and molluscs.

Non-mollusc Invertebrates

Overall, the findings of the 1992 macroinvertebrate survey indicate that non-mollusc invertebrates occur throughout the entire Inner Bay and also that the distribution of non-mollusc invertebrate abundance is not uniform. Ten different taxonomic orders of non-mollusc invertebrates were surveyed in Long Point's Inner Bay. Species of *Diptera* and *Amphipoda* comprised 89% of the non-mollusc invertebrates in the Inner Bay. Table 2.2 shows the average number of non-mollusc invertebrates per square meter across the Inner Bay, and for the purposes of comparing areas in the following chapter provides a breakdown of non-mollusc invertebrate abundance for each area. Figure 2.6 shows non-mollusc invertebrates as an average number per square meter in the Inner Bay to illustrate their general distribution. Because 'potential mapping' was completed using the Spans system, the data points appear as circles (Spans is a computerized mapping program by Intera Tydac). This method of mapping involves drawing a perimeter around each of the data points and shading within this perimeter relative to the abundance at each site.

Table 2.2 1992 Non-mollusc Invertebrate Composition in Long Point's Inner Bay (shown as an average number per m2 at each sampling station) (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton ,1994)

Invertebrates		Entire Inner Bay	Turkey Point	North Shore	Big Creek	Crown Marsh	Thorough-fare Point	Open Water Marsh
Common Name	Scientific Name							
Chironmid larvae	*Diptera*	685	1111	255	234	1164	790	819
Scuds	*Amphipoda*	427	456	195	362	576	612	471
Sow bugs	*Isopoda*	140	157	108	181	136	172	128
Mites	*Acarina*	58	231	33	2	8	38	58
Worms	*Oligeocheatea*	53	77	84	49	28	40	39
Blood suckers	*Hirudinaea*	22	22	19	5	60	23	23
Caddisfly larvae	*Tricoptera*	17	11	12	20	12	26	19
Nematode	*Planaria*	7	3	9	20	8	2	5
Mayfly larvae	*Ephemeroptera*	2	6	1	2	0	2	2
Dragonfly larvae	*Odonata*	1	0	1	0	0	0	0
Number of Sample Stations		159	16	33	18	11	23	58
Avg. Number of invertebrates per/m2		**1412**	**2074**	**717**	**875**	**1992**	**1705**	**1564**

Figure 2.6 Non-mollusc Invertebrate Distribution in the Inner Bay, Summer 1992. (Adapted from the Long Point Folio Series, Wilcox and Knapton ,1994)

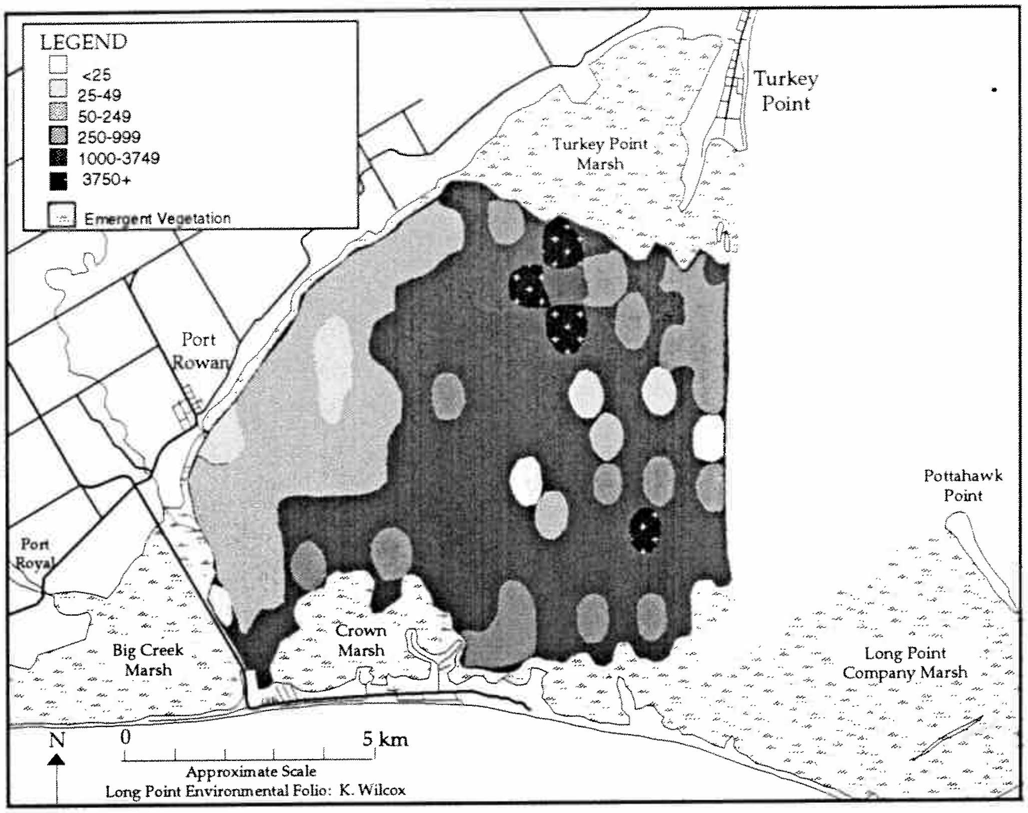
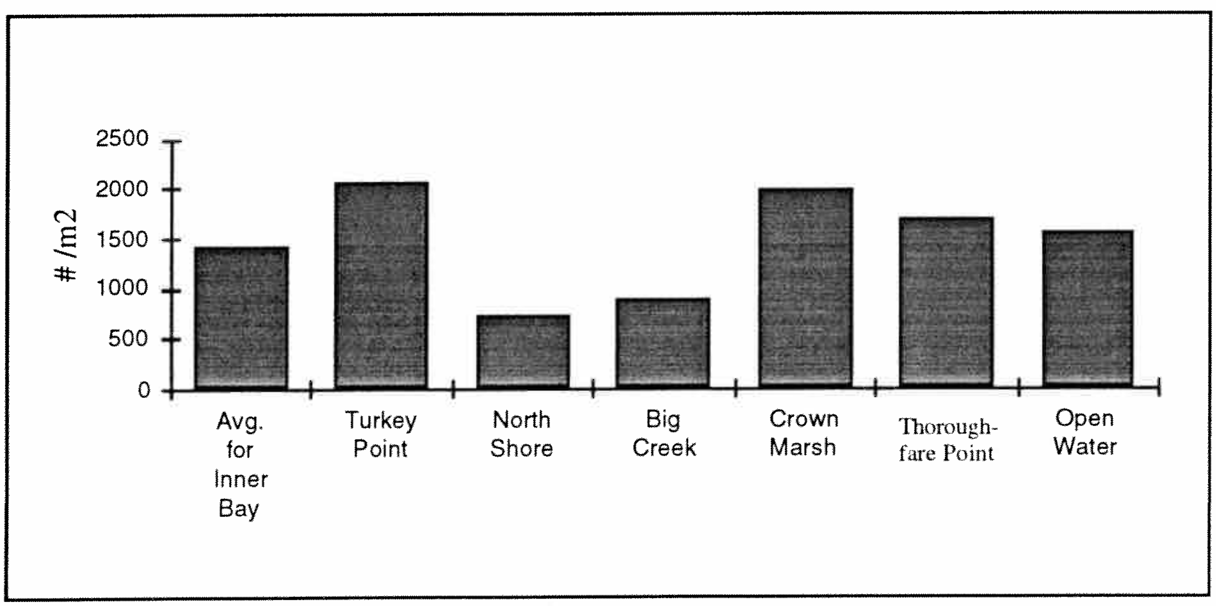


Figure 2.7 Non-mollusc Invertebrate Abundance in Long Point's Inner Bay



Student Newman-Keuls (Statistical Analysis Software, Version 6.0) was used to compare the abundance of non-mollusc invertebrates among the Inner Bay areas. A significant difference ($p<0.05$) was found between the abundance of non-mollusc invertebrates in the North Shore and Big Creek areas and the other four areas, i.e., the North Shore and Big Creek areas had significantly lower numbers of non-mollusc invertebrates than the other four areas (Table 2.3).

Table 2.3 Non-mollusc Invertebrate Abundance Correlations: Significant at 5% level

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Non-mollusc Invertebrates	A	B	B	A	A	A

Note: no significant difference among areas with the same letter

Summary

While caution is advised in interpreting the results, it appears that there are differences in the abundance of non-mollusc invertebrates among areas in the Inner Bay. In particular, the North Shore and Big Creek areas are similar to one another in having significantly fewer non-mollusc invertebrates than the other areas.

Molluscs

The findings of the 1992 macroinvertebrate survey indicated that molluscs are distributed throughout the entire Inner Bay and that they are comprised mainly of snails (*Gastropoda*) (43.7%) and zebra /quagga mussels (54%). It is important to note that zebra mussels and quagga mussels are exotic species of molluscs and that they were not distinguished from one another in 1992.

Table 2.4 shows the average number of molluscs/per meter square for the entire Inner Bay, as well as an average number per square meter in each of the Inner Bay areas, in order to provide a basis for comparing areas in the following chapter. Figure 2.8 shows molluscs distribution in the Inner Bay. Figure 2.9 illustrates mollusc abundance in each Inner Bay areas using a histogram. It is also important to note that there was a differential distribution of molluscs, i.e., snails were concentrated along the western side of the Inner Bay, and zebra/quagga mussels on the eastern side.

Table 2.4 1992 Mollusc Composition in each of the Areas of Long Point's Inner Bay (shown as a number per m2 at each sampling station) (Source: the Long Point Waterfowl and Wetland's Research Fund)

Molluscs		Entire Inner Bay	Turkey Point	North Shore	Big Creek	Crown Marsh	Thorough-fare Point	Open Water
Common Name	Scientific Name							
Snail	*Gastropoda*	690	366	973	1222	484	660	668
Clam	*Pelecepoda*	34	85	14	42	16	67	27
zebra/quagga mussels	*Dreissena polymorpha/ D. bugensis*	854	839	629	210	48	319	1752
Number of Sample Stations		159	16	33	18	11	23	58
Avg. Number per/m2		**1578**	**1290**	**1616**	**1474**	**548**	**1046**	**2447**

2.8 Mollusc Distribution in Long Point's Inner Bay, Summer 1992 (Source: the Long Point Waterfowl and Wetland's Research Fund)

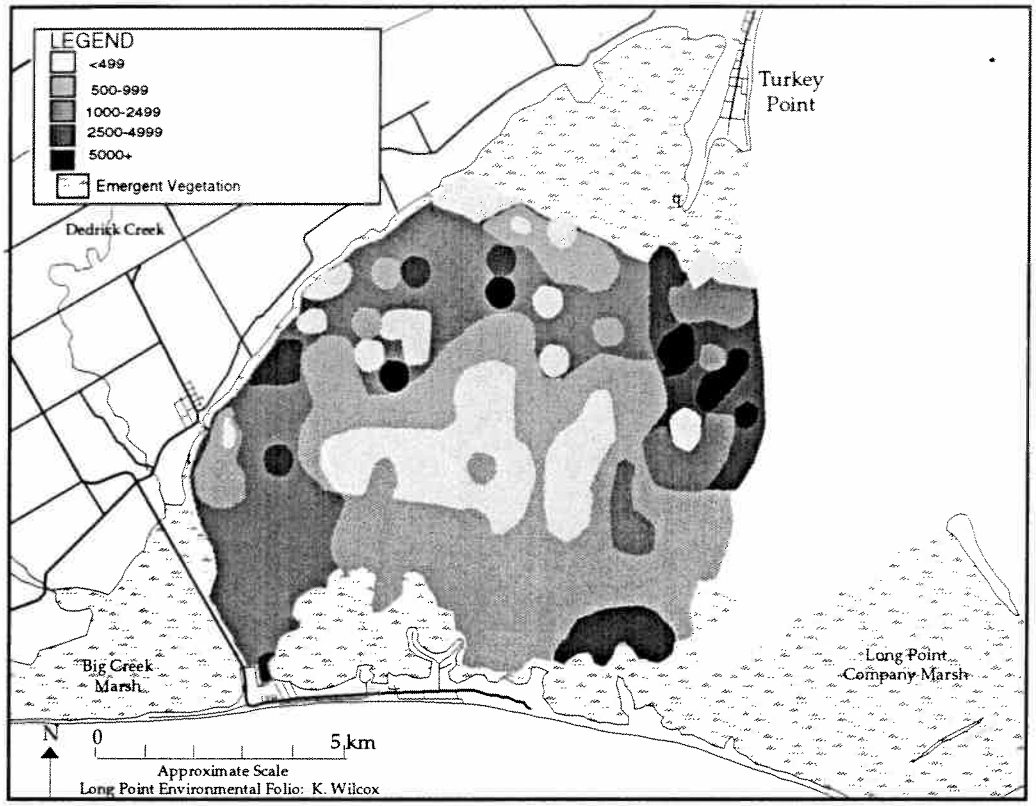
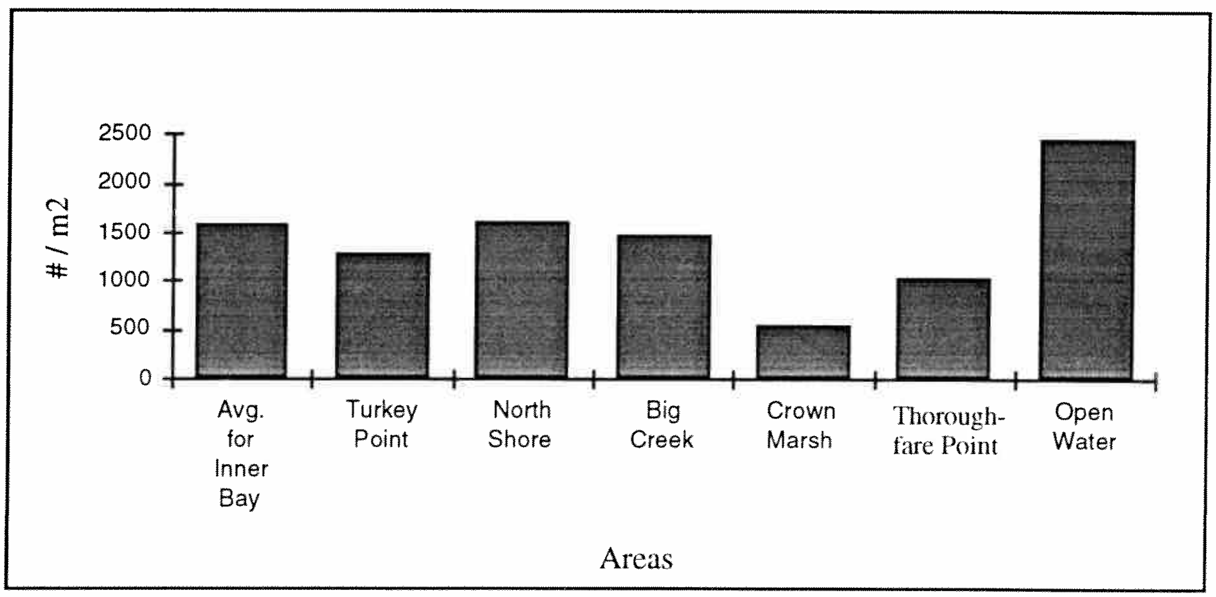


Figure 2.9 Mollusc Abundance in Long Point's Inner Bay



Student Newman-Keuls (Statistical Analysis Software, Version 6.0) was used to compare the abundance of all molluscs in each of the Inner Bay areas. The difference among the areas are shown on Table 2.5 .

Table 2.5 Mollusc Abundance Correlations: Significant at 9% level

	Open Water Area	North Shore Area	Big Creek Area	Turkey Point Area	Thorough-fare Point	Crown Marsh Area
Molluscs	A	A	B A	B A	B	B

Note: No significant difference among areas with the same letter

2.1c. Food Habits of Waterfowl at Long Point during Fall Migration

Prior to Pauls and Knapton (1993), no studies had been compiled on the food habits of waterfowl staging at Long Point's Inner Bay. While studies of ecological isolation between diving ducks (*Aythya* species) have been undertaken at Long Point (Smith, 1979), the focus has been on identifying differences among general foraging behavior, foraging characteristics such as bill length, and the selection of general food types; not on species identification of plant and animal foods. The information presented here is based on one year of data, 1992. While information was available for waterfowl food habits in 1991, it was not used because different species were collected and therefore are not comparable. Even the 1992 data should be interpreted with caution because the representation of the different species in the sample is not proportional to the number of different waterfowl species in the area. The information included here is based on the analysis of 200 waterfowl stomachs collected by the Long Point Waterfowl and Wetlands Research Fund in 1992. The findings are summarized in Technical Report #1 of the Long Point Folio Series. Since this is the first study of its kind on food habits of waterfowl at Long Point, it is not possible to determine if food habits of waterfowl at Long Point have changed over time.

Methods

The methods used by Long Point Waterfowl and Wetland's Research Fund involved the analysis of duck gizzards and proventriculi provided by hunters at the Long Point Waterfowl Management Unit in the fall of 1992 (Pauls and Knaptons, 1993). In addition, a number of ducks, particularly wood ducks and scaup, were provided for analysis by hunters from other hunting locations in the Long Point area.

Table 2.6 List of waterfowl studied and the numbers of stomachs analyzed (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

Common Name	Scientific Name	No. Analyzed in 1992
American Black Duck	*Anas rubripes*	34
Wood Duck	*Aix sponsa*	29
Canvasback	*Aythya valisineria*	19
Redhead	*Aythya americana*	22
Goldeneye	*Bucephala clangula*	3
Greater Scaup	*Aythya marila*	24
Lesser Scaup	*Aythya affinis*	46
Oldsquaw	*Clangula hyemalis*	2
Bufflehead	*Bucephala albeola*	18
Ruddy Duck	*Oxyura jamaicensis*	3
	Total	200

The proventriculi and gizzards were taken from each bird, bagged separately and put on ice as quickly as possible for later processing. Contents were separated into the following groups: leaves, stems, seeds, invertebrates and grit. Detailed identification were then based on Britton and Brown (1976), Martin and Barkley (1961) and Pennak (1978). Food items were dried at 65 C until constant weight was obtained, with each food item then being weighed to the nearest milligram. Food items were expressed as a percent occurrence of the total aggregate dry weight (Pauls and Knapton, 1993).

Findings

The results of the fall food habit study have been divided into two parts: plant foods, and invertebrate foods. Plant foods consumed by waterfowl, particularly submerged macrophytes, are discussed first, followed by a description of the macroinvertebrate foods consumed by waterfowl.

Plant Foods

Overall, the findings of the fall food habit study suggest that waterfowl exploit a variety of plant food resources during their stay at Long Point. Over thirty different species of plants were consumed. Plant food items ranged in type from grains, such as oats and corn, to emergent vegetation, such as wild rice (*Zizania palustris*) and burr reed (*Sparganium eurycarpum*), to submerged vegetation, such as wild celery and musk grass.

The results showed that corn and oats were consumed in the greatest quantities as an aggregate percent dry weight of all the plant food items. While these items comprised over 55% of the total weight of the plant foods consumed in 1992, these items were likely consumed by waterfowl in established waterfowl feeding areas in the Long Point Waterfowl Management unit, and were not likely consumed in nearby fields, although more research is needed to confirm this idea. Of the submerged aquatic vegetation, wild celery and musk grass were consumed in the greatest quantities. Other important plant foods were seeds of fragrant waterlily (*Nymphaea odorata*), wildrice (*Zizania palustris*) and burr reed (*Sparganium eurycarpum*) Table 2.7.

For the purposes of comparing the importance of areas in the following chapters, only submerged macrophytes consumed by waterfowl are used because they are naturally occurring in the study areas.

Table 2.7 Plant Foods Consumed by Selected* Waterfowl at Long Point, Fall 1992. (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

Common Name	Scientific Name	% Occurrence.	Agg. % (weight	
Corn	*Zea mays.*	7.0	38.39	--------------------------------
Oats	*Aven sativa*	2.5	17.7	-----------------
Wild Celery	*Vallisneria americana*	8.0	7.02	------
Fragrant Waterlily	*Nymphaea odorata*	2.0	4.44	---
Wildrice	*Zizania palustris*	4.5	3.21	--
Burr reed	*Sparganium eurycarpum*	16.5	1.63	-
Musk Grass	*Chara vulgaris*	7.5	1.45	-
Variable Pondweed	*Potamogeton gramineus*	6.5	1.39	-
Naiad	*Najas spp.*	12.0	1.28	-
Richardson's Pondweed	*Potamogeton richardsonii*	9.5	1.05	-
Arrowhead	*Sagitaria latifolia*	3.5	1.05	-
Coontail	*Ceratophyllum demersum*	2.5	0.57	-
American Lotus	*Nelumbo lutea*	0.5	0.48	-
Eurasian Milfoil	*Myriophyllum spicatum*	9.5	0.35	-
Floating Leaved-pondweed	*Potamogeton natans*	2.5	0.34	-
Smart Weed	*Polygonum lapathifolium*	6.0	0.33	-
Pannic Grass	*Panicum spp.*	1.5	0.33	-
Hard Stem Bulrush	*Scirpus acutus*	20.5	0.31	-
Sago Pondweed	*Potamogeton pectinatus*	4.5	0.23	-
Pickerel Weed	*Pontederia cordata*	6.0	0.21	-
Lesser Duckweed	*Lemna minor*	0.5	0.17	-
White-water Buttercup	*Ranunculus longirostris*	5.0	0.08	-
Smart Weed	*Polygonum pensylvanicum*	1.5	0.08	-
American Bulrush	*Scirpus americanus.*	12.0	0.07	-
Bullhead Waterlily	*Nuphar variegata*	7.0	0.05	-
Soft Stem Bulrush	*Scirpus validus*	9.0	0.05	-
Smart Weed	*Polygonum amphibium*	2.5	0.04	-
Spike Rush	*Eleocharis palustris*	1.5	0.04	-
Bulrush	*Scirpus fluviatilis*	5.7	0.03	-
Water Shield	*Brasenia schreberi*	4.0	0.01	
Pondweed	*Potamogeton pusillus*	2.0	0.01	
Spikerush	*Eleocharis equisetoides*	1.0	0.01	
Smart Weed	*Polygonum punctatum*	1.5	0.01	
Smart Weed	*Polygonum persicaria*	0.5	0.01	
misc	Unidentified leaves, stems, and tubers		17.60	

*Species and numbers of Waterfowl listed in Table 2.6.

Invertebrate Foods

Overall the findings of the 1992 stomach analysis study indicated that waterfowl consume a variety of invertebrates during their stay at Long Point. The composition of the invertebrates consumed in this study, however, may be biased towards foods with slower digestion rates because food items found in the proventriculus and gizzard were used.

Of the non-mollusc invertebrates consumed by waterfowl at Long Point, caddisfly larvae (*Tricoptera*) comprised the highest aggregate weight, at least partly due to the fact that casings are included in this weight and have a slower rate of digestion than other invertebrates without casings. Next in importance by weight were true bugs (*Hemiptera*), (9%) followed by chironomid larvae (*Diptera*) (5%). Other invertebrates of lesser importance included scuds (*Amphipods*), and sow bugs (*Isopods*) (Table 2.8).

Table 2.8 Non-mollusc Invertebrates Consumed by Selected* Waterfowl in 1992. (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

Genus	Common Name	% Composition	
Tricoptera and casings	Caddisfly larvae	71.23	————————————
Hemiptera	True Bugs	15.41	———
Diptera	Chironomid larvae	5.05	—
Amphipoda	Scuds	2.83	–
Isopoda	Sow bugs	2.16	-
Odonata	Dragonfly larvae	1.44	-
Coleoptera	Beetles	1.18	-
Oligeocheatea	Worms	0.43	
Unidentified		0.16	
Arachnidae	Mites	0.10	

*Species and Numbers of Waterfowl listed in Table 2.6.

Although molluscs eaten by waterfowl at Long Point were also recorded as an aggregate dry weight, it is not possible to describe their importance to waterfowl because shell fragments are probably not a good indication of food value. Shell fragments have a low digestion rate which may bias results, and shells may be eaten accidentally during the consumption of grit.

2.2 PART II Refuge Areas

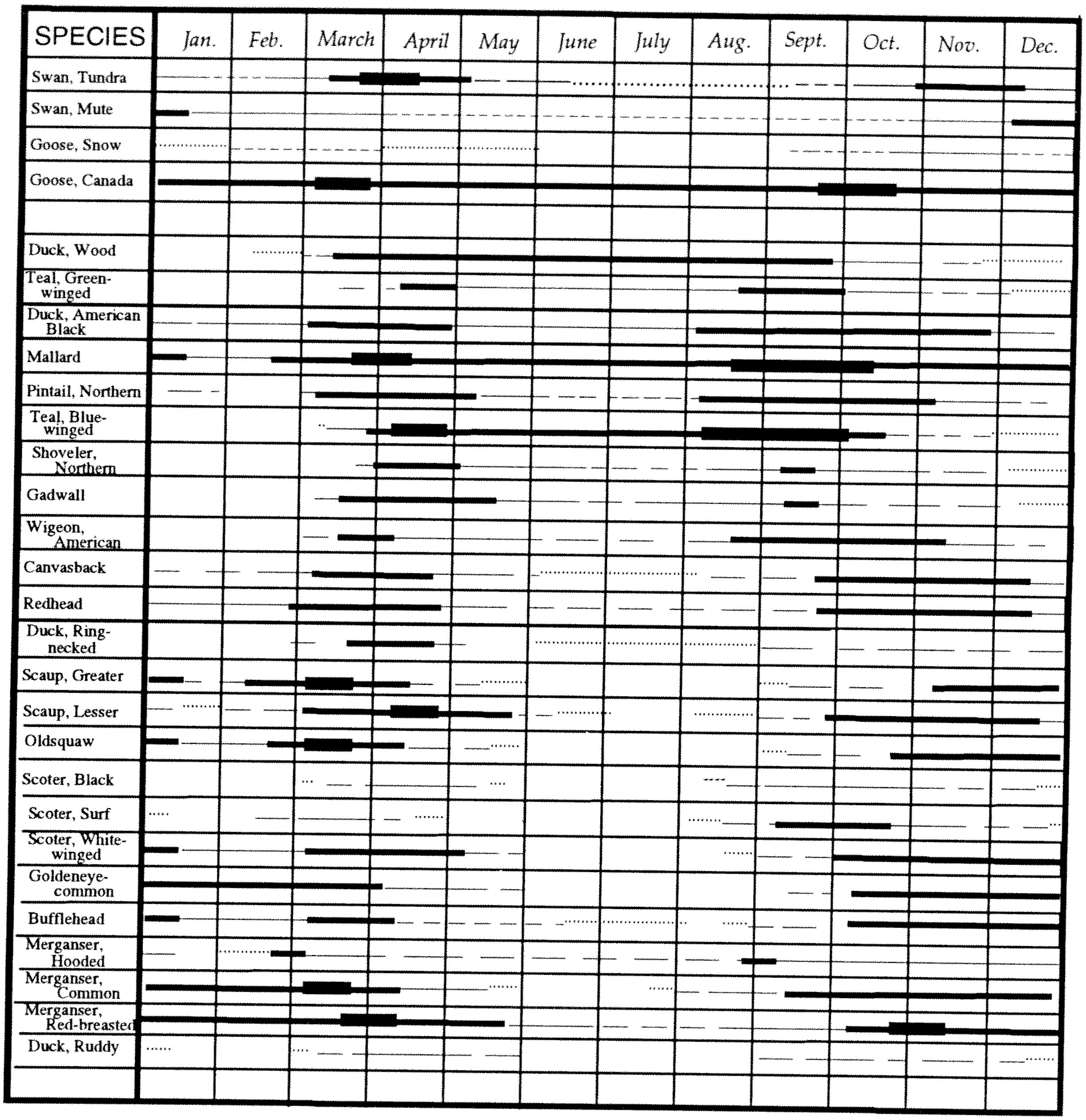
Refuge from disturbance has been identified as a key component of staging areas (Korschgen *et al.*, 1985). Disturbances are considered energetically costly for waterfowl because of increased flight time and the coinciding loss of feeding time (Owen and Reinecke, 1979). Disturbances, especially during migration, can have dramatic effects on the birds energy balance, affecting their survival during migration and upon their arrival in wintering or summering areas (Stroud *et al.*, 1990). Breeding success has also been directly related to the fat reserves obtained on staging areas. Some species of waterfowl have changed foraging time from day to night in response to disturbance (Pedroli, 1982), and Jahn and Hunt (1964) suggested that even the best of habitats will be used lightly, if at all, by migrating ducks if human disturbance is excessive.

Waterfowl surveys of the Long Point Waterfowl and Wetland's Research Fund are used in this section to indicate what areas waterfowl are congregating in or using as refuge areas. The information is organized relative to the six areas of Long Point's Inner Bay that were identified in section 1.2. For each area, a description is given of the numbers and types of species of waterfowl in the areas during both spring and fall migration.

Waterfowl Refuge Areas

The abundance, distribution and species of waterfowl at Long Point during migration were recorded by the Canadian Wildlife Service from 1969-1988 (Dennis and North, unpublished data) and by the Long Point Waterfowl and Wetland's Research Fund in 1991-1992 (Pauls and Knapton, 1993). Common waterfowl that utilize the Long Point area generally are shown in Figure 2.10. The results of these surveys were compared in an earlier folio report *An Ecosystem Approach to Management of an Internationally Significant Area: Long Point's Inner Bay (*Wilcox and Knapton, 1994). The results suggested that there has been a general overall decline in waterfowl numbers and that severe declines occurred in the

Figure 2.10 Common Waterfowl Species in the Long Point Area (Adapted from Fazio *et al.,* 1985)



KEY TO RELATIVE FREQUENCY AND OCCURRENCE

▬ Abundant- the species is always to be found in season in high density/numbers

— Common - the species is usually found in season daily: well distributed or in moderate numbers

—— Uncommon- the species is present in low density/numbers, unlikely to be found on a daily basis

– – – Rare- the species may be present annually but found infrequently: usually difficult to tell

.... Occasional- very few records: normally absent mid 1980's (Wilcox and Knapton, 1994) For the purposes of this study, only the results of the 1992 survey will be used to describe the Inner Bay, since duck stomach analysis and vegetation/ invertebrate survey results are also available for this year. The other years of data are given, however, to provide an indication of changes in numbers of waterfowl over a 22 year time span.

Methods

The aerial survey techniques used for documenting waterfowl use of Long Point were similar for both the Canadian Wildlife Service and the Long Point Waterfowl and Wetland's Research Fund. At least two observers conducted the surveys from a fixed wing aircraft between 10am and 12pm at an altitude of approximately 100 meters along a predetermined route. Although different routes were used by the CWS and LPWWRF, they covered the same area. Since waterfowl surveys were not conducted for the same duration in each survey year, the shortest common survey time spans covered in a single year were used to compare each of the years. These time spans were; 73 days in fall, from approximately September 20 to December 1, and 44 days in spring, from approximately March 20 to May 2. This allowed for a comparison of results between years based on approximately the same time span in each year.

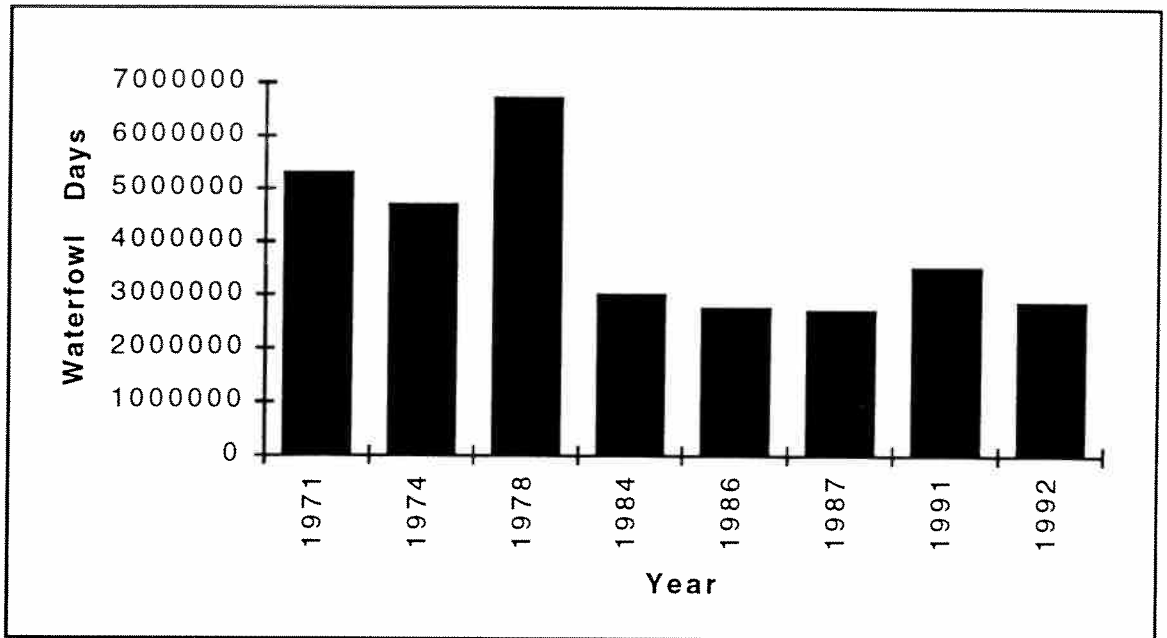
In estimating total waterfowl use of an area, it is important to recognise the methods used by waterfowl biologists. Waterfowl use is generally described using 'Waterfowl days'. Waterfowl days, as described by Dennis and Chandler (1984), are calculated by taking the average of the numbers of waterfowl observed on two survey dates and multiplying this by the number of days between survey dates. Spring or fall totals are obtained by summing the results for the entire period (Figures 2.10 and 2.11).

During surveys, waterfowl species and numbers were recorded along 23 transect lines/ locations in Long Point's Inner Bay and coastal marshes. This information was then organized into the separate Inner Bay areas used in this study by Dr. R. Knapton, Research Director of the LPWWRF. Survey results are presented separately for diving and dabbling waterfowl because of their differences in foraging techniques and habitat requirements. Dabblers, for example, feed in shallow waters by tipping and by dabbling along the edges of lakes, ponds and smaller bodies of water (Kortright, 1967). Mallard, American black duck, gadwall, American wigeon, green-winged teal, blue-winged teal, northern shoveler, northern pintail, wood duck, tundra swan, mute swan, Canada goose and snow goose, for convenience, are considered as dabblers in this study. Divers generally frequent larger bodies of water, and feed by diving, often seeking their food at considerable depths. Redhead, ring-necked duck, canvasback, greater and lesser scaup, common goldeneye, bufflehead, oldsquaw, ruddy duck, and hooded, common and red-breasted mergansers are considered divers.

Findings

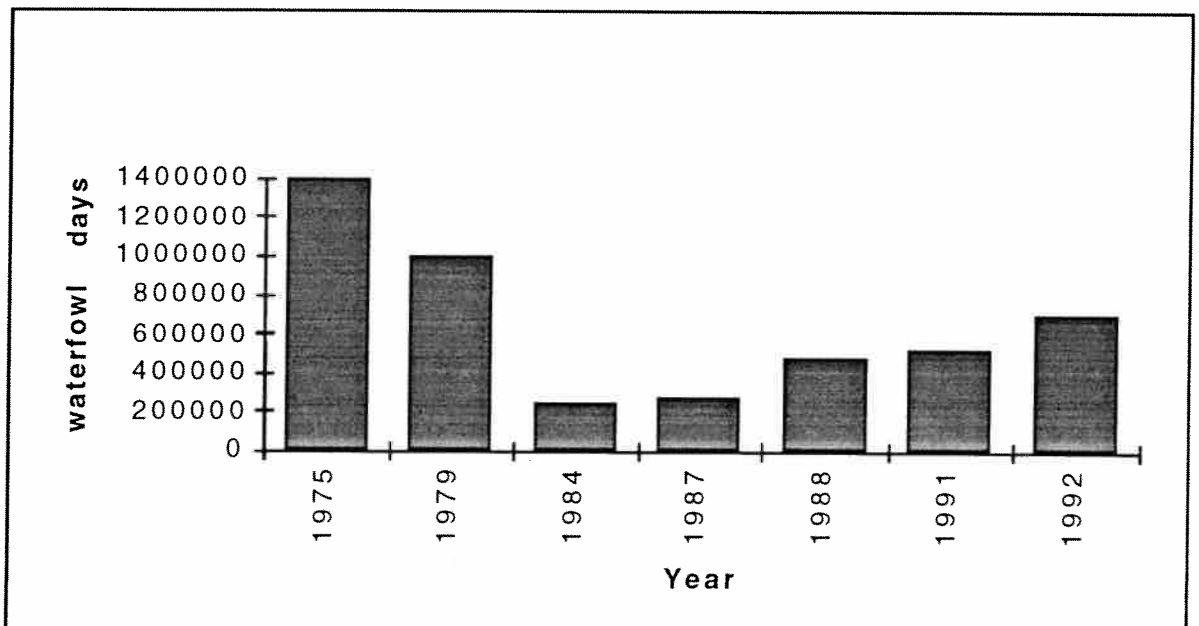
Overall, the findings of the Canadian Wildlife Service aerial surveys and the Long Point Waterfowl and Wetland's Research Fund Surveys indicate that peak numbers of waterfowl utilizing the Long Point area were recorded in the mid to late 1970's (nearly 7 000 000 waterfowl days in the fall of 1978). This was followed by sharp decreases in waterfowl numbers to approximately half of the 1978 estimate by the mid 1980's.

Figure 2.11 Estimated Waterfowl Days at Long Point during Fall Migration.



Waterfowl day estimates are based on 73 survey days from approximately Sept. 20 -Dec. 1 in all years. Sources:1971-1987 Canadian Wildlife Service Aerial Survey Data, 1991-1992 Long Point Waterfowl and Wetlands Research Fund Aerial Survey Data

Figure 2.12 Estimated Waterfowl Days at Long Point during Spring Migration.



Waterfowl day estimates are based on 44 survey days from approximately March 20 - May 2 in all years. Sources:1975-1988 Canadian Wildlife Service Aerial Survey Data, 1991-1992 Long Point Waterfowl and Wetlands Research Fund Aerial Survey Data.

During spring migration highest dabbling waterfowl days were observed in the Turkey Point area, (42 165 dabbler days), followed by the Open Water area (20 426 dabbler days). The Crown Marsh area and Thoroughfare Point area both had moderate numbers of dabblers when compared to the other areas (5 000 dabbler days in each) (Figure 2.13, Table 2.9). Highest numbers of diving waterfowl days during spring migration were observed in the Open Water area (332 975 diver days) followed by the Big Creek area (130 380 diver days) and North Shore area (43 017 diver days). All other areas had less than 12 000 diver days in each. Figure 2.14 shows the distribution of divers in the Inner Bay areas. It is important to note that numbers during spring migration are strongly influenced by the date of spring ice break-up.

Table 2.9 Distribution of Waterfowl in each of the Inner Bay Areas based on Waterfowl Days, 1992 (adapted from Wilcox and Knapton, 1994)

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Spring Diving Waterfowl	11526	43017	130380	5390	5390	332 975
Spring Dabbling Waterfowl	42165	1019	3096	5305	5305	20426
Fall Diving Waterfowl	47150	1850	2750	1929	1929	195467
Fall Dabbling Waterfowl	1307	1160	17051	15257	15257	11645

Figure 2.13 Distribution and Abundance of Spring Dabbling Waterfowl (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

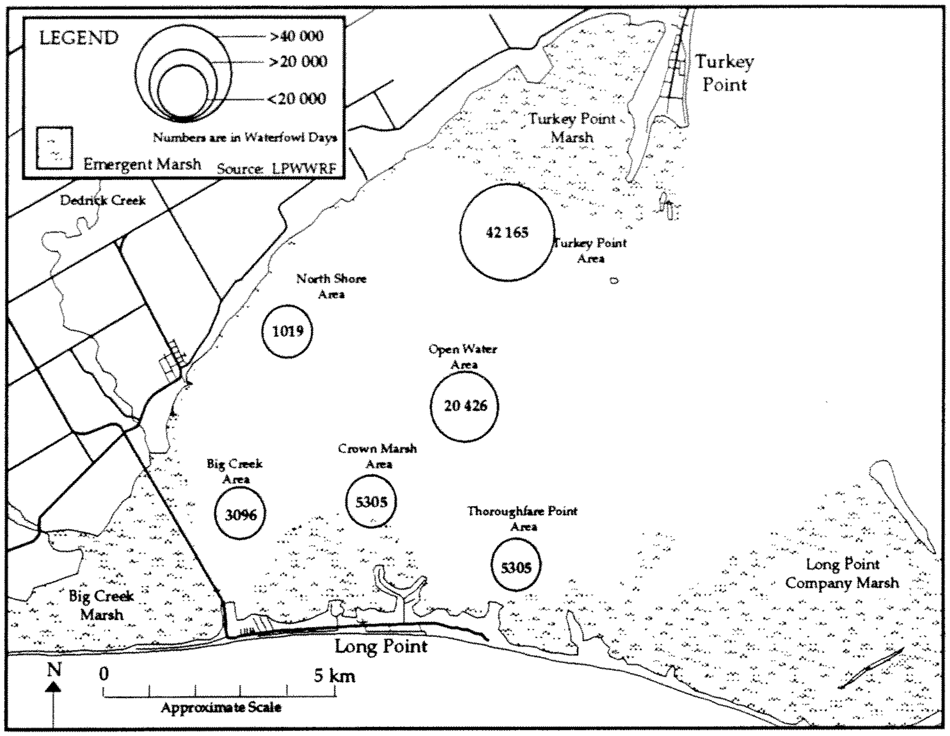
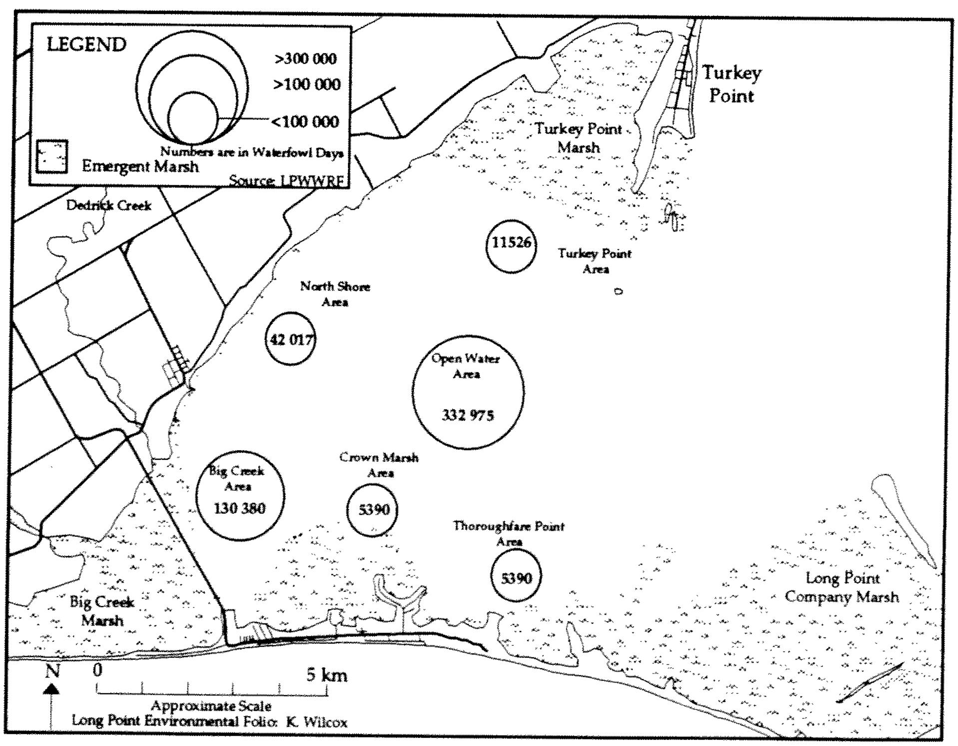


Figure 2.14 Distribution and Abundance of Spring Diving Waterfowl (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)



In fall, dabbling waterfowl spent the highest numbers of waterfowl days in the Big Creek area (17 051) (Figure 2.15, Table 2.9). The Crown and Thoroughfare Point areas had similar numbers of dabbler days, with approximately 15 257 in each, and the Open Water area had 11 645 dabbler days. Of relatively less use to dabbling waterfowl as resting areas were the Turkey Point and North Shore areas hosting less than 2 000 dabbler days each. Diving waterfowl in fall (Figure 2.16) used the Open water area most with 195 467 diver days recorded, followed by the Turkey Point area at 47 150 diver days. The remaining areas, Crown Marsh, Thoroughfare Point, North Shore and Big Creek, hosted less than 3 000 diver days each.

Figure 2.15 Distribution and Abundance of Fall Dabbling Waterfowl (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)

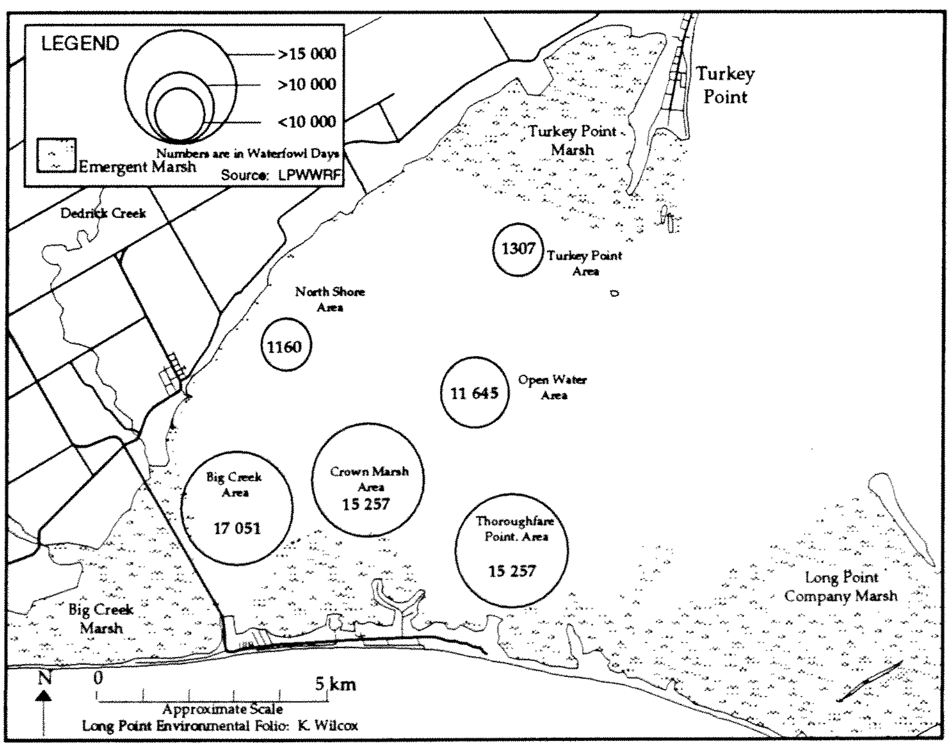
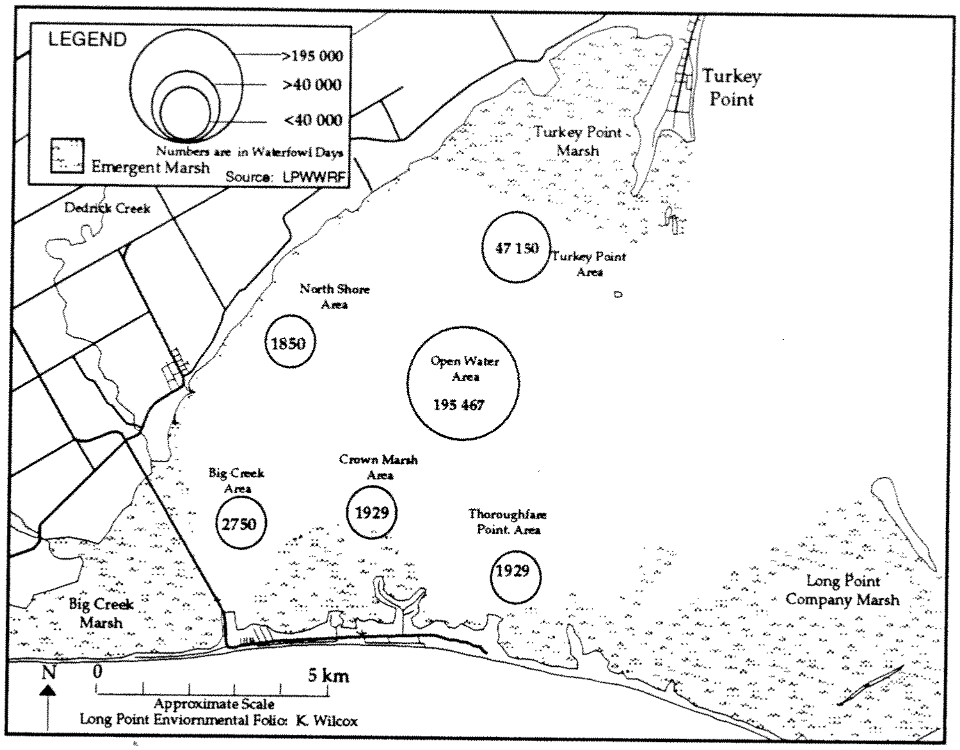


Figure 2.16 Distribution and Abundance of Fall Diving Waterfowl (Adapted from the Long Point Environmental Folio Series, Wilcox and Knapton, 1994)



2.4 Summary

In summary, the general purpose of this chapter was to describe the food resources and refuge areas in Long Point's Inner Bay. This was accomplished using 1991 and 1992 surveys of submerged macrophytes, 1992 surveys of macroinvertebrates, and 1992 aerial surveys of waterfowl. The findings of the surveys were described and mapped in the six Inner Bay areas to provide a comparison of significance among these areas for waterfowl as well as the stresses or constraints that are acting upon these areas.

The findings indicate that each of the Inner Bay areas are distinct in terms of their vegetation communities, non-mollusc invertebrate communities, mollusc communities and their use by waterfowl. Several significant differences were found among Inner Bay areas in terms of plant composition and non-mollusc invertebrate abundance. It appears that the North Shore area and the Big Creek area in particular have distinct plant communities and that the Open Water area, Thoroughfare Point area, and Turkey Point area all had significantly higher numbers of non-mollusc invertebrates than these areas.

In looking at refuge areas, it appears that the Open Water area is particularly important to diving waterfowl in both spring and fall as highest diver days were recorded in this area during both seasons. Dabbling waterfowl were observed in the highest numbers in the Turkey Point area in spring and in the Big Creek area during fall.

In looking at food habits, emergent vegetation, such as wild rice and burr reed, and submerged macrophytes, such as wild celery, musk grass, and naiads, were important food items to waterfowl at Long Point.

CHAPTER 3

THE SIGNIFICANCE OF AND CONSTRAINTS UPON WATERFOWL FOOD RESOURCES AND REFUGE AREAS

3.0 Introduction

The purpose of this chapter is to identify significant areas in Long Point's Inner Bay for waterfowl and to highlight the stresses or constraints that are acting upon these significant areas. This assessment provides information that can be used by planners and managers to guide their priorities and activities. The assessment in this chapter uses the second level of the ABC resource survey method and involves several steps. The first step in this approach is the selection of criteria and methods to determine significance and constraints. The second step is the identification and comparison of significance among areas and the delineation and mapping of areas considered highly significant for waterfowl. The third step is the identification and comparison of constraints among areas and the identification and mapping of areas considered highly stressed or constrained for waterfowl. This delineation is based upon maintenance or enhancement of food resources and refuge areas.

The interpretation presented here is meant to be both of an initial and strategic nature. The assessment is intended to provide an indication, or first approximation, of the relative significance of different areas in the Inner Bay to waterfowl. The information is intended for use by planners, citizens, and decision makers generally in the Long Point area.

The comparison of Inner Bay areas using the available information was a complicated task. Many problems were encountered with the organization and availability of data, and with the selection of appropriate indices for comparison of areas. For example, data for resting waterfowl areas prior to 1991 could be used to look at overall trends in waterfowl numbers at Long Point, but could not be used to examine changes in use of different areas because it was not possible to separate the data among the six Inner Bay areas. Water quality data collected by Environment Canada in the Inner Bay in 1991 and 1992, were not available for use in this study. Thus, the confidence in the selection of indicators of significance and constraints for waterfowl among the six Inner Bay areas varies depending on the amount of data available.

These difficulties limited the analysis primarily to an assessment of significance of Inner Bay areas for food resources. The assessment of significance of Inner Bay areas for refuge was limited by the amount of available data and because at this point it is unknown how waterfowl use the different areas on daily or short term bases. Assessment of constraints of Inner Bay areas for both food resources and refuge was limited by a lack of understanding of the limiting factors for waterfowl use and details on the impacts of boating, pollution and other activities on the Inner Bay. The advantage of this assessment, however, is in the development of an initial framework that will be useful for planning and additional research initiatives and monitoring. The findings of this chapter provide the basis for the initial identification of priority areas for planning and management in Chapter 4.

3.1 Selection of Criteria

In the second level of the ABC resource survey method, criteria are developed to evaluate and interpret the significance and constraints of information collected in the theme maps at the first level of study. Nelson (1991) suggested that the selection of criteria for significance and constraints at this level involves judgment and must be done in relation to the goals or objectives of the study. For example, if the goal of the study is to identify important wetland or wildlife areas, then the information and the ranking selected should reflect this goal. In other words, unique plant or animal species, breeding areas, and migratory routes are all likely to be ranked highly in terms of significance. In this context, lumbering, residential development and other land uses are also likely to be identified and ranked highly as important stresses or constraints which could damage or destroy significant natural resources like those noted previously (Nelson, 1991).

There have been many efforts to develop criteria for evaluating and assessing significance and constraints in natural areas for planning and resource management. Criteria for rating the ecological significance of marshes were developed by Oviatt *et al.* (1977). They rated coastal marshes for their ecological contribution using 17 biological parameters as well as morphological and geographic characteristics including; standing crop height, density, and seed set of creek bank Spartina grass *(Spartina alterniflora* and *S. patens)*, the abundance and diversity of adult, juvenile and larval fish; the abundance of grass shrimp, fiddler crabs, and insects; and the diversity and relative abundance of birds. Smith (1984) reviewed seventeen criteria used to evaluate ecological sites in selected studies and recommended the following eight: 1) rarity, 2) diversity, 3) size, 4) naturalness, 5) productivity, 6) fragility, 7) representativeness, and 8) importance to wildlife. Smith and Theberge (1986) reviewed the criteria used in 22 evaluation systems. In descending order of use: rarity, diversity, size, naturalness, fragility, representativeness, importance to wildlife, threat, educational value, and recorded history/research investment were used most often. More generally, within the context of the ABC approach used in the Long Point Environmental Folio project, three criteria have been stressed for interpreting biotic significance (Beazley, 1993): 1) community diversity, 2) community uniqueness, and 3) faunal diversity.

The criteria that are utilized in this study have been adapted from these previous applications to meet the objective of protecting food resources and refuge areas for staging waterfowl. Criteria used for measuring biotic significance are presented in Table 3.0. These criteria are divided into two parts which are based on the two essential components of staging habitat: food resources and refuge from disturbance, although refuge from disturbance is not a major focus in this study due to a lack of data.

Table 3.0 Criteria Used to Examine Biological Significance of the Inner Bay Marshes for Waterfowl Migration

FOOD RESOURCES	
1)	Macrophyte Productivity (abundance of important waterfowl plant foods)
2)	Macrophyte Diversity (number of different plant foods)
3)	Significant Macrophyte Species (significant plant foods i.e., wild celery)
4)	Non-mollusc Invertebrate Productivity (abundance of non-mollusc invertebrates)
5)	Mollusc Productivity (abundance of snails and clams)
REFUGE AREAS	
6)	Waterfowl Use (number of waterfowl days observed)
7)	Waterfowl Diversity (number of different waterfowl species)
8)	Significant Species (species identified as a concern for management)

To compare the six different Inner Bay areas with respect to their importance for food resources, the following criteria are used: macrophyte productivity, macrophyte diversity, significant macrophyte species, and invertebrate productivity (non-mollusc invertebrate and mollusc productivity). Macrophyte productivity refers to the abundance of important submerged plant food resources for waterfowl in each of the Inner Bay areas. Macrophyte diversity is used to indicate the number of different submerged plant food resources, and significant macrophyte species is used to indicate the location of critical or limiting food resources. Non-mollusc invertebrate productivity refers to the abundance of non-mollusc invertebrates as food resources for waterfowl and mollusc productivity refers to the abundance of molluscs.

To compare the Inner Bay areas with respect to their importance for refuge to waterfowl the following criteria are used: waterfowl use, waterfowl diversity, and significant waterfowl species. Waterfowl use refers to the amount an area is used by resting waterfowl. Waterfowl diversity refers to the number of different species of waterfowl utilizing an area.

Significant waterfowl, refers to the location of canvasbacks, a species identified as a concern for management.

In planning for waterfowl staging habitat, constraints or stresses on staging waterfowl need to be considered in addition to outlining criteria for significance. In this context, for example, areas where there is heavy boat traffic could destroy the significance of an area as a refuge site for waterfowl and thus boat traffic is considered a stress or constraint. A constraint in this study refers specifically to threats affecting food resources and resting areas for waterfowl.

In the ABC resource survey approach, three criteria have been promoted for interpreting biotic constraints: 1) vegetation recoverability, 2) fire susceptibility, and 3) faunal/habitat dependence (Bastedo and Theberge, 1986; Bastedo, 1986). Criteria to compare stresses for food resources and for waterfowl refuge in Inner Bay areas have, however, not been developed fully at this point. The author would like to use faunal/habitat dependency, i.e., a direct relationship or dependence on a specific food resource, and vegetation recoverability, but the data are not sufficient to make this possible. More direct indicators of constraints on food resources are therefore considered as noted in the following text.

Possible constraints for food resources used in this study include marina and cottages, exotic plant species, infrastructure, and agricultural runoff. These criteria were selected because they have been known to impact food resources negatively in other areas. For example, a high correlation has been observed between cottage/marina developments and algae blooms in Ontario (Muskoka-Haliburton District Report, 1989). Algae blooms prevent light penetration and therefore interfere with photosynthesis in submerged macrophytes, resulting in die-offs. In 1988, 1073 private sewage disposal systems were inspected in the Muskoka cottage area. Of the 1073 sampled only 31.5% were performing satisfactory (Muskoka-Haliburton District Report, 1989). Artificial fertilizers used on lawns around cottage and marina developments often contain high levels of phosphates and nitrates and thus contribute to eutrophication in coastal areas and pose a threat to plant food resources in these areas. Removal of submerged macrophytes in channels near marinas and use of herbicides reduces the amount of plant food resources available for waterfowl. Exotic plants, which could be brought by boats, cars or other means to marinas and other settled areas, have been known to outcompete important plant foods for waterfowl and thus reduce the abundance of food resources. For example, exotic species such as Eurasian milfoil, which exists in the Inner Bay, has been known to outcompete native vegetation in other areas such as Chesapeake Bay and produce monospecific stands (Orth, 1985). Infrastructure, such as the Causeway, can impact on food resources. Use of roadway salt in winter and subsequent runoff into the Inner Bay may cause the death of nearby plants, and warm water run-off in the summer reduces oxygen content in the adjacent waters and can contribute to eutrophication. Agricultural activities along Big Creek can have negative impacts on the food resources for waterfowl. For example, the use of fertilizers in agriculture areas contain phosphates and nitrates and thus could lead to eutrophication in the Inner Bay (Downey *et al.,* 1994). The use of pesticides and herbicides can eliminate organisms and result in a loss of submerged plants (Downey *et al.,* 1994). Cultivation of fields and erosion of top soil into Big Creek could contribute to sedimentation in the Inner Bay. Particles suspended in the water column prevents light penetration, and thus reduces the ability of plants to photosynthesize.

Criteria for comparing areas in terms of stresses or constraints for refuge from disturbance include; recreational boating, fishing, and hunting (Table 3.1). While the total number of constraints on waterfowl food resources and refuge areas is unknown at this point, these criteria were selected because of their known impacts on waterfowl in other areas. Hunting and motor boating activities, for example, have been described as the two main activities that disturb waterfowl (Korschgen *et al.,* 1985). In addition to these disturbances, Knapton and Herring (1993) indicated that fishing activities on Long Point's Inner Bay were also a main source of disturbance for waterfowl flocks. Jahn and Hunt (1964) suggested that even the best habitats will be used lightly, if at all, by migrant ducks if human disturbance is excessive. Disturbance of migrating ducks can have dramatic effects on the birds' energy balance, and may affect their survival during migration, upon arrival to wintering and summering areas, and breeding success (Frederickson and Drobney, 1979).

Table 3.1 Criteria for Assessing the Constraints of the Inner Bay Marshes for Waterfowl Migration

FOOD RESOURCES	
	cottages/marinas and associated activities
	exotic plant species
	infrastructure
	farming practices
REFUGE AREAS	
	fishing
	hunting

3.2 Methods for Evaluating Significance and Constraints

Two types of multi-criteria evaluation models can be used to focus attention on areas of high significance or high constraints, these are compensatory models and non-compensatory models. Both models involve different scales of measurement and as such different mathematic operations can be applied.

The first method, or compensatory model, results in the determination of a single value ranking for each site. This is accomplished through a simple additive weighting method, where scores for each criterion are added to provide a total value (Beazley, 1993). This model generally requires that all criteria be measured on interval or ratio scales and are in comparable units. Interval or ratio scales are measurements based on real numbers. They have numerical distances separating numbers, for example, altitude or time measurements.

The second method, or non-compensatory model, is used when different criteria cannot be compared; they are like 'apples and oranges' and thus can not be subjected to addition or subtraction (Smith and Theberge, 1987). For example, in conservation evaluation, how can you compare the ecological significance of a small, disturbed site hosting a single rare plant species such as a sedge, with a large, old growth forest, that hosts no rare species? In these cases alternatives must then be used to assess each criterion individually. The non-compensatory model is useful when comparing things like rarity, diversity and productivity. Nominal scales, which refer to a yes/no or presence/absence evaluation, and ordinal scales, which refer to a ranking of criteria fulfillment, such as high, medium or low, can be used in this model.

This study uses different scales of measurement and as such, both compensatory and non-compensatory models are used to evaluate areas for significance and constraints as is required by the ABC approach.

3.3 Evaluation of Significance

In this section criteria are applied to assess the significance of Inner Bay areas for food resources and for refuge from disturbance. The section is divided into three parts: first, food resources in each area are assessed; second, refuge from disturbance in each area is evaluated; and third, significant areas for waterfowl are outlined.

3.3a Food Resources

The significance of Inner Bay areas for plant food resources and animal food resources is compared based on the set of criteria identified in section 3.1. Specifically; macrophyte productivity, macrophyte diversity, macrophyte significance, and invertebrate abundance are used to assess each area for food resources. Several different methods of applying the criteria are used, and several different outcomes are reached. Each method is outlined, followed by a description of the method that was adopted for use in this study.

In reading the following text, it is important for the reader to recognize that little information was available from other sources or areas on the significance of these criteria. The criteria used in this current study and the estimates of significance of the different areas in the Inner Bay, based on these criteria, are related to the Bay only and not to other areas outside of the Bay.

Macrophyte Productivity

Macrophyte productivity, as described earlier, refers to the abundance of important submerged macrophyte species as food resources for waterfowl in each Inner Bay area. The purpose of using this criterion is to evaluate the importance of each Inner Bay area as a feeding area for waterfowl. To accomplish this task, several methods of ranking the areas were considered. First an ordinal ranking system was applied. Second, an interval ranking system was considered using the calories of submerged plants as a distinction among areas. And third, prominence values were used as a method of comparing the importance of areas.

An ordinal ranking scheme was used in the preparation of a preliminary report (Wilcox and Knapton, 1994). The report was a first attempt to assess Long Point's Inner Bay for waterfowl planning. In the preliminary report, values were assigned to each of the dominant plants in the Inner Bay areas based on a large scale study of waterfowl food habits in North America. Upon analysis of over 7 000 duck stomachs across North America, Martin and Uhler (1935) assigned values of excellent, good, fair, and slight to plants (Table 3.2). A plant species occurring in the Inner Bay that was assigned a value of excellent in Martin and Uhlers' (1935) report was given a rank of three in the preliminary report (Wilcox and Knapton, 1994). A plant species ranked as good was given a two and a plant species ranked as fair or slight was given a one. If the majority of all the dominant plant values in an area were a three, then the area was rated as highly significant for waterfowl. If the majority of the dominant plants were a two, than the area was rated as moderately significant. If the majority of the dominant plants were a one, than the area was rated as having low significance. This ranking scheme indicated that the North Shore and Big Creek areas were highly productive because they contain species of submerged macrophytes that are highly important to waterfowl. The Crown and Thoroughfare Point areas were identified as being moderately productive, and the Turkey Point and the Open Water areas were rated as having low productivity of important food sources.

Table 3.2 Plant Composition of the Inner Bay and their Estimated Food Value*

Submerged Macrophytes				
Common Name	Scientific Name	% Composition	Value	Value
Musk Grass	*Chara vulgaris*	57.4	Good to Excellent	2
Eurasian Milfoil	*Myriophyllum spicatum*	13.4	Slight to Fair	1
Naiad	*Najas spp.*	12.1	Excellent	3
Wild Celery	*Vallisneria americana*	8.8	Excellent	3
Coontail	*Ceratophyllum demersum*	3.1	Slight to Fair	1
Richardson's Pondweed	*Potamogeton richardsonii*	0.9	Good	2
Variable Pondweed	*P. gramineus*	0.8	Fair to Good	1
Canadian Waterweed	*Elodea canadensis*	0.4	Slight	1
Sago Pondweed	*P. pectinatus*	0.2	Excellent	3
Slender pondweed	*P. pusillus*	0.1	Fair to Good	1
Curly-leaved Pondweed	*P. crispus*	0.1	Good	2
Illinois Pondweed	*P. illinoensis*	0.1	unknown	
Mud Plantain	*Heteranthera dubia*	0.1	Slight	1
Flatstem Pondweed	*P. zosteriformis*	0.1	Fair	1
Slender Pondweed	*P. strictifolius*	tr	Fair to Good	1
Floating-leaf Pondweed	*P. nodosus*	tr	unknown	

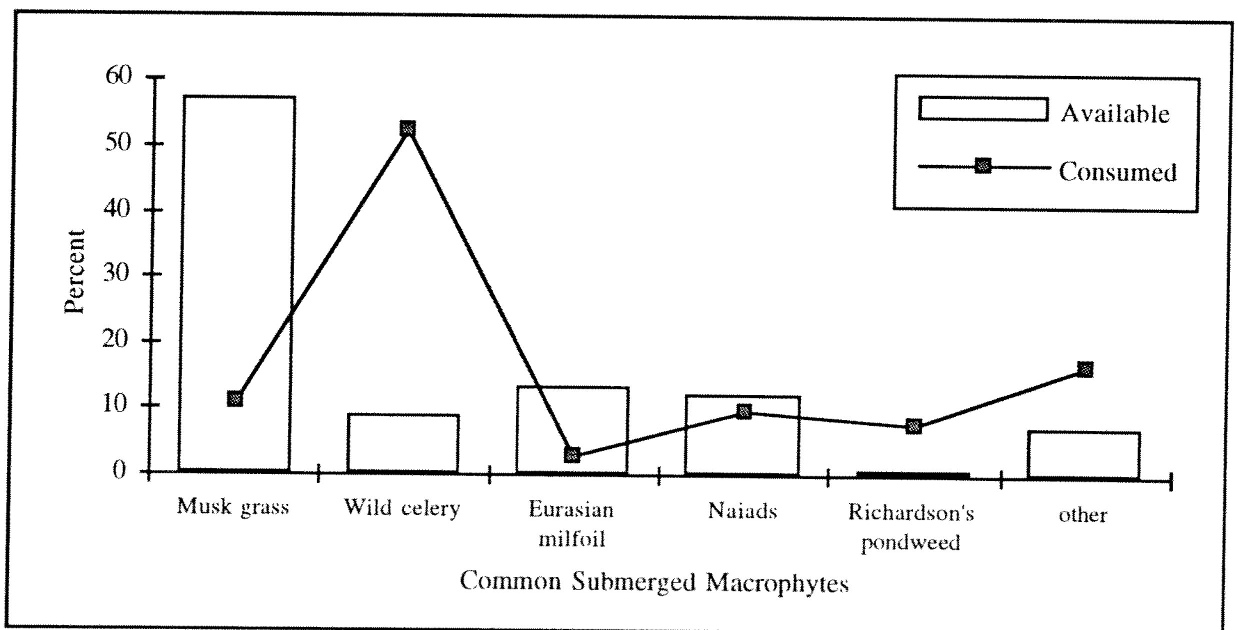
*From Martin and Uhler, 1935.

A criticism of this method was that it used a scheme to rank the importance of plants and areas for waterfowl at Long Point based on a North American wide study. In response to suggestions prompted by the preliminary report, caloric content of macrophytes was considered as a method of comparing the importance of areas for waterfowl. The rational for this consideration was based on Optimal Foraging Theory, which suggests that waterfowl should feed optimally, i.e., they should select food items with the highest calories and the least output of energy to find and eat. Few analyses have been conducted to determine the energy content of autumn and winter waterfowl foods (Hoffman and Bookhout, 1985). Some studies have examined the metabolizable energy of cultivated grains (Sugden 1971; 1973; 1979), winter foods of blue-winged teal in Louisiana (Baldwell, 1963), and naturally occurring seeds (Hoffman and Bookhout, 1985). Studies to date, however, have not combined the consumption, gross energy and metabolizable energy of natural foods for autumn waterfowl populations (Hoffman and Bookhout, 1985).

The difficulty in obtaining large amounts of natural foods to feed captive waterfowl and the lack of a precise analytical procedures have limited research on nutrition and caloric content of naturally occurring autumn foods (Hoffman and Bookhout, 1985). Differential calorie content of plants at different times of the year, in different habitat conditions, and in different parts of the plants (seed, stems, leaves and tubers) may also be a limiting factor in studies and may be the reason few studies have been conducted on fall waterfowl foods. In any event, data were not available on all the species of submerged macrophytes in Long Point's Inner Bay and thus it was not feasible to use this method in comparing the six areas in the Inner Bay. An additional limitation of using this method in comparing the importance of food resources in each Inner Bay area, is that waterfowl may not be selecting foods based on calories, there may be several other factors affecting their choice, i.e., availability, absence of disturbance.

The method used in this study compares the importance of areas for plant food resources using prominence values. Data on the prominence values, or availability of plants, and the utilization of plants for food were prepared and are presented on Table 3.3. Prominence values provide an index of 'commonness' for each plant species in the Inner Bay areas. This method has been used as a descriptive and analytical measure for plants (Stringer and La Roi, 1970; Douglas, 1972); for birds (Beals, 1960); and for deer (Theberge, 1978). The index of 'commonness' is obtained by multiplying the sum of the densities of a species on all sample stations by the square root of its percent frequency of occurrence in an entire area (Theberge, 1978). The importance of each area was then determined by adding the sum of the prominence values for each plant, times its use value, i.e., the amount that was consumed. On examining the relative availability of submerged macrophytes in Long Point's Inner Bay, musk grass had the highest value, followed by Eurasian milfoil and naiads. On examining the relative use of submerged macrophytes, wild celery ranked first followed by musk grass and naiads. Spearman's Rank Order Correlation Coefficient (Siegel, 1956) showed that there was no correlation ($p>0.05$) between availability of submerged macrophytes in Long Point's Inner Bay and consumption of submerged macrophytes by selected species of waterfowl in 1992 (Figure 3.0). This suggests that some species of waterfowl are selecting preferred plants rather than eating those most available as indicated by prominence values. Knapton and Pauls' (1994) study of food habits of wigeon (*Anas americana*) at Long Point also showed evidence of selectivity in diet. Thus, the six Inner Bay areas can tentatively be compared for waterfowl sustainability and planning purposes in terms of the relation between availability and percent utilization of each plant species (Table 3.3).

Figure 3.0 Comparison of Availability of Plants in 1992 with Plants Consumed in 1992



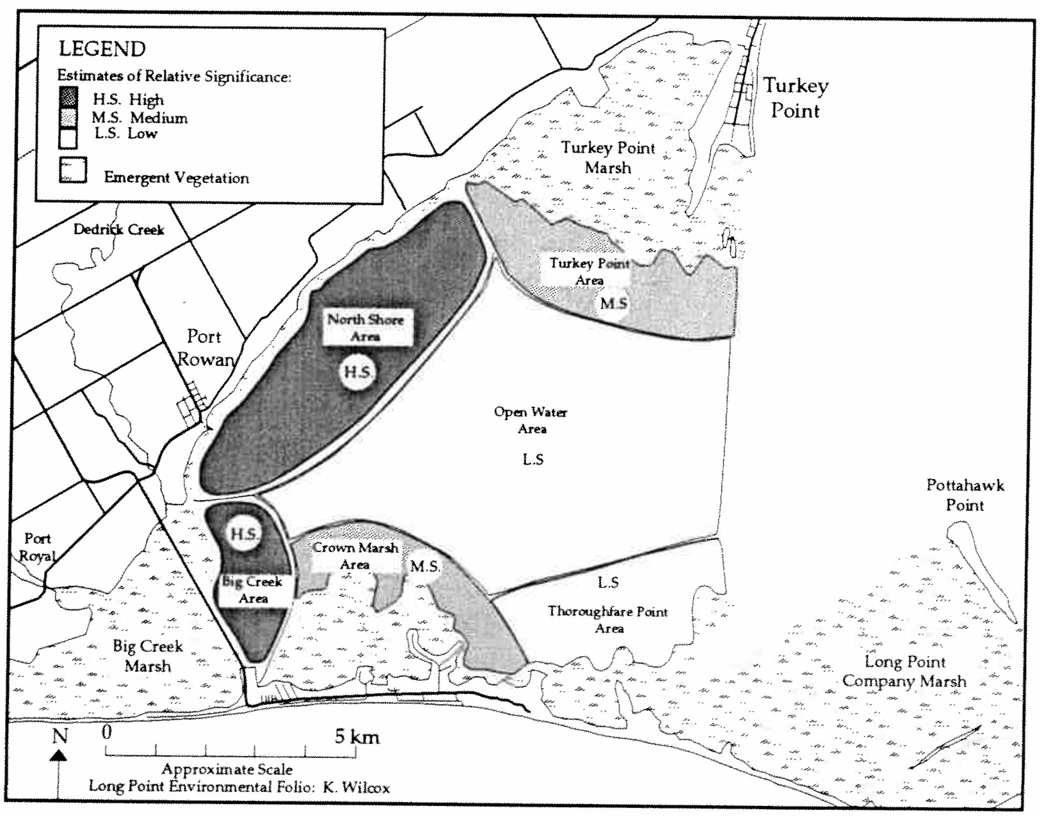
1992 Variable (% Available) (% Consumed)
Correlation -0.03, Probability 0.96

Table 3.3 Availability and Utilization of Submerged Macrophytes by Waterfowl in the Inner Bay Areas.

Species	Utilization	Big Creek Area		North Shore Area		Crown Marsh Area		Turkey Point Area		Thoroughfare Point Area		Open Water Area	
	% of diet (U)	Prominence Value (PV)	PV(U)	Prominence Value (PV)	PV(U)	Prominence Value (PV)	PV(U)	Prominence Value (PV)	PV(U)	Prominence Value (PV)	PV(U)	Prominence Value (PV)	PV(U) Value (PV)
Chara vulgaris	10.8	205.5	**2223.1**	23.0	**248.7**	608.9	**6588.8**	871.4	**9428.5**	916.9	**9920.9**	713.0	**7714.6**
Vallisneria americana	52.4	255.5	**13393.4**	162.6	**8522.1**	57.2	**2998.4**	34.5	**1809.1**	11.0	**577.9**	18.9	**990.7**
Myriophyllum spicatum	2.7	51.1	**135.3**	384.4	**1018.6**	6.8	**18.0**	3.6	**9.6**	2.2	**5.8**	69.8	**184.9**
Najas spp.	9.8	151.8	**1490.7**	219.7	**2157.2**	213.5	**2096.6**	37.7	**370.2**	28.2	**276.7**	52.8	**518.6**
Elodea canadensis	0.0	7.6	**0.0**	6.5	**0.0**	18.0	**0.0**	0.0	**0.0**	0.0	**0.0**	0.8	**0.0**
Potamogeton richardsonii	7.9	14.0	**110.0**	20.8	**163.6**	4.7	**23.6**	3.5	**27.5**	1.9	**14.8**	0.9	**7.2**
P. pectinatus	1.7	10.7	**13.7**	0.7	**1.1**	0.0	**0.0**	0.9	**1.6**	0.0	**0.0**	0.6	**0.9**
Ceratophyllum demersum	4.3	0.3	**594.9**	34.3	**146.9**	5.5	**0.0**	0.0	**0.0**	0.0	**0.2**	0.2	**0.0**
Heteranthera dubia	0.0	0.1	**0.0**	9.4	**0.0**	3.7	**5.9**	0.0	**0.0**	0.0	**0.0**	0.2	**43.6**
P. gramineus	10.4	0.5	**3.5**	3.7	**38.9**	0.6	**0.0**	4.7	**48.9**	14.3	**148.6**	4.2	**0.0**
P. pusillus	0.1	0.0	**0.0**	1.8	**0.1**	0.0	**0.0**	0.0	**0.1**	0.0	**0.0**	0.3	**0.0**
P. crispus	0.0	0.0	**0.0**	0.2	**0.0**	0.6	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**
P. zosteriformis	0.0	0.0	**0.0**	0.9	**0.0**	0.0	**0.0**	0.1	**0.0**	0.0	**0.0**	0.0	**0.0**
P. nodosus	0.0	0.0	**0.0**	0.1	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**
Ranunculus longirostris	0.0	0.0	**0.0**	0.2	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**
P. strictifolius	0.0	0.0	**0.0**	1.0	**0.0**	2.0	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**
P. illinonensus	0.0	0.0	**0.0**	1.2	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**	0.0	**0.0**
TOTAL SITES			**17964.5**		**12297.3**		**11767.8**		**11695.5**		**10944.8**		**9461.4**

Upon summing the prominence values of all the submerged macrophyte species (availability) and multiplying this value by the utilization (% of diet) of all plants, it was found that the Big Creek area was highest in importance for food resources (17 964) followed by the North Shore area (12 297). In descending order of importance, Crown Marsh area (11 767) and Turkey Point area (11 695) are given a rating of medium significance. And the Thoroughfare Point area (10 944) and Open Water area (9 461) are both given a rank of relatively low significance for food resources. The divisions between levels of significance are based upon evidence of natural breaks in the data. Differences between levels of significance could not be varified using statistics as the sample size was too small. Figure 3.1 illustrates these areas and their significance for macrophyte productivity.

Figure 3.1 Relative Macrophyte Productivity in the Inner Bay Areas



This approach for assessing the Inner Bay areas for food resources produced results similar to the preliminary report by Wilcox and Knapton (1994) (Table 3.4). The Big Creek and North Shore areas were ranked as high significance using both approaches and the Open Water Area and Crown marsh also were given the same rank using both approaches.

Table 3.4 Comparison of Significance Findings for Macrophyte Productivity

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
This Study	medium	high	high	medium	low	low
Wilcox and Knapton (1994)	1	3	3	2	2	1

The system of high, medium, and low was used in this study- rather than a 1,2,3 ranking system used in (Wilcox and Knapton, 1994) because this more general system seemed to be a more appropri ate indicator of the state of the data and the relationships. This statement applies to the use of the (Wilcox and Knapton, 1994) system in the remainder of this thesis.

Macrophyte diversity

The main goal of using macrophyte diversity as a criteria for comparing the importance of each of the Inner Bay areas is to provide information on the potential selection of food resources by staging waterfowl. In other words, areas having a high diversity of plant food resources may support a greater diversity of waterfowl as well as provide stability of food supplies in the event of a change in water level, temperature, sediment load and other variables.

Two indices have been used to compare diversity of plant food resources in each of the Inner Bay areas. The first index was an ordinal ranking method used in the preliminary report by Wilcox and Knapton (1994). Diversity, in this first attempt, referred to the number of different dominant plants in each of the study areas. A rank of '3' was assigned to areas having greater than four different dominant plants, a rank of '2' to areas having between two and three different dominant plants and a rank of '1' to areas having one dominant plant.

This analysis indicated that the North Shore and Big Creek areas had the highest diversity, or high significance, the Crown, Thoroughfare Point, and Open Water areas had moderate significance and Turkey Point area had low significance. This method gave a general impression of the diversity of food resources in each area, but did not account for plants occurring in small numbers throughout the Inner Bay. A method was needed for comparing areas based on all the plants in each area.

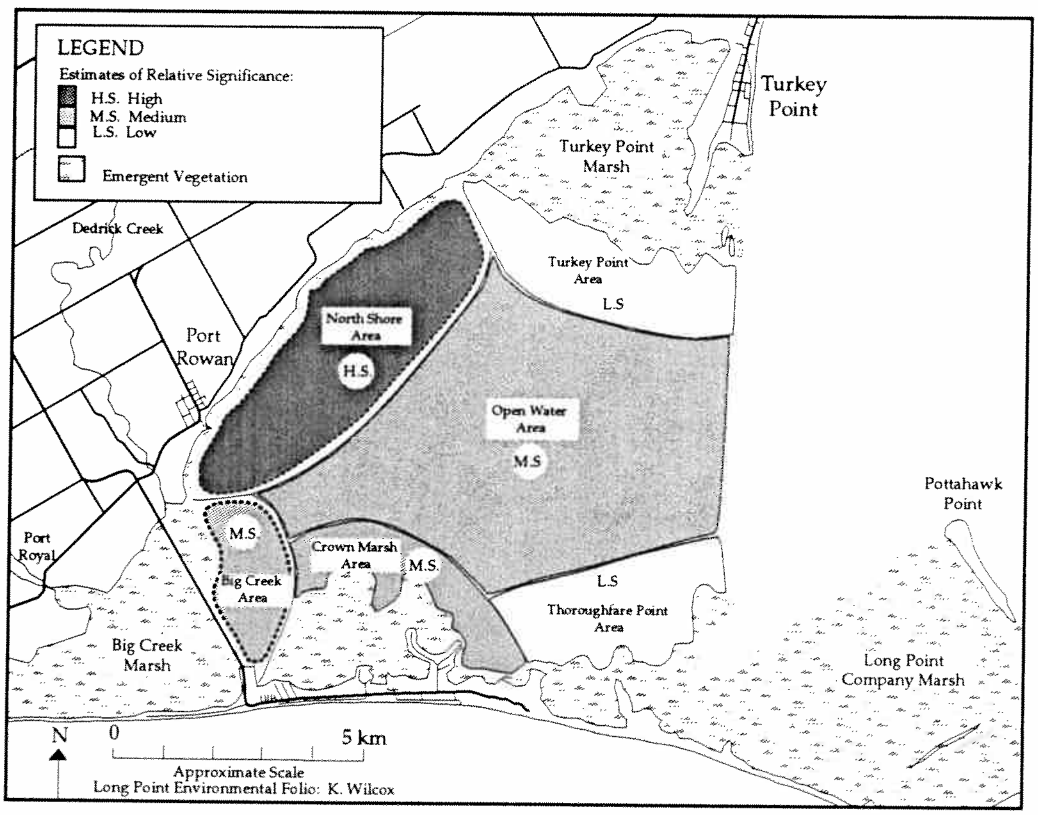
The method used in this study for identifying diversity of food resources utilizes an ordinal ranking scheme based on the sum of all the different plant species occurring in each area. Natural divisions in the data were used to separate levels of significance for waterfowl. The North Shore area, for example, had a notably higher diversity of plant food resources (17) than the other areas (i.e., the next closest area in terms of numbers of species had a diversity of 12). The Big Creek, Crown Marsh and Open Water Areas were considered to be of medium significance as they were notably higher in diversity than the Thoroughfare Point and Turkey Point areas, but lower than the North Shore Area. The Big Creek, Crown Marsh, and the Open Water areas had diversities of 12, 11, and 11 different species respectively. Thoroughfare Point and Turkey Point areas were considered to be of low relative significance, having less only 9 and 7 different species of submerged macrophytes.

When compared with the findings of the preliminary report, this study showed many similarities. Both attempts at assessing the areas ranked the North Shore area as highly significant (3), and Big Creek, Crown Marsh and the Open Water area as moderate (2), with Big Creek ranked as high in the first method and moderate in the second. Table 3.5 compares the results of the findings of the first method (Wilcox and Knapton, 1994), with the findings of this study. Figure 3.2 illustrates the Inner Bay areas and their relative significance for waterfowl in relation to macrophyte diversity.

Table 3.5 Comparison of Relative Significance Findings of Macrophyte Diversity

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
This Study	low	high	medium	medium	low	medium
Wilcox and Knapton (1994)	1	3	3	2	2	2

Figure 3.2 Relative Macrophyte Diversity in the Inner Bay Areas



Significant Species of Macrophytes

Winter buds and tubers of wild celery, a submerged macrophyte, have been identified by several researchers as highly important food plants for migrating canvasbacks (McAtee, 1917; Cottam, 1939; Korschgen and Green 1988). Canvasbacks were identified as a species of concern by the United States Fish and Wildlife Service (1984) and the Northern Prairie Wildlife Research Centre (1982) and also identified as a priority species for increased research and management due to staging habitat loss and to hunter demand exceeding supply (Kahl, 1991b). In recent years, relatively low canvasback populations have led to hunting season closures and considerable concern among biologists and hunters. With this in mind, wild celery is considered to be a significant macrophyte for waterfowl and areas with a relative abundance of wild celery were considered to be highly significant for waterfowl.

In the preliminary report by Wilcox and Knapton (1994) dominant plant distributions were used to estimate the importance of areas for wild celery and thus for canvasbacks. A '3' was given to Inner Bay areas where wild celery occurs as a dominant plant in two or more sample stations, a score of two was assigned to areas where wild celery occurred as a dominant plant in less than two sample stations, and a score of one was assigned to areas where wild celery was not a dominant plant. This method indicated the North Shore and Big Creek areas as being locations highly important for growth of significant macrophyte species, the Crown and Thoroughfare Point areas as moderately important for growth of significant macrophyte species, and Turkey Point and the Open Water areas as having low importance for growth of significant macrophyte species. Although this method provided an indication of where wild celery was a dominant plant, it did not take into account whether it was widespread sub-dominant plant. Thus, a method was needed that takes into account the distribution and abundance of wild celery throughout each of the six Inner Bay areas.

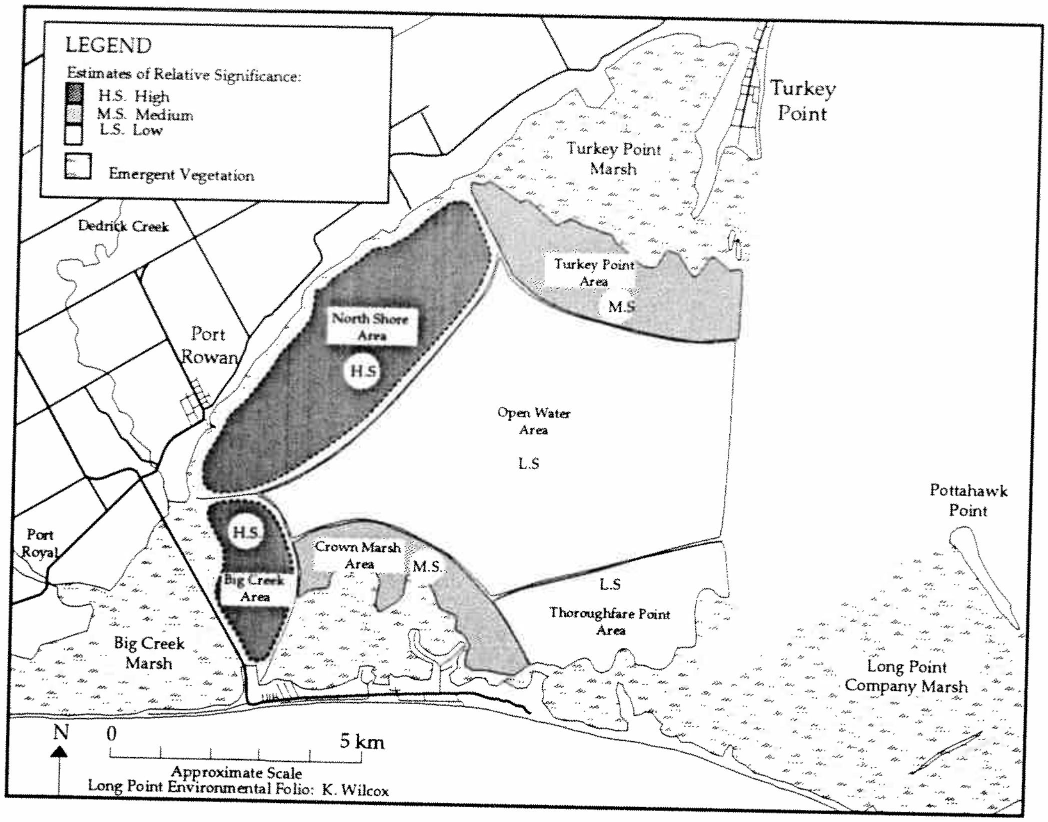
Percent occurrence of wild celery at each sampling station, i.e., proportion of wild celery to all plants at a sampling station, was therefore chosen as the method of comparison between areas for this study. Significant differences in percent occurence of wild celery between areas was used as the division between levels of signficance (Student Newman Keuls Plant Species Correlations, Table 2.1). A value of high significance was given to the North Shore and Big Creek areas as they were found to have a significantly higher percent occurence of wild celery than the other areas with 17% and 27% respectively. Turkey Point and Crown Marsh areas were considered to be of medium significance as they had a significantly higher percent occurence of wild celery with 4.2% and 7.15% than the Thoroughfare Point area and Open Water area. The Thoroughfare Point and Open Water areas were found to be of relatively less significance when compared to the other areas, having percent occurences of 2.2% and 3.0% only of wild celery.

When compared to the findings of the preliminary report (Table 3.6), the findings of this study shows similar results in that both studies ranked Big Creek and North Shore areas as being highly significant for waterfowl.

Table 3.6 Comparison of Significance Findings for Wild Celery

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
This Study	medium	high	high	medium	low	low
Wilcox and Knapton (1994)	1	3	3	2	2	1

Figure 3.3 Relative Abundance of Wild Celery in Inner Bay Areas



Invertebrate Foods

The purpose of examining macroinvertebrate populations in the six areas of Long Point's Inner Bay was to compare their availability for waterfowl consumption. The availability or abundance of invertebrate food resources (both non-mollusc invertebrates and molluscs) for each area was identified from the Long Point Waterfowl and Wetland's Fund survey completed in the summer of 1992. First, indices for comparing Inner Bay areas for non-mollusc invertebrate food resources will be discussed, followed by a description of mollusc food resources.

Non-mollusc Invertebrate Productivity

Several different measures were considered for comparing non-mollusc invertebrate productivity or abundance among Inner Bay areas. The first method, used by Wilcox and Knapton (1994), compared relative abundance of non-mollusc invertebrates in each area. The areas were given a rank of '3' for non-mollusc invertebrate food resources if they had at least 3 sample stations with densities greater than 1 000 non-molluscs invertebrates per square meter. A rank of '2' was given to areas having at least three sample stations with non-mollusc invertebrate densities between 50 and 1 000 per square meter, and a rank of '1' was assigned to areas having a least three sample station with non-mollusc invertebrate densities lower than 50 per square meter.

The analysis indicated Turkey Point as being of high significance for non-mollusc invertebrates, the North Shore as being of low significance and the rest as being of moderate significance. This approach, however, was limited in that it does not give a clear indication of the abundance of non-mollusc invertebrates in each area. An approach was needed that would take into account the abundance of non-mollusc invertebrates throughout the entire area.

One method that was considered for comparing the different areas in this respect was prominence values. This method, however, would not be appropriate for comparing the importance of areas based on non-mollusc invertebrate food resources because of the differential digestion rates among invertebrates. The inclusion of caddisfly casings in Wilcox and Knaptons' (1994) results may bias their importance in waterfowl diets at Long Point because they are heavier and take longer to digest than the other non-mollusc invertebrates, giving the impression that they are of greater importance than they actually are. In addition, they also may be incidental and not an actively sought food source.

An ordinal ranking scheme was adopted for comparing non-mollusc invertebrate populations among the six Inner Bay areas in this study. The division of levels of significance was based on statistical differences between areas (Student Newman Keuls comparison of means,Table 2.3). Turkey Point, Thoroughfare Point, Crown Marsh, and the Open Water areas were not found to be significantly different than each other, but were significantly higher in abundance of non-mollusc invertebrates than the North Shore and Big Creek areas and thus are considered to be of high significance in this study. The areas had abundances ranging from 1 564/m^2 in Open Water area, 1 705/m^2 in Thoroughfare Point area, 1 992/m^2 in Crown Marsh area, to 2 074/m^2 in the Turkey Point area. The North Shore and Big Creek areas were significantly lower in abundance 717/m^2 and 875/m^2 than the other four areas and are thus considered to be of medium significance for waterfowl. Figure 3.4 illustrates Inner Bay areas and their relative significance in terms of non-mollusc invertebrate abundance.

Table 3.7 Non-Mollusc Invertebrate Abundance in the Inner Bay Areas and their Relative Significance.

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
# of inverts	2 073	875	717	1 992	1 704	1564
Score	high	medium	medium	high	high	high

This approach for assessing the Inner Bay areas for non-mollusc invertebrate food resources produced similar results to the preliminary report by Wilcox and Knapton, (1994) (Table 3.8). The Turkey Point area was ranked as having high significance in both studies and the Big Creek area was ranked as having moderate significance in both. The other areas differed, however, in that they were ranked higher in this study.

Figure 3.4 Non-Mollusc Invertebrate Abundance in Inner Bay Areas

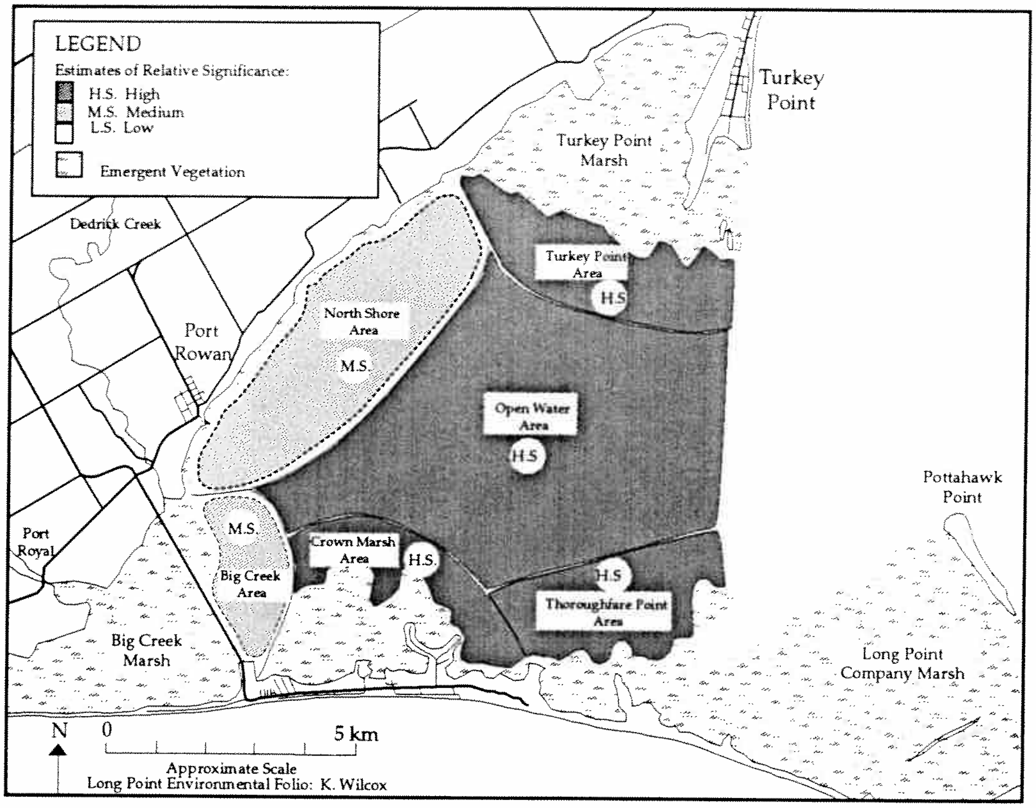


Table 3.8 Comparison of Significance Findings for Non-mollusc Invertebrate Productivity

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
This study	high	medium	medium	high	high	high
Wilcox and Knapton (1994)	3	1	2	2	2	2

Mollusc Productivity

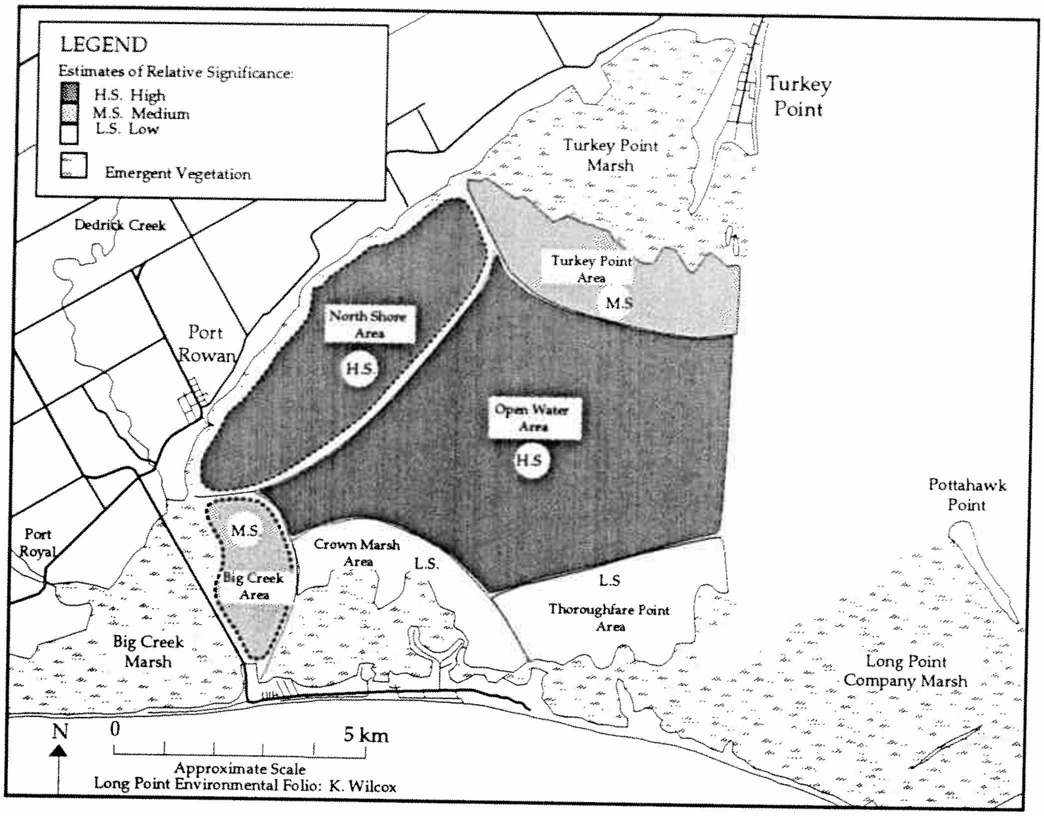
Mollusc productivity refers to the abundance of molluscs, i.e., zebra mussels/quagga mussels, snails, and clams, in each of the six Inner Bay areas. The purpose of using this criterion is to evaluate the importance of each Inner Bay area as an area for waterfowl to feed on molluscs. To accomplish this task, a similar ordinal ranking scheme to that used for comparing areas for non-mollusc invertebrate productivity is used. Divisions of levels of relative significance are based on Student Newman Keuls comparison of means (Table 2.5) i.e., significant differences among areas in terms of the average number of molluscs/m^2. A value of high significance was given to the Open Water area (2447 per m^2) and the North Shore area (1 616 per m^2) as they were found to have a significantly higher abundance of molluscs than the other areas. Turkey Point (1 290 per m^2) and Big Creek areas (1 474 per m^2) were considered to be of medium significance as they were significantly higher in abundance than Thoroughfare Point and the Crown Marsh areas. Thoroughfare Point area (1 046 per m^2) and Crown marsh area (548 per m^2) were considered to be of relatively less significance for waterfowl in terms of mollusc abundance.

Figure 3.5 illustrates Inner Bay areas and their relative importance to waterfowl in terms of mollusc productivity. A ranking scheme comparing mollusc productivity among Inner Bay areas was not completed in the preliminary report as data on molluscs was not available at that time.

Table 3.9 Mollusc Abundance in the Inner Bay areas and their Significance rating

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
# of molluscs	1 290	1 616	1 474	548	1 046	2 448
Score	medium	high	medium	low	low	high

Figure 3.5 Mollusc Abundance in Inner Bay Areas



3.3b Refuge Areas

The foregoing section has outlined information about food resources in Long Point's Inner Bay. This section will consider the second important component of staging waterfowl habitat, refuge areas. Upon completion of this section both components will be summarized.

At this stage in research and knowledge, it is not possible to develop measures or indicators to compare the importance of the six Inner Bay areas for refuge from disturbance. Links among areas have not been established, and it is not possible to say with any certainty what the role of the areas are over a 24 hour period. What we do know, at this point, is the use of areas during the period from 10am till 12pm, which is generally considered to be a resting period for waterfowl. The information presented here, is based on waterfowl surveys by the Long Point Waterfowl and Wetlands Research Fund (LPWWRF) conducted in 1992. Information is presented using waterfowl days to indicate areas of high waterfowl use, high waterfowl diversity and significant species. This general approach for examining areas was utilized during the completion of a preliminary report (Wilcox and Knapton, 1994) and is used again here.

Waterfowl Abundance in Resting Areas

Waterfowl days during spring and fall migration were used to compare the Inner Bay areas and to illustrate their significance as refuge or resting areas. The assumption was made that waterfowl were using these areas for resting because surveys were conducted during a time when waterfowl are not actively feeding.

Two measures have been used to compare waterfowl use in each of the Inner Bay areas. The first measure was an ordinal ranking method used in the preliminary report by Wilcox and Knapton, (1994). Waterfowl use in this first attempt referred to the number of waterfowl days observed in each area during spring and fall migration in 1992. A score of '3' was assigned to areas that had greater than 200 000 waterfowl days during spring and fall migration. A score of '2' was assigned to areas having between 100 000 and 200 000 waterfowl days, and a score of '1' was assigned to areas having less than 100 000.

This analysis indicated that during fall migration, the Open Water area had the highest number of waterfowl days, or high significance (207 112). The rest: Turkey Point (48 457), Big Creek (19 801), Crown Marsh area (17 185), Thoroughfare Point area (17 185), and North Shore area (3010), were of relatively low significance. During spring migration, the Open water area was considered to be of high significance (353 401), the Big Creek area was considered to be of moderate significance (133 476) and the rest, Turkey Point area (63 691), North Shore area (44 036), Crown Marsh area (10695) and Thoroughfare Point area (10695) were of relatively low significance.

Table 3.10 Estimated Waterfowl Days in the Inner Areas, Spring and Fall, 1992 (Wilcox and Knapton, 1994)

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Fall						
Waterfowl Days	48 457	3 010	19 801	17 185	17 185	207 112
Rank	1	1	1	1	1	3
Spring						
Waterfowl Days	53 691	44 036	133 476	10 695	10 695	353 401
Rank	1	1	2	1	1	3

The method used in this study for comparing the abundance of waterfowl among areas also uses waterfowl days observed during the 1992 LPWWRF aerial surveys. Diving waterfowl and dabbling waterfowl, however, are considered separately because of the different habitats they use, and ranking is not applied. Uncertainties about the links among areas in terms of daily or longer use by waterfowl, were felt to limit the accuracy of any conclusions that could be drawn and thus prevents the use of ranking in this study. A comparison is made among areas, however, to give an initial indication of the possible importance of areas as measured by their abundance.

The findings indicate that during the spring of 1992, the Open Water area was used most by diving waterfowl (332 975 diver days) and the Turkey Point areas was used most by dabbling waterfowl (42 165 dabbler days). This suggests that the Open Water area is an important refuge area for divers and the Turkey Point area is an important refuge area for dabblers.

In fall, the Open Water area was used most by diving waterfowl with 195 000 diver days being observed in this area, suggesting that it is important as a refuge area for diving waterfowl. The Turkey Point area experienced the second most diving duck days in fall with greater than 40 000 diver days being observed. Dabbler days were low relative to diver days. Highest dabbler days, however, were observed in Big Creek, Crown Marsh and Thoroughfare Point areas with greater than 15 000 dabbler days observed in each. This suggests that these three areas may be important refuge areas for dabbling waterfowl during fall migration.

Table 3.11 Estimated Waterfowl Days in the Inner Bay Areas, Spring and Fall 1992. Adapted from Wilcox and Knapton (1994)

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Spring Divers	11 526	42 017	130 380	5 390	5 390	332 975
Spring Dabblers	42 165	1 109	3 096	5 305	5 305	20 426
Fall Divers	47 150	1 850	2 750	1 929	1 929	195 467
Fall Dabblers	1 307	1 160	17 051	15 257	15 257	11 645

Waterfowl Diversity in Resting Areas

The main goal of using waterfowl diversity as a criteria for comparing the importance of each of the six Inner Bay areas is to indicate the range of waterfowl that the area can support. Two measures have been used to compare the diversity of waterfowl species in each of the Inner Bay areas. The first measure was an ordinal ranking method used in the preliminary report by Wilcox and Knapton, (1994). Diversity of waterfowl species in this first attempt referred to the number of different species observed in each area. A rank of '3' was assigned to areas having greater than 15 different species of waterfowl during migration, a score of '2' was assigned to areas having 10-14 different species, and a score of '1' was assigned to areas with less than 10 different species of waterfowl (Table 3.12).

Table 3.12 Diversity of Waterfowl Species in the Inner Bay Areas, Spring and Fall, 1992 (Adapted from Wilcox and Knapton, 1994)

	Turkey Point	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-Fare Point Area	Open Water Area
Spring	9 1	8 1	14 2	11 2	11 2	18 3
Fall	5 1	8 1	8 1	6 1	6 1	16 3

This analysis indicated that during fall migration, the Open Water area had the highest diversity, or high significance, the North Shore, and Big Creek areas of moderate significance and the rest were of low significance for diversity. During spring migration, the Open water area was considered to be of high significance, the Big Creek and Crown Marsh areas of moderate significance and the rest of relatively low significance for diversity.

The method used in this study for comparing the diversity of waterfowl species among areas also uses the number of species observed during the 1992 LPWWRF aerial surveys. Ranking, however, has not been completed for the same reason as cited previously. In descending order of importance, the Open Water area had the highest diversity of waterfowl in the fall, with 16 different species, the North Shore and Big Creek areas both had 8 different species of waterfowl in each, and the Crown Marsh, Thoroughfare Point area, and the Turkey Point areas had 6, 6, and 5 species respectively.

In spring, the Open water area supports the highest diversity of waterfowl species, 18 different species, the Big Creek, Crown Marsh and Thoroughfare Point areas all had a diversity between 10 and 15 different species and the rest of the areas had less than 10 different species in each. Table 3.13 illustrates the areas and their relative importance as resting areas in terms of waterfowl diversity in spring. Caution is advised, once again, in the interpretation of these results as waterfowl numbers and species were recorded between 10am and 12am. It is unknown where waterfowl rest and feed over a 24 hour period.

Table 3.13 Diversity of Waterfowl Species in the Inner Bay Areas, Spring and Fall, 1992

	Turkey Point	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Spring	9	8	14	11	11	18
Fall	5	8	8	6	6	16

Significant Species

Canvasbacks and American black ducks (*Anas rubripes*) are both identified as species of concern in the North American Waterfowl Management Plan. In this study, however, only canvasback populations will be used as an indication of the significance of an area in terms of the occurrence of a significant species. American black duck population declines over the past 30 years, are not primarily related to staging habitat loss, but rather related to the conversion of natural breeding habitat to farmland, breeding habitat loss, degradation caused by other human activities, and competition and hybridization with pioneering mallards (NAWMP, 1985). Canvasback populations, on the other hand are threatened by loss and degradation of migrational and staging habitat (U.S. Fish and Wildlife Service, 1984; Kahl, 1991) and thus are of interest in this study of Long Point's Inner Bay.

The abundance of canvasbacks in the six Inner Bay areas were compared in the preliminary report by Wilcox and Knapton (1994) and are also compared here. The same methods are used in both studies, and ranking is once again not applied.

In fall of 1992, highest canvasback days in the Inner Bay were recorded in the Open Water area (50 750 canvasback days). All other Inner Bay areas did not host resting canvasbacks during the survey period (10am-12pm), except Big Creek which had 80 canvasback days recorded.

Large numbers of resting canvasbacks were recorded, however, outside of the Inner Bay in Lake Erie along the south shore of the Long Point Sand Spit (534 900 canvasback days). These ducks are presumed to move into the Inner Bay at night to feed (Knapton, pers comm.), however, this has not been well documented.

In spring, 123 101 canvasback days were observed in the Open Water area. Next in importance for canvasback use was the Turkey Point area with 750 canvasback days, followed by the Crown and Thoroughfare Point areas with 70 canvasback days each. Relatively few canvasbacks were observed outside of the Inner Bay in Lake Erie in spring compared with fall migration (1 118 canvasback days). These canvasbacks also likely move into the Inner Bay at night.

An overall comparison of the importance of areas to significant species of waterfowl or canvasbacks, is given on Table 3.14. The Open Water area appears to be of high importance to canvasbacks in both spring and fall. Caution is advised in interpreting this data, however, as this is only representative of one year and peaks in numbers may have been missed during the surveys.

Table 3.14 Estimated Canvasback Days in the Inner Bay Areas

	Turkey Point	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Spring	750	0	0	70	70	123 101
Fall	0	0	80	0	0	50 750

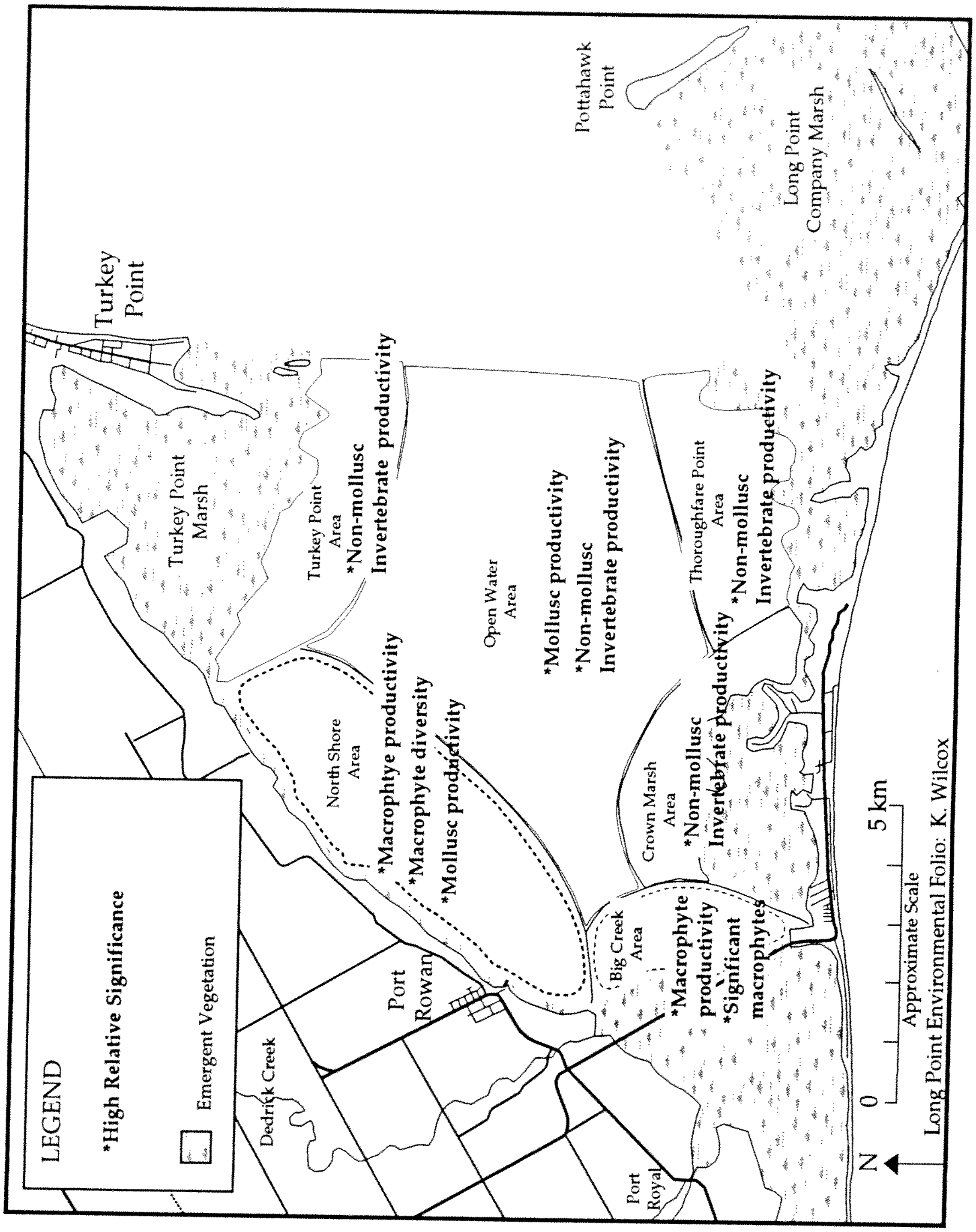
3.3c Summary of Significant Areas in Long Point's Inner Bay for Waterfowl

While the results of this assessment of significance among Inner Bay areas are preliminary, they suggest that the Open Water, North Shore and Big Creek areas may be of particular importance for staging waterfowl. Table 3.15 shows areas and their relative rankings of food importance. The Open Water area appears to be of importance as a refuge area for waterfowl as it hosts the highest number of waterfowl days of any area, the highest diversity of species, and has high numbers of canvasbacks, a species of concern. The North Shore and Big Creek areas seem to be of particular importance to waterfowl as feeding areas. Both are highly productive with respect to important plant foods and have a high abundance of wild celery, a significant plant food. The North Shore areas also hosts a high diversity of plants. Figure 3.6 illustrates significant areas in Long Point's Inner Bay.

3.15 Summary of Estimated Ranking for Waterfowl Food Resources

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Macrophyte productivity	medium	high	high	medium	low	low
Macrophyte diversity	low	high	medium	medium	low	low
Significant macrophytes	medium	high	high	medium	low	low
Non-mollusc Invertebrate abundance	high	medium	medium	high	high	high
Mollusc abundance	medium	high	medium	low	low	high

Figure 3.6 Summary of Areas of High Significance



3.4 Evaluation of Constraints

In this section, criteria are applied to provide an indication of the stresses or constraints upon food resources and upon refuge from disturbance in the six Inner Bay areas. This section is divided into two parts. The first part identifies constraints for food resources and the second part identifies constraints for refuge from disturbance. In both parts a comparison among the six Inner Bay areas is completed.

3.4a Food Resources

The stresses or constraints among areas for plant and invertebrate food resources were compared based on land use and other processes observed in the Inner Bay area. As identified in section 3.1, the constraints that have been considered in this preliminary examination are: marina and cottage developments, the presence of exotic species, infrastructure, and agricultural runoff. A presence/absence measurement was applied in this initial assessment. Cottage and marina developments, refers to the location of cottages and marinas along the coast of the Inner Bay. Exotic species of submerged macrophytes refers specifically to the location of Eurasian milfoil, an exotic species, in Long Point's Inner Bay. Infrastructure refers to roadways, or transportation networks adjacent to the Inner Bay. Agriculture runoff refers to areas where there may be a potential for pollution from nutrients, pesticides, herbicides or sediments.

These constraints have been identified and are illustrated in Figure 3.7. Using this comparison scheme, it appears that the food resources in the North Shore and Big Creek areas have the highest number of different constraints acting upon them. These areas are constrained by the presence of cottage and marina developments along their coastlines, by the presence of Eurasian milfoil (Table 2.0), by the Causeway which runs adjacent to Big Creek area and potentially by agriculture runoff, i.e., sediments, fertilizers, pesticides and herbicides, entering

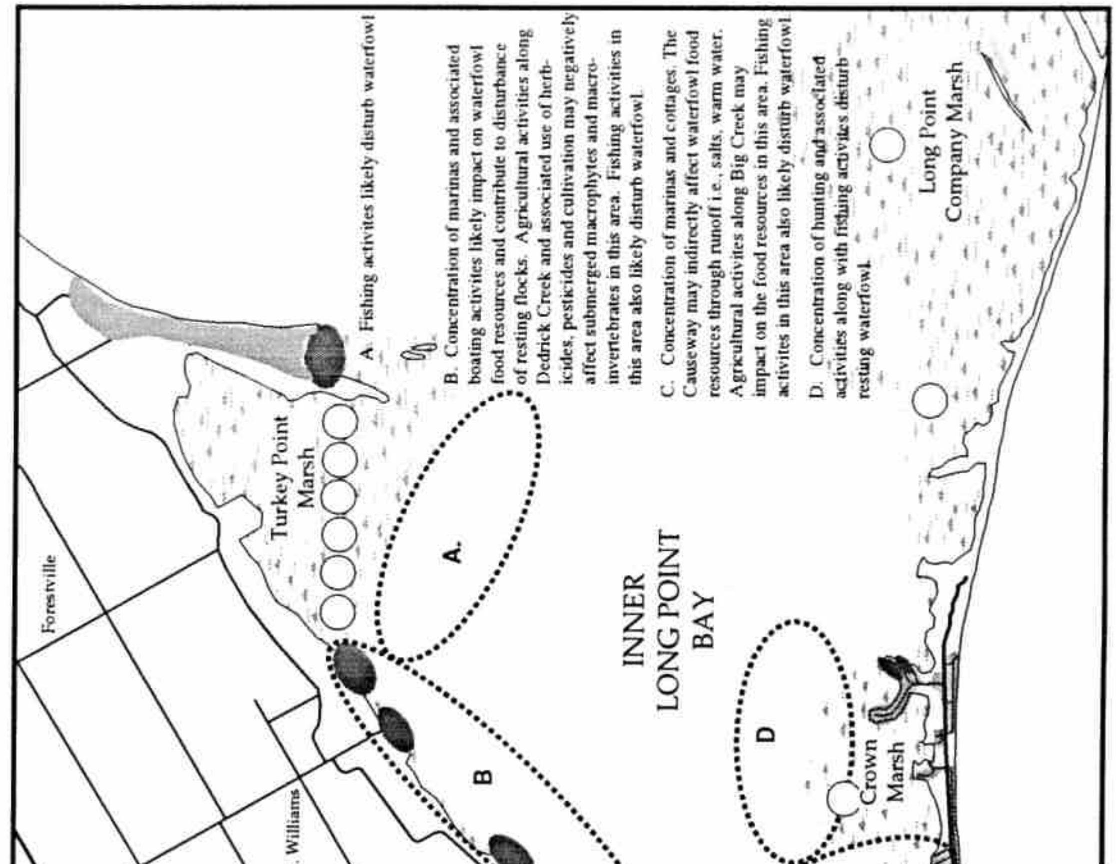
Big Creek (Downey *et al.*, 1994). The food resources in the Turkey Point area also may be constrained by agriculture runoff in adjacent farm fields.

3.4b Constraints for Refuge from Disturbance

The stresses or constraints acting on areas of refuge from disturbance were also compared based on activities and processes that have been considered to have an impact on refuge areas. As outlined in section 3.1, these processes and activities include; hunting, fishing and recreational boating. Hunting refers specifically to the location of known hunt clubs and hunting areas around the Inner Bay. Fishing, refers specifically to areas licensed for commercial fishing. Recreational boating or sport fishing probably have large impacts on resting waterfowl. Initiatives to collect and to assess this constraint, however, have only recently been undertaken (Knapton and Herring, 1994). Additional research is required to identify patterns and areas of disturbance that can be attributed to these uses.

Fishing and hunting constraints have been identified and are illustrated in Figure 3.7. Using this comparison scheme, it appears that all of the six areas, except the Open Water area, are constrained by fishing activities and that the Crown Marsh area and Turkey Point area are also constrained by hunting activities. It should be noted however, that this is a preliminary assessment and that the outcome may change with the addition of recreational boating and other criteria.

Figure 3.7 Constraints for Staging Waterfowl in Inner Bay Area



3.4c Identification of Areas of Constraints

While the results of this assessment of constraints among Inner Bay areas are preliminary, they suggest that the North Shore and Big Creek areas may be particularly constrained for staging waterfowl food resources. These areas appear to be constrained by the presence of cottages/marinas, exotic species, infrastructure, such as the Causeway, and because of the potential for agricultural runoff. The food resources in Turkey Point area also appear to be constrained by agriculture runoff. Table 3.16 illustrates the presence or absence of constraints in each of the areas.

The findings also indicate that the Crown Marsh and Turkey Point areas in particular may be constrained for refuge as both hunting and fishing disturbances occur in these areas.

Table 3.16 Preliminary Assessment of Constraints for Food Resources and Refuge from Disturbance.

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Constraints for: FOOD RESOURCES						
Cottage/ Marina		*	*			
Exotic Species		*	*			*
Infrastructure		*	*			
Agriculture	*	*	*			
Constraints for: REFUGE						
Hunting				*	*	
Fishing	*	*	*	*	*	

* Indicates the presence of a constraint for waterfowl.

3.5 Summary

In summary, the general purpose of this chapter was to identify significant areas in Long Point's Inner Bay for waterfowl and to highlight the stresses or constraints that are acting upon these significant areas. This was accomplished using the second level of the ABC resource survey method and applying it to available information on waterfowl food resources and refuge areas. While the criteria used and findings of the assessment apply only to this study, they are valuable for planning and management around the Inner Bay.

Table 3.17 shows the six Inner Bay areas and their estimated rankings of significance and constraints for waterfowl. Overall it appears that the North Shore area and the Big Creek areas may be of particular importance as feeding areas for waterfowl because they have a relatively high abundance of plant food resources and host wild celery, a significant plant species for waterfowl. The findings also indicate that the food resources in these areas are stressed or constrained by land use activities such as cottage and marina developments, infrastructure (roadways), and agricultural practices.

Table 3.17. Summary of Significance and Constraints Among Inner Bay Areas for Waterfowl

	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Thorough-fare Point Area	Open Water Area
Significance of: FOOD RESOURCES	Estimation of Significance Levels					
Macrophyte productivity	medium	high	high	medium	low	low
Macrophyte diversity	low	high	medium	medium	low	low
Significant Macrophytes	medium	high	high	medium	low	low
Non-mollusc Invertebrate productivity	high	medium	medium	high	high	high
Mollusc productivity	medium	high	medium	low	low	high
Constraints for: FOOD RESOURCES	Identification of Presence/Absence					
Cottage/ Marina		*	*			
Exotic Species		*	*			*
Infrastructure		*	*			
Agriculture	*	*	*			
Constraints for: REFUGE						
Hunting				*	*	
Fishing	*	*	*	*	*	

* Indicates the presence of a constraint for waterfowl.

CHAPTER 4

SUMMARY WITH IMPLICATIONS FOR PLANNING

4.0 Introduction

The purpose of this study was to assess Long Point's Inner Bay from the perspective of its importance as a critical staging area for waterfowl and to interpret the results in terms of their significance and constraints for planning and managing staging waterfowl. In the study, significance was considered in terms of various indicators of available food resources and potential resting areas. In analyzing, synthesizing and assessing the data, the ABC Resource Survey was applied. This chapter summarizes the insights gained from this exercise, outlines implications for planning, makes recommendations, and identifies additional research opportunities.

4.1 Summary

Long Point is an important staging area for waterfowl. Each spring and fall, hundreds of thousands of waterfowl stop over at Long Point to rest and feed during migration. Long Point's importance to waterfowl has been internationally recognized with its designation as a RAMSAR site and a World Biosphere Reserve. Its importance has also been recognized nationally by designations as a National Wildlife Area and provincially by designations as a Class 1 Wetland. Recreation and tourist development in the form of marinas, cottages, boating, fishing, and hunting, and agricultural infrastructure and other stresses in the Bay, are a potential threat to this critical staging area. To understand the effects of development and to minimize and mitigate impacts, it is essential to know where waterfowl are resting and feeding during their stay at Long Point, what foods and other resources waterfowl are using, and how are they changing over time.

The specific objectives of this thesis therefore were 1) to describe the waterfowl food resources and refuge areas in Long Points Inner Bay, and 2) to identify significant areas for waterfowl as well as to highlight the constraints that are acting upon these significant areas.

These objectives were addressed in the following general manner. The Inner Bay was divided into six areas to provide a framework for the collection of data and for a comparison of their importance for waterfowl. The division of areas was based on preliminary evidence of differences in plant communities identified in an earlier study by Whillans (1985). This division was supported to some degree by the distribution and patterns of plants and invertebrates found in this study. Critical components of staging areas, food resources and refuge from disturbance, were identified and the ABC resource survey method was applied. The ABC method provided a framework for the collection, analysis, and synthesis of data and for assessing the information in terms of their significance and constraints for waterfowl.

Food resources, i.e., submerged macrophytes and macroinvertebrates, of Long Point's Inner Bay were described to provide information about the availability of food resources for waterfowl. Stomach contents of waterfowl at Long Point were collected and described to provide insight about the food habits of waterfowl during their stay. Finally, various aerial surveys of waterfowl were described and their results outlined to provide an indication of the importance of different areas for refuge from disturbance.

Criteria for significance and constraints were selected and applied to the foregoing information to provide for a comparison of importance of and the pressures upon the six Inner Bay areas. Estimates of high, medium and low significance were given to areas in relation to their food resources and provision of refuge for waterfowl. In estimating constraints, criteria were outlined and applied to areas on a presence/absence basis. In all cases, these estimates are preliminary and need to be subjected to further study. The estimates do provide an initial guide for planning and management.

Food Resources and Refuge Areas

The waterfowl plant food resources in Long Point's Inner Bay consist of 17 different species of submerged macrophytes. Of these, musk grass, Eurasian milfoil, naiad, and wild celery comprised 91.7% of the vegetation community in the Inner Bay. The findings show that all of the areas have distinct plant communities. Statistical tests of the vegetation composition in each of the Inner Bay areas indicated that both the North Shore and Big Creek areas were significantly distinct from the other four areas in their distribution and abundance of plant types.

In terms of macroinvertebrate food resources, the non-mollusc invertebrate composition of Long Point's Inner Bay consisted of ten different taxa. Of these, chironomids, scuds, and sow bugs occurred in the highest numbers. Statistical tests showed that the North Shore and Big Creek areas had significantly fewer numbers of non-mollusc invertebrates than the other four areas. The mollusc composition overall in the Inner Bay was comprised mainly of species of snails and zebra/quagga mussels. Snails were abundant on the western side of the Inner Bay and zebra/quagga mussels on the eastern side. The Open Water and North Shore area had the highest numbers of molluscs.

Stomach analysis of waterfowl collected in fall of 1992 indicated that waterfowl consume a range of foods during their stay at Long Point. As an aggregate percent of the total weight of the foods consumed by waterfowl, grains such as corn and oats, floating plants such as fragrant waterlily, emergents such as wild rice and burr reed, and submerged macrophytes such as musk grass, naiads and wild celery were all important food items. The corn and oats are believed to be obtained at waterfowl feeding sites near the Bay and not from agricultural fields, but this needs further study.

Of the non-mollusc invertebrates consumed, species of *Tricoptera*, *Hemiptera*, *Diptera*, and *Amphipoda* were consumed in the highest quantities by weight. Among molluscs, species of *Gastropoda* and zebra mussels were important food items.

The Open water area in particular is important as refuge area for waterfowl. Highest waterfowl days were recorded in this area. High numbers of diving duck days in particular were recorded in this area in both spring and fall. Highest dabbling duck days were recorded in the Turkey Point area and in the Big Creek area.

Significant Areas

The results of this study suggest that the Open Water area, the North Shore area and the Big Creek areas of the Inner Bay may be of particular importance to waterfowl.

> The Open Water area is considered to be important because of the high numbers waterfowl days observed in the area, the high number of different waterfowl species that rest in the area, and because high numbers of threatened canvasbacks use this particular area as a refuge/resting site during spring and fall migration.
>
> The North Shore area was identified as important to waterfowl due to its high productivity of important plant foods, its high diversity of plant food species, its high abundance of wild celery, and its high numbers of molluscs.
>
> The Big Creek area was identified as being of high importance due to its high productivity of important plant foods, and because it has a high abundance of wild celery, a significant food resource for canvasbacks.

The findings also indicated that the Open Water, Turkey Point, Crown Marsh and Thoroughfare Point areas have significantly higher numbers of non-mollusc invertebrate food resources than the North Shore and Big Creek areas. In this report it remains important to think of the entire Bay as providing different kinds of feeding opportunities that are not understood and require further study while also recognizing the high estimated importance of the North Shore and Big Creek areas for food and for this reason given priority.

In relation to refuge areas, the Open water area is critical for diving waterfowl, since in both spring and fall large numbers of diver days were recorded in this area. The Turkey Point area appears to be of relatively high importance to dabbling waterfowl in spring as the highest numbers of dabblers were recorded in this area, and the Big Creek area may be of importance for dabblers in fall as relatively high numbers were recorded in this area at this time.

The findings suggest that the Inner Bay Areas are a unit and together perform different and complementary roles for feeding and resting waterfowl. Thus, it may be that certain areas are used as refuge areas during the day, such as the use of the Open Water area by diving ducks, and Turkey Point area by dabbling ducks. At night, waterfowl may move into other areas, such as the North Shore and Big Creek areas to feed on plant food resources.

What this study has identified then, is a preliminary outline of a general system of areas that appear to fulfill the ecological requirements of staging waterfowl at Long Point's Inner Bay. The delineation of the boundaries of the areas, however, is still preliminary and the configuration of the units is tentative. The areas and divisions may change with changes in water levels or the water quality of the Inner Bay. While some areas currently appear to be more significant than others in terms of food and other needs, studies are needed to confirm these and also to ascertain how the areas are related to one another in terms of overall waterfowl use on a daily or a longer term basis. At a minimum we can recognize that there is a connection between areas, but we do not know if the relationship changes at different times of the day (i.e., at night) or between years. It is therefore necessary that research on all areas and on all aspects of waterfowl ecology continue, while planning and management take into account the relatively high estimated value of the Open water, the North Shore, and the Big Creek areas.

Areas Stressed or Constrained for Waterfowl

- The findings also suggest that the different ecological units or areas of the Inner Bay have different levels of stress or constraints on them for staging waterfowl. Based on the presence of marinas, cottages, and exotic species, the North Shore and Big Creek area were identified as being highly constrained for waterfowl use. Because these areas may be highly important for food resources, the presence of cottages and marinas and associated pollution, disturbance and other effects, pose threats for waterfowl in these areas. The presence of Eurasian milfoil in both of these areas threatens important food resources through competition.

The Open Water area may be constrained for waterfowl use by disturbance. Both recreational boaters, and anglers/hunters use this area to travel across the Inner Bay and so disturb the area which is estimated to have the highest numbers of resting waterfowl of any of the six Inner Bay areas. In this respect, it has been noted that waterfowl will use an area lightly, if at all, if disturbance is excessive.

Long Point's Importance

The findings of this study re-iterate that the entire Inner Bay is of major importance to waterfowl at a local, national and international level in terms of overall numbers of waterfowl and diversity of species. In 1992, for example, over 600 000 waterfowl days were spent at Long Point during spring migration and close to 3 million during fall migration. The findings also confirm the critical importance of Long Point's Inner Bay internationally because of its importance to canvasbacks, a threatened species of waterfowl. During 1992, for example, Long Point's Inner Bay supported over 50 000 canvasback days during fall migration. This study also confirms that we are only beginning to understand how the Inner Bay works in terms of its use and value for waterfowl. Some understanding of the ecology of the Bay and the role of its different areas for waterfowl is emerging. And we are beginning to get some understanding of waterfowl feeding, refuge and other behavioral requirements as well as effects of human activities on waterfowl. On the basis of these beginnings, it is possible to begin strategic and structured planning for the Bay and also to highlight important research needs in order to understand and plan and manage the Bay more effectively.

4.2 Implications for Planning

The findings of this study, while preliminary in nature, have many implications for planning. These implications are given mainly as a starting point to solicit ideas and to provide the initial basis for bringing waterfowl ecology into the planning and decision making process.

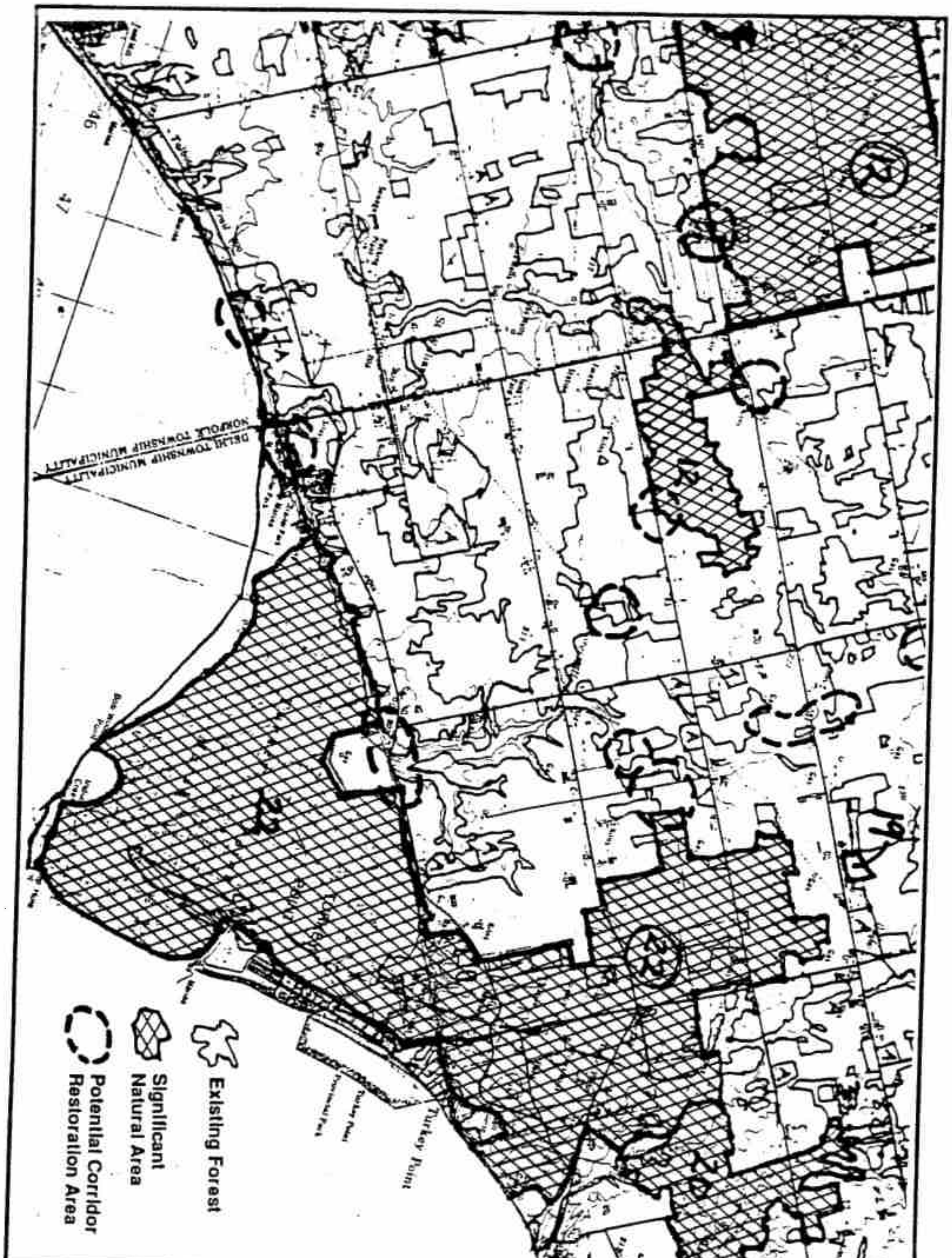
- First, given the overall importance of the Inner Bay as an internationally significant staging area, all proposals for development around the Inner Bay should be screened in terms of the federal and provincial Environmental Assessment process.

- Second, six areas or ecological units have been identified in the Inner Bay. Planners should take these divisions into account and be aware of them in reviewing applications for development. Careful attention should be given particularly to proposals along the shores of the Big Creek and North Shore areas as these have been identified as distinct and as having high importance for food resources. These areas also are highly stressed by agricultural, recreational and other developments.

- Third, the impacts of boating disturbance on staging waterfowl in Long Point's Inner Bay should be carefully considered by planners. Knowledge of the impacts of recreation at different times of the year on staging waterfowl should be used as a basis for regulating tourist activities. The promotion of tourist based activities is likely to result in increased recreation activities, especially water based and nature viewing activities. It is therefore important that the promotion of recreation activities be carefully considered and regulated so that the very resources which these activities depend on do not degenerate. In this respect it is important that a zoning system be considered to protect the Open Water area of the Bay particularly in the fall. Possibly, a waterfowl sanctuary, similar to the fish sanctuary could be established to provide staging waterfowl with a refuge area in the Open Water area of Long Point's Inner Bay.

- Fourth, from a strategic standpoint, planners should recognize potentially viable links among nearby terrestrial and Bay areas. Calls for a protected network {by Beazley (1993)} should be extended beyond the shoreline to include the areas identified as important within the Inner Bay. Beazley (1993) proposal to connect the Turkey Point and Spooky Hollow areas by providing a corridor of natural land cover could be extended to include Inner Bay areas identified as significant in this study (Figure 4.0). In particular, the link between the North Shore area, which was identified as significant in this study, and the Turkey Point area, which was identified in Beazley's (1993) terrestrial study, should be recognized and planned for in terms of land use development, conservation, restoration programs and research.

Figure 4.0 Proposed Restoration Demonstration Project (Adapted from the Long Point Environmental Folio Series, Beazley, 1993)



4.3 Recommendations

Given the major importance of Long Point's Inner Bay to waterfowl on an international scale and given the numerous factors that contribute to declining waterfowl habitat quality, several recommendations can be made.

- First and foremost, it is recommended that the most effective approach to managing Long Point's Inner Bay is through a comprehensive conservation strategy that attempts to balance the conservation of waterfowl habitat with the continued economic well-being of the local community. The strategy should be prepared in close consultation with residents and other users of the Long Point's Inner Bay. The strategy should include a co-ordinated information, communication, assessment and monitoring system. While recognizing the overall importance of the Bay, the North Shore and Big Creek areas should be targeted for immediate conservation efforts. It is recommended that no significant development proposals be approved in the Inner Bay and especially in the North Shore and Big Creek areas until a conservation strategy is prepared.

- Boat traffic within the Inner Bay should also be monitored and mapped along with research on the impacts of disturbance on waterfowl. At this point, it is unknown where boat traffic is concentrated or where its effects can be minimized. Possibly, preferred routes of travel can be established in the Inner Bay, pending the findings of further research.

- Beazley's (1993) demonstration restoration project connecting Turkey Point and Spooky Hollow should be extended to include the North Shore and Turkey Point areas of the Inner Bay.

Research into the economic importance of waterfowl to the local community such as that completed by Wilcox, (1994) on the economic importance of 'Birds' in the Long Point Area would be helpful in gaining community and general support for habitat protection. Research is also needed on the 'institutional ecology' of the Inner Bay. Skibicki (1993) has provided a description, analysis and assessment of the various acts, policies, agencies and other institutions that are involved in planning, managing and making decisions. But this study is essentially a structural or organizational study and not a functional analysis and the latter is needed so that we have a better understanding of how the institutions actually works, what the strengths and weaknesses are and how they can be improved.

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