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An Ecosystem Approach to Management of an Internationally Significant Waterfowl Staging Area: Long Point's Inner Bay

Long Point Environmental Folio

Long Point Environmental Folio
Publication Series

Technical Paper 5

Long Point Environmental Folio Publication Series
Managing Editors: J. Gordon Nelson and Patrick L. Lawrence

A study team at the Heritage Resources Centre is developing an Environmental Folio for the Long Point Biosphere to assist management agencies and local citizens in understanding the human and natural components of the ecosystem. The folio will consist of a series of maps and text that would outline current major management issues and areas of concern. A series of project publications is being prepared to accompany the folio. These reports will consist of supplementary information collected during the study. This project is supported by the Royal Canadian Geographic Society and the Social Sciences and Humanities Research Council of Canada.

An Ecosystem Approach to Management of an Internationally Significant Waterfowl Staging Area: Long Point's Inner Bay[2]

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Publication Series

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An Ecosystem Approach to Management of an Internationally Significant Waterfowl Staging Area: Long Point's Inner Bay

1.0 INTRODUCTION

Waterfowl require a range of essential areas during their annual cycle. Staging areas, used by waterfowl during long distant travel, act as stepping stones and refueling stops on flights across ecological barriers such as mountain ranges, oceans, and forests. Not only are the food resources acquired on staging areas essential for migration, but also for egg production during the breeding season, and for survival on wintering grounds (Stroud, et al., 1990; Ankney and MacInnes, 1978). Each stop over area is an essential link in a chain of sites and thus, conservation of these sites is crucial for waterfowl.

Long Point, Ontario, is an important staging area for North American waterfowl. Each year the marshes of Long Point are visited by hundreds of thousands of waterfowl during spring and fall migration. In fact, Long Point was reported to have the greatest waterfowl use (highest numbers of waterfowl days during spring and fall migration) of any area on the Great Lakes (Bookhout and Bednarik, 1989) and has been recognized internationally as a significant staging area for waterfowl with its designation as a RAMSAR site. Tourist development, however, in the coastal marshes of Long Point's Inner Bay and boating, fishing, and other activities 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 purpose of this study is to provide a means of assessing Long Point's Inner Bay from the perspective of a critical staging area for waterfowl migration. The major objectives of this study were: 1) to outline areas of significance and constraints for waterfowl use, planning and decision making in and around the Inner Bay; and 2) to identify priority areas for future management efforts. This study builds on an earlier work of Pauls and Knapton (1993) which addressed the submerged macrophytes of Long Point's Inner Bay and their value for waterfowl. As such, this working paper is a contribution to the development of an Environmental Folio for the Long Point Biosphere Reserve and region, where a major goal is to present important environmental information in a manner useful to area residents, managers and public officials in an understandable fashion (Nelson et al., 1993).

To assess Long Point's Inner Bay for waterfowl migration, the ABC resource survey method was applied. This method involves the collection of a wide range of information and provides a system for integrating, evaluating and interpreting such information in terms of its significance and constraints for certain projects, programs, activities or purposes in accordance with values, preferences and goals of groups in the area of concern. The ABC survey approach uses several levels of information in order to assess an area for planning (Bastedo et al. 1986). The first level of data is generally presented in a series of theme maps outlining abiotic (geology, hydrology), biotic (plants, animals) and cultural information (land use, economics, institutions) in the area of concern. The second level of information involves interpretative work. Judgments are used at this level to identify significance and constraints for planning and decision making. The final levels of information in the ABC resource survey method are used to define priority areas for future management.

This paper is divided into four sections: Study Area, Methods, Results and Discussion. The first section provides a broad description of Long Point's Inner Bay. The methods section outlines sources of information, how information was gathered, and what steps were taken in the assessment. The results and discussion sections are divided in three parts. The first part provides level one information in a set of theme maps outlining characteristics of the Inner Bay which specifically affect or relate to waterfowl migration i.e., depth, sediments (abiotic), macrophytes, invertebrates, and waterfowl distributions (biotic) and hunting locations, marina and cottage developments (cultural information). The second part defines criteria for an analysis of significance and constraints for planning in and around the Inner Bay based on maintaining waterfowl migration at Long Point. The third part identifies priority areas, based on the foregoing criteria, for planners and decision-makers in the Long Point area.

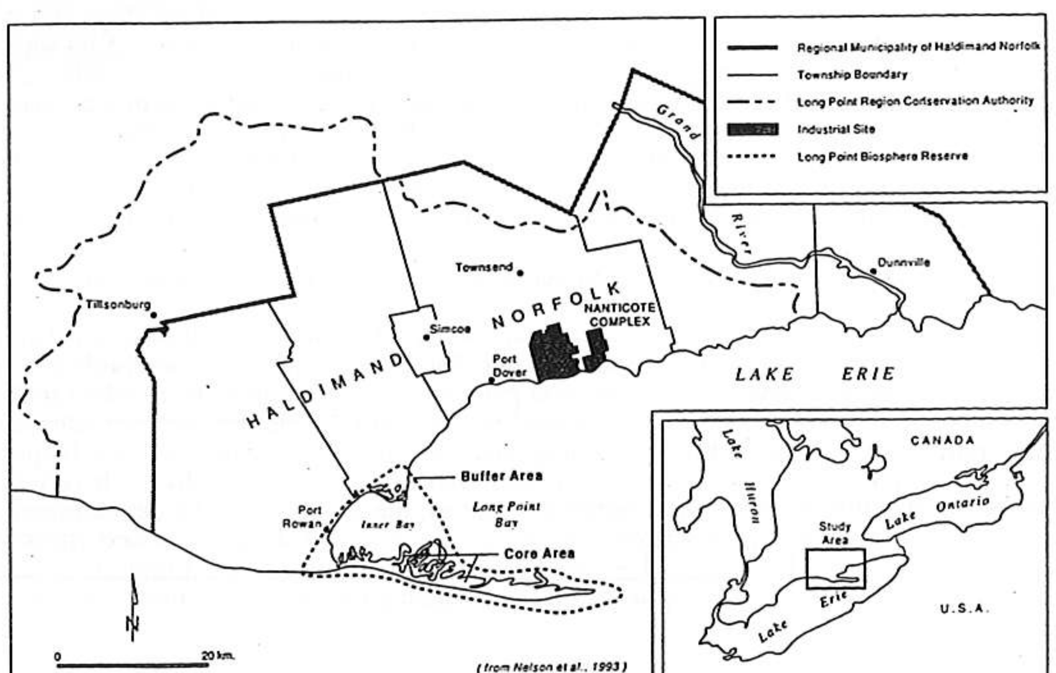
2.0 STUDY AREA

Located on the north shore of Lake Erie, Long Point is the largest sand spit on the Great Lakes and one of the most extensive wild areas left in southwestern Ontario (Reznicek and Catling, 1988) (Figure 1a). Long Point's Inner Bay, the focus of this study, 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 Pottohawk Point (Figure 1b, Whillans, 1985). The Inner Bay is approximately 28km^2 in surface area and has only one major tributary - Big Creek. Big Creek has a 730km^2 watershed that drains the agriculture fields of Norfolk, Oxford and Brant Counties. The creek accounts for 77% of the water from tributaries entering the Inner Bay (Whillans, 1985), and is the major source of nutrients and suspended materials entering the Bay. Other significant tributaries are Dedrick Creek and Forestville Creek, (Figure 1b). Eroded materials from exposed sand bluffs, located along the north shore east of the Inner Bay reportedly may be responsible for much of the natural turbidity and siltation in the Inner Bay (Hamley and MacLean, 1979).

Three of the four sides of the Inner Bay are surrounded by emergent marsh vegetation, providing essential habitat and food sources for fish and waterfowl. The nutrient loadings from Big Creek that have helped to make the Inner Bay eutrophic have also helped to make it highly productive for warm water fishes and attractive to waterfowl (Berst and McCrimmon, 1966). In fact, Whillan's (1977) reported that the Inner Bay is significant to the entire Lake Erie fishery as many Lake Erie fish spend at least part of their life cycle in the Inner Bay. Its significance for waterfowl is internationally recognized.

The major land use in the drainage basin of Long Point Bay is agriculture. The Nanticoke industrial complex exists at the northeast edge of Long Point's Outer Bay (Whillans, 1985; Skibicki, 1993). 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, Wilcox, 1993, Figure 1b). The Inner Bay supports a substantial fisheries industry (Whillans, 1979). The entire shoreline of the Inner Bay is licenced for commercial fishing, mostly hoop and seine fishing. Sport fishing occurs primarily in July, and August and occurs throughout the Bay (Wilcox, 1994).

Figure 1a. Long Point Study Area



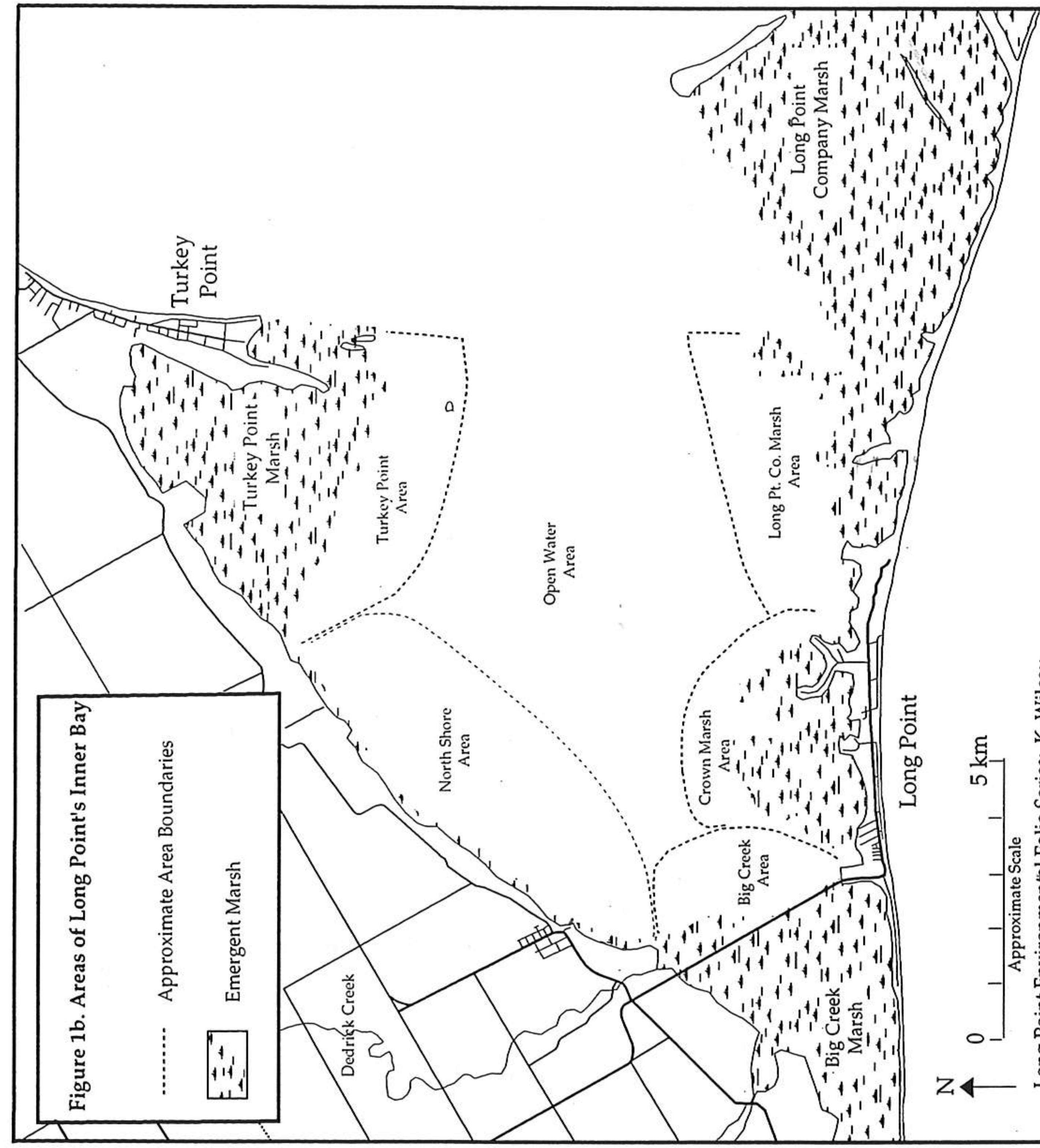


Figure 1b. Areas of Long Point's Inner Bay

3.0 METHODS

Information for this report was gathered from a number of sources and has been organized in a manner consistent with the ABC Resource Survey Method. Historical data were obtained from literature searches at the University of Waterloo Library and from local residents in the Long Point area in 1991 and 1992. Submerged macrophyte distributions were established by conducting transects across the Inner Bay at five hundred meter intervals and collecting vegetation every four hundred meters along each transect using an Eckman dredge. The results were compared to the findings of Smith (1979) based on similar work in 1976. In our analysis of this data, relative abundance was used as the measure of importance for each vegetation type (details in Pauls and Knapton, 1993). Food habits of waterfowl staging at Long Point were obtained through the analysis of the contents of 409 duck gizzards and proventriculii contents during the falls of 1991 and 1992 (Pauls and Knapton, 1993). The relative dry weight of seeds, leaves and stems, and of invertebrates was used as the measure of importance (details in Pauls and Knapton, 1993). Waterfowl numbers at Long Point were obtained from Canadian Wildlife Service (CWS) and Long Point Waterfowl and Wetlands Research Fund (LPWWRF) Survey Data.

The abiotic, biotic, and cultural information relates to the critical components of staging habitat identified by Kahl (1991), specifically food and refuge from human disturbance. To facilitate the making of such relations, the Inner Bay was divided into six areas defined by Whillans (1985) in his study of long term trends in fish and vegetation ecology of the Long Point Bay: Turkey Point area, North Shore area, Big Creek area, Crown Marsh area, Long Point Company area and the Inner Bay Open Water area. These areas were regarded as distinct, individually recognizable areas by Whillans, (1985), however, the boundaries are considered as estimates.

4.0 RESULTS AND DISCUSSION

4.1 ABIOTIC COMPONENTS OF THE INNER BAY

An examination of information on sediments, hydrology, and other abiotic features and processes in the Inner Bay, much of which has been summarized by Stenson, (1993) revealed two key themes that directly affect waterfowl food resources: water depth and sediments.

4.1a Water Depth

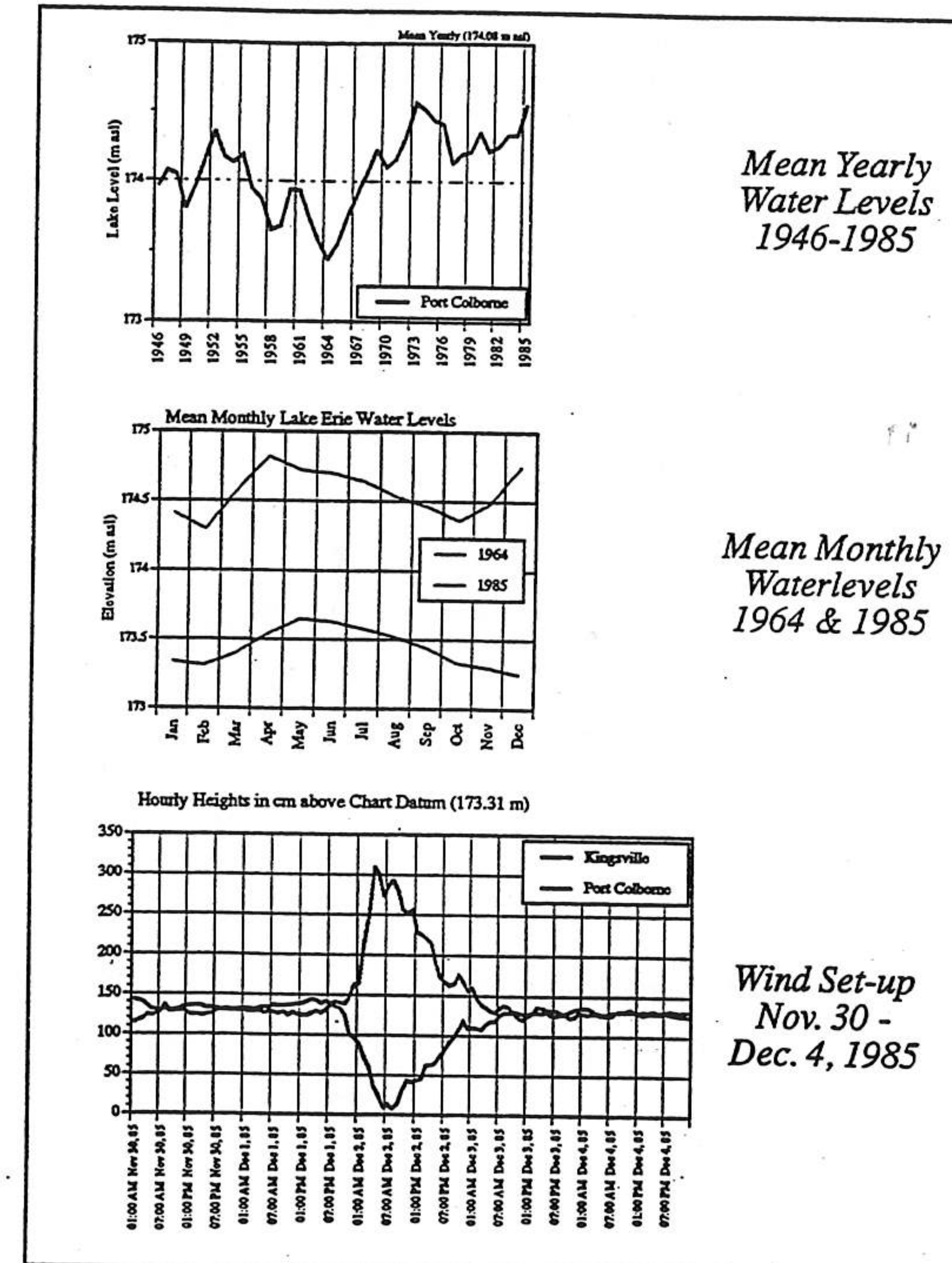
Water depth, a constantly changing feature of the Inner Bay, is important in determining the distribution and abundance of food resources for migrating waterfowl. Water levels in Lake Erie and in the Inner Bay fluctuate from year to year, within a year and sometimes over a period of a day, for example, when the prevailing west winds produce lake surges or seiches and push water into the eastern basin (Reznicek and Catling, 1989). Figure 2 shows changes in Lake Erie water levels yearly, monthly, and daily . These fluctuations result in corresponding changes in the vegetation composition and have an important role in the maintenance of unusual species and high floristic diversity at Long Point (Keddy and Reznicek, 1985). In fact, Long Point has 42 provincially rare plant species with the great majority being wetland species or aquatics (Reznicek and Catling, 1989).

The morphology of the Inner Bay has varied considerably in historic times (Whillans, 1977). Whillans reported records of minimum and maximum depths in the Inner Bay of both 1.66 m and 12.33 m since 1790. Changes in shoreline configuration and bathymetry in Long Point's Inner Bay are shown in Figure 3. While the shape of the bay in the past is relatively similar to its shape today, its depth and shoreline configuration have altered considerably. The earliest (1795) bathymetric map shows the Inner Bay to have a maximum depth of merely 2m, with a single entrance to Lake Erie. The 1815 map shows record high water levels in the Inner Bay. The boat channel, which is still present today at the entrance to Lake Erie, appears to reach a depth of over 12 meters. This is eight meters deeper than the present depth of the channel (Pauls and Knapton, 1993).

The 1835 bathymetric map shows a second entrance to Lake Erie at the present location of Big Creek. At this time, depths also had increased in the middle of the Bay. By 1865, the entrance to Lake Erie, at Big Creek, had narrowed and was completely gone by 1925. Depths ranged from 1 to 3 meters between 1895 and 1965.

Pauls and Knapton (1993) recorded water depths in the Inner Bay in 1991. The greatest depth was approximately 4 meters in the channel going out into Lake Erie and the average depth was about 2 meters (Figure 4).

Figure 2. Water levels in Lake Erie



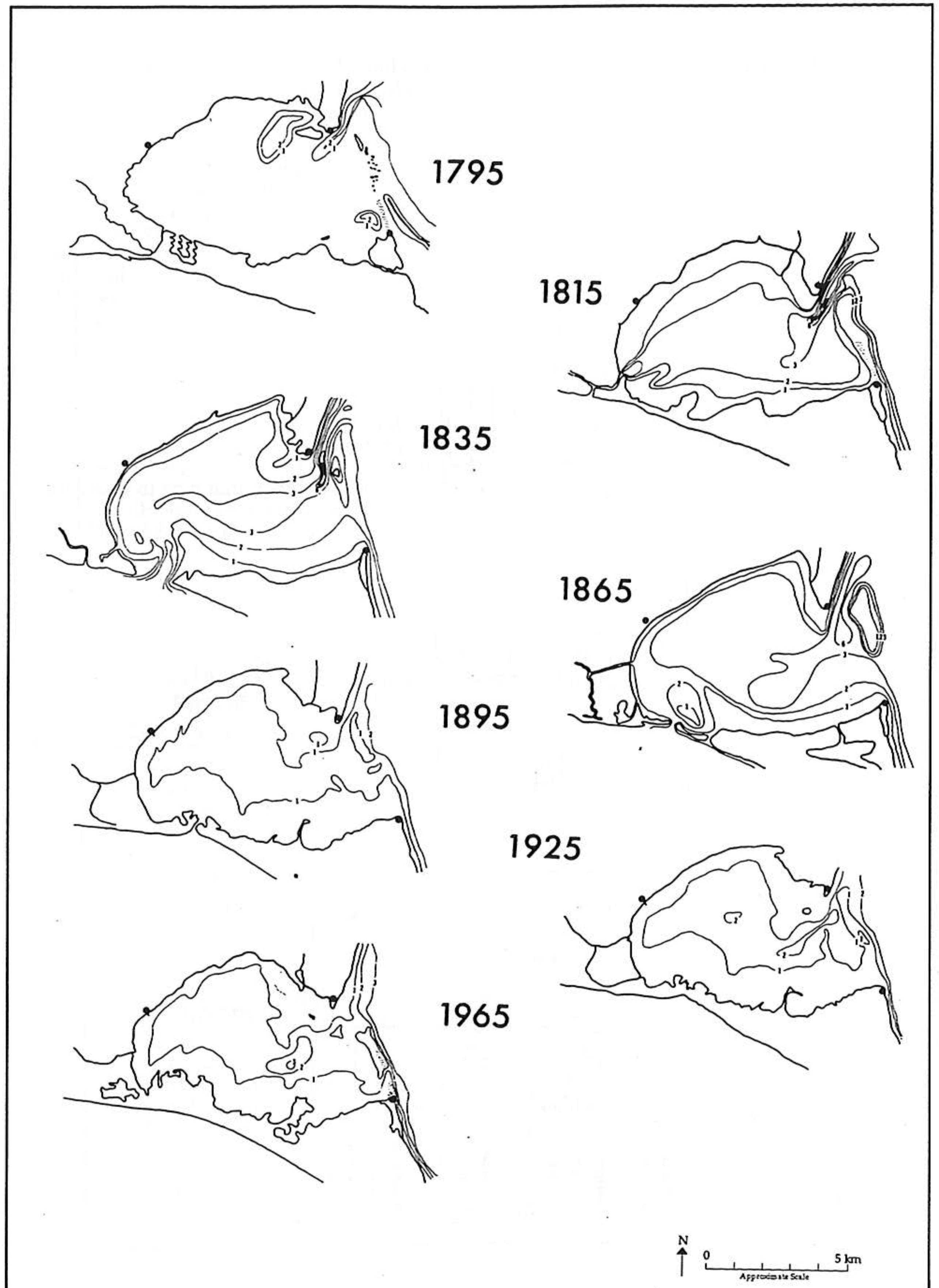


Figure 3. Chronological Bathymetry (Whillans, 1977).

4.1b Sediments of Long Point's Inner Bay

The composition of the bottom deposits in the Inner Bay varies with changes in depth which influence waterfowl food resources such as submerged macrophytes and macroinvertebrate distribution and abundance. Shoreline and surrounding sediments consist of a clay plain along the Inner Bay's North Shore and Big Creek marshes, a sand plain which extends from the lake to a shorecliff 30m or more above the Inner Bay (Heathcote, 1981), and till moraines which thread through the sand plain to the north of the Inner Bay.

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 5 shows general sediment types in the Inner Bay identified by Smith, (1979).

Big Creek delivers sediments to the Inner Bay throughout the year. Movement of these sediments to the east and south is restricted by the influence of a sand point, Turkey Point, on the north shore. According to Heathcote, (1981), the Inner Bay therefore grows shallower and marshier each year as part of the natural shoreline-building process and may eventually silt in completely. This may be accelerated since the entire Eastern Basin is still rebounding from the pressure of Pleistocene ice sheets and the elevation of Long Point Bay above sea level increases slightly each year at somewhere between zero and 7 cm per one hundred years (Stenson, 1993). Global warming also may cause lower water levels in Long Point's Inner Bay and coastal marshes (Staples, 1993). The decrease in water levels associated with warmer and drier conditions in the Inner Bay may result in increased terrestrial vegetation along the southern and northwestern shores, and will likely affect the distribution of submerged macrophytes (Staples, 1993)

4.2 BIOTIC COMPONENTS OF THE INNER BAY

In this section key information is summarized in regards to waterfowl food resources and refuge areas, with more details to be found in Pauls and Knapton, (1993). Macrophyte distributions in the Inner Bay have been mapped to show what plant foods are available for waterfowl and where they are located. Second, invertebrate density and distributions have been mapped to show invertebrate food locations for waterfowl. Third, the results of stomach analysis of waterfowl at Long Point have been summarized to show what foods were selected by waterfowl during their stay at Long Point during fall migration. Fourth, maps have been produced to show waterfowl refuge or resting areas.

4.2a Inner Bay Areas

The Inner Bay, as noted in Section 3. 4 can be divided into six areas. In this section, the submerged vegetation is discussed separately for each of these areas, i.e., Turkey Point area, North Shore area, Big Creek area, Crown Marsh area, the Long Point Company area and the Open Water area. These areas generally indicate what plant food resources are available to waterfowl in each area.

A historical examination of the Inner Bay macrophyte composition is limited by a lack of comprehensive data. While macrophyte communities have been described in the past, (Cruise, 1969; Whillans, 1985) it is difficult to use the results. Cruise (1969) completed a floristic study of Norfolk county as part of the preparation of a flora of the entire peninsula of south-western Ontario. The Inner Bay, however, played a minor role in his analysis. For the purposes of this report, Cruise's work is not used as baseline data because the methodology is unclear and does not provide the exact location of plants within the bay itself.

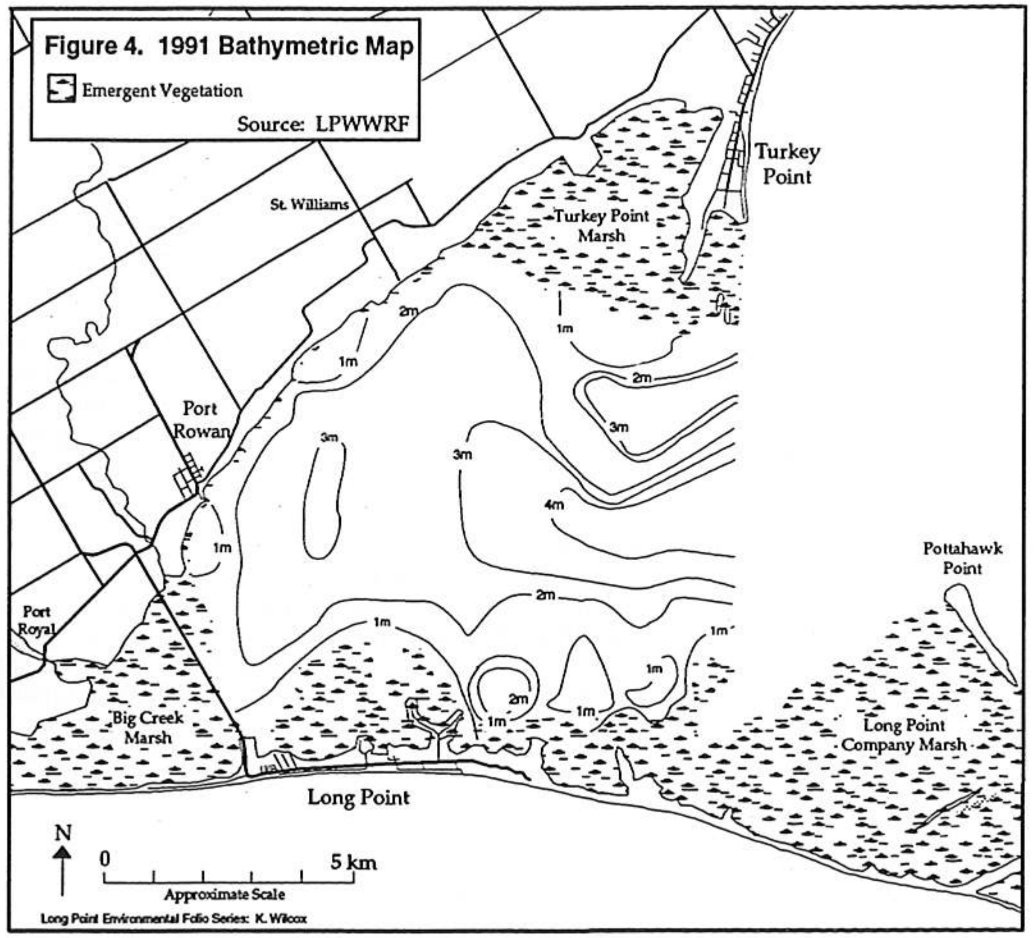


Figure 4. 1991 Bathymetric Map

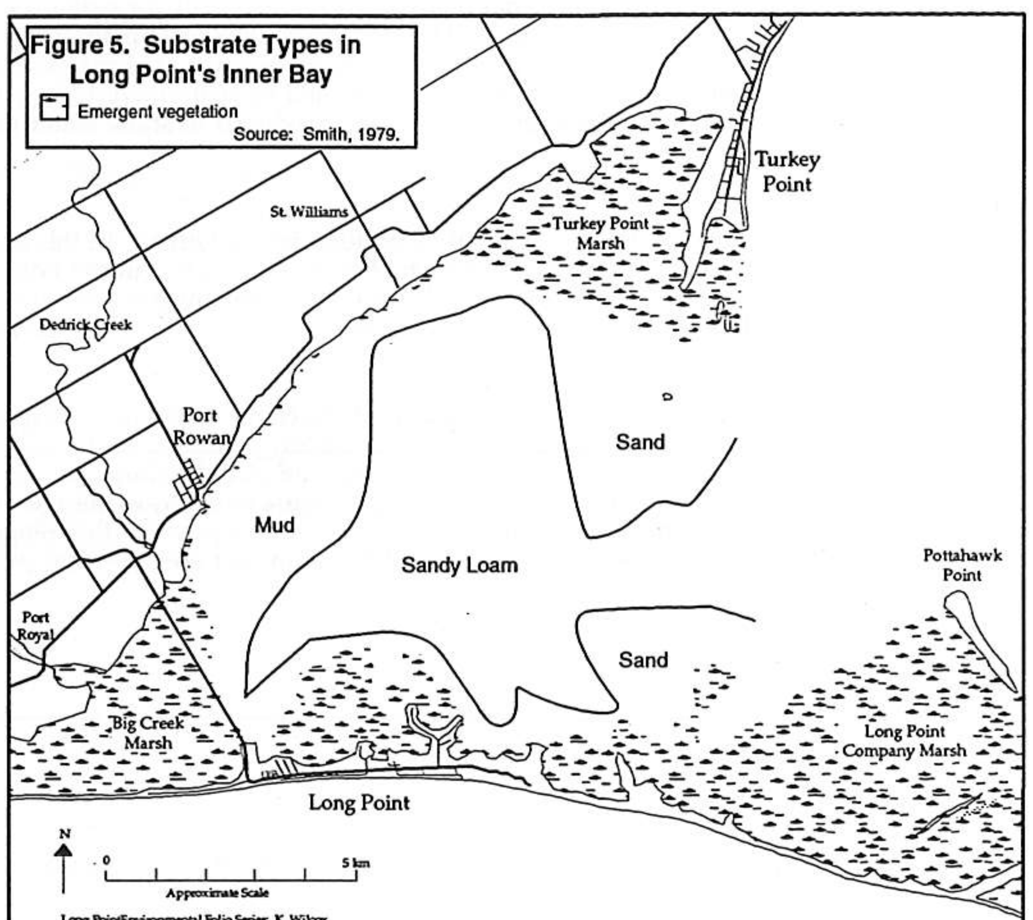


Figure 5. Substrate Types in Long Point's Inner Bay

Whillans, (1985) described the vegetation composition in the six areas of the Inner Bay. His work was based on interpretation from air photos in which he discussed general changes in plant community composition from 1945 to 1978 principally in relation to water level fluctuations. Whillans recorded the vegetation as classes or groups (i.e., floating-leaved plants, submerged macrophytes), as a percentage of the total vegetation composition in each of his six areas. He noted a distinct relationship between water level and aquatic plants, and between shoreline configuration and aquatic plants. As water levels declined, wetland plants spread lakeward and cover types changed composition to more emergent and woody wetland species. In general, he described the variability in shoreline vegetation starting with a decline in emergent vegetation in all Inner Bay marshes between 1945 and 1951. In Turkey Point marsh and in the Long Point Crown marsh, the decline continued till 1955. Then, all wetlands increased in area till 1962 before declining again. 1968 marked the beginning of another increase in wetland area. Presently, Long Point is experiencing high water levels (Long Point Bird Observatory Newsletter 25(1); 1993) and consequently a decrease in emergent wetland area.

Whillans' analysis of vegetation, however, is of limited value for use in ranking the significance and constraints of food resources for waterfowl or for comparison with recent studies in this report because individual plant species were not identified from air photos. His analysis is provided, however, in Appendix 1 to show which emergents are available for consumption by waterfowl.

Smith (1979) surveyed the submerged plant communities on a species basis in the Inner Bay in 1976. This was the first comprehensive study of the submergent vegetation across the entire Inner Bay and thus can be used as the basis for comparison of vegetation communities with our 1991 and 1992 surveys in this report. Our study involved the completion of two surveys (1991 and 1992) using the same sampling stations as Smith. In all three survey years (1976, 1991 and 1992), the dominant plant species were *Chara vulgaris* (musk grass), *Myriophyllum spicatum* (Eurasian milfoil), *Najas* spp. (naiad), and *Vallisneria americana* (wild celery) (Pauls and Knapton, 1993). Together these four species of macrophytes comprised over 90% of the total macrophyte composition of the Inner Bay. Other common plants found in all three years include: *Potamogeton richardsonii* (Richardson's pondweed), *Ceratophyllum demersum* (coontail), *P. pectinatus* (sago pondweed) and *Elodea canadensis* (water weed). Statistical analyses revealed few changes in vegetation distribution between years, however, a significant increase in the amount of *C. vulgaris* and a significant decrease in *V. americana* was detected between 1976 and 1992 (see Pauls and Knapton, 1993).

In the paragraphs below, information on submerged macrophytes is summarized for the dominant plants in each of the areas. Details are available in Pauls and Knapton (1993) where information is presented on a per species basis (Figure 6).

In general, Pauls and Knapton (1993) found that the Open Water area of the Inner bay is dominated by *C. vulgaris* , an algae known as musk grass (Figure 6). This portion of the Inner Bay has predominantly sandy-loam soils and an average depth of 2 meters. In depths of over 4m in the Open Water area of the bay, *M. spicatum* is dominant.

The Turkey Point area and the Long Point Company area are dominated by *C. vulgaris* (Figure 6). A small portion of the Long Point Company area shoreline is however, dominated by *V. americana*. These areas both have sandy substrate and range in depth from 1 to 2 meters.

The North Shore area has a diverse community of dominant submerged macrophytes. *M. spicatum*, *C. vulgaris*, *V. americana* and *Najas* spp. are all dominant in this area (Figure 6). This area has a mud bottom and ranges in depth from 1 to 2 meters.

The Big Creek area also has diverse community of dominant submerged macrophytes. *V. americana* is dominant in this area, along with *Najas* spp., *M. spicatum* , and *C. vulgaris*. Figure 6 shows the dominant plants at each survey station (Pauls and Knapton, 1993). This area has muddy substrate and a depth of approximately 1 meter.

The Crown Marsh area is dominated by species of *Najas* and *C. vulgaris*. It has sandy substrate and a depth of 1 meter.

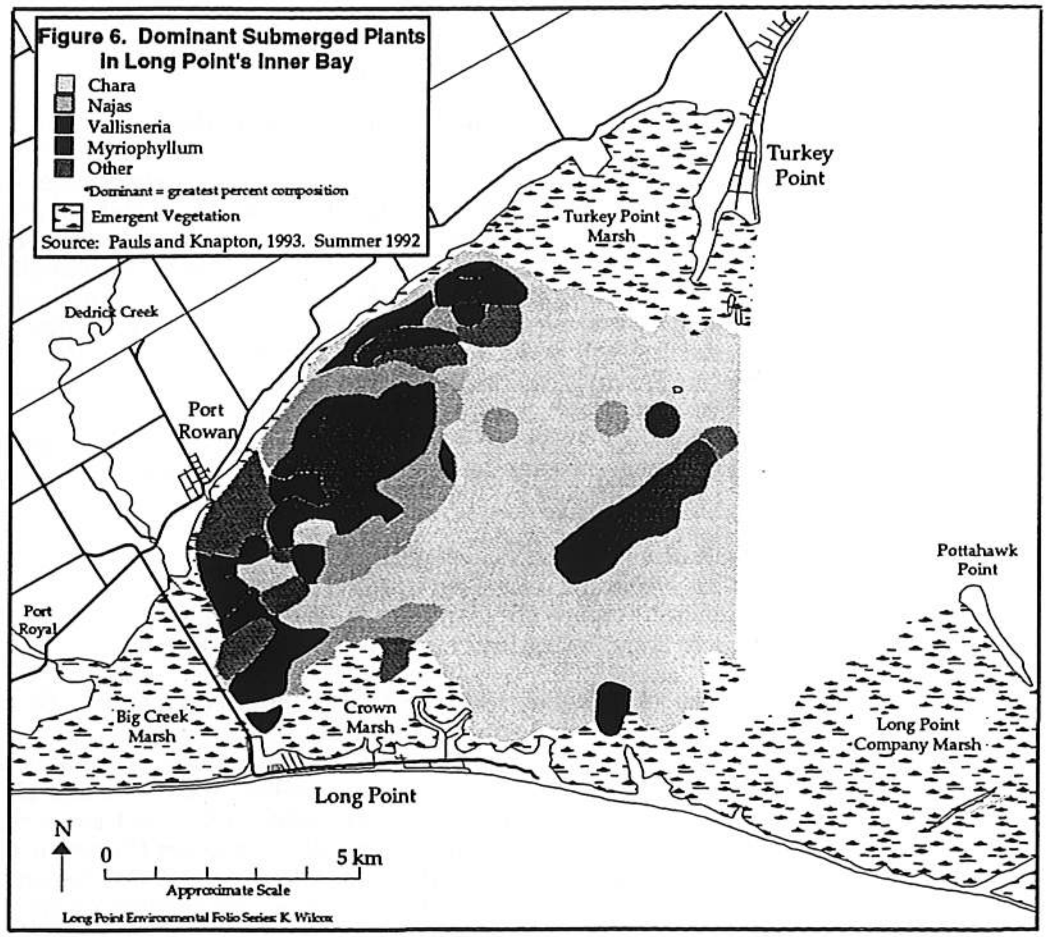


Figure 6. Dominant Submerged Plants In Long Point's Inner Bay

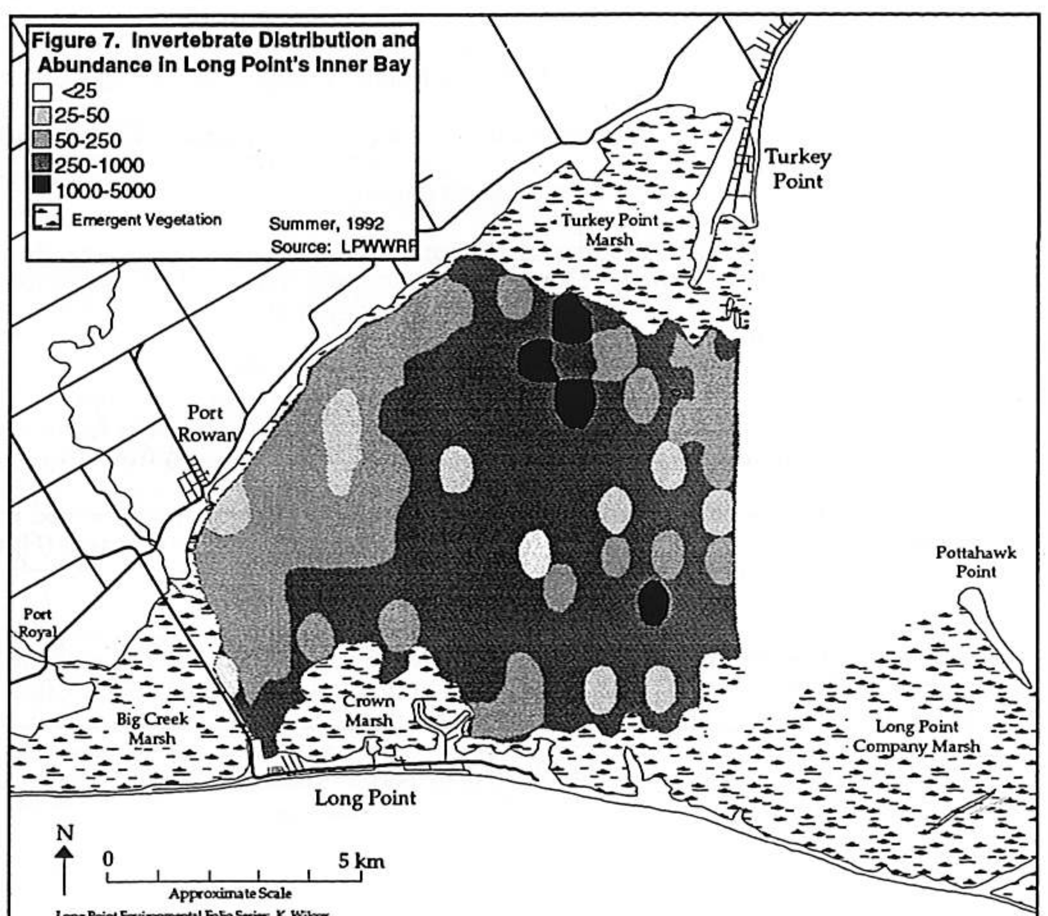


Figure 7. Invertebrate Distribution and Abundance In Long Point's Inner Bay

4.2b Invertebrate Distributions in Long Point's Inner Bay

The Long Point Waterfowl and Wetland's Research Fund collected invertebrates along transect lines across the Inner Bay during July and August of 1992. An Eckman dredge was used for collection, samples were brought back to the laboratory, invertebrates were counted, locations were recorded and later the findings were mapped using the GIS Spans* facilities at the Canadian Center for Inland Waters.

Ten different species of invertebrates were recorded in the 1992 survey. Species of *Diptera* (Chironomid larva), and *Amphipoda* (fresh water shrimp) comprised the majority (88.8%) of the invertebrate composition. Other species of some importance include species of *Isodpoda* (scuds), *Acarina* (water mites), *Oligeocheata* (worms), *Hirudinaea* (blood suckers), and *Tricoptera* (caddisfly larva).

The largest concentrations of invertebrates were found in the Turkey Point area i.e., between 50 and 5000 per square meter, and the lowest invertebrate concentrations were in the North Shore area i.e., between 25 and 250 per meter square (Figure 7). The distribution of invertebrates in the Crown Marsh area, Big Creek area and the Long Point Company area was between 50 and 1000 per square meter with 250-1000 per square meter generally being found in the Open Water area of the Inner Bay.

With no comprehensive assessments of invertebrate densities and distributions across the entire Inner Bay in the past, it is difficult to know how representative our 1992 data are historically. Reasons for the 1992 differences in invertebrate abundance among areas of the Inner Bay may be at least partly related to plant type. Rosine's (1955) study of invertebrates on submerged aquatic plant surfaces in Muskee Lake, Colorado, found that the greater the leaf dissection of a submerged aquatic plant, the larger and usually the more varied was the animal population associated with it. Consistent with these findings, the areas where *Vallisneria americana* -a submerged plant with long tape-like leaves- is the dominant or subdominant plant have the lowest numbers of invertebrates, i.e., in muddy substrate areas such as the North Shore area.

In any event, on the basis of the 1992 survey, invertebrate densities throughout the Inner Bay appear to be too low to support optimal duckling production i.e., high numbers of broods associated with high food availability. A study of duckling productivity undertaken by Godin and Joyner, (1981) found that areas with invertebrate densities lower than 3600 per square meter were sub optimal for duckling production i.e., these areas had lower numbers of broods per hectare compared with areas having greater than 3600 invertebrates per meter square. Based on this number and Figure 7, the Inner Bay appears unable to support optimal duckling production except in one area, at the edge of Turkey Point area (Figure 7).

4.2c. Foods consumed by Waterfowl

The stomach contents of 409 ducks of 9 different species were examined by the Long Point Waterfowl and Wetlands Research Fund to determine food preferences of waterfowl during their stay at Long Point (Table 1 shows waterfowl species analyzed). The study found that plant material made up over 90% of the foods consumed by waterfowl, and invertebrates less than 10%. Of the 90% plant material, *C. vulgaris*, *Najas* spp. and *V. americana* comprised the largest portion of the submerged macrophytes consumed by waterfowl and thus may be an important factor in attracting waterfowl to the area, (Table 3; Pauls and Knapton, 1993). *Zizania palustris*, *Sparganium eurycarpum* and *Scirpus acutus* comprised the highest portion of emergent plants consumed by waterfowl and *Nymphaea odorata* was the only floating leafed plant of significance for waterfowl. Of the true invertebrates (insects and insect larvae) consumed by waterfowl, *Tricoptera* made up the highest proportion, followed by *Coleoptera* and *Hemiptera*. (Table 2). *Dreissena polymorpha* comprised a high proportion of the invertebrates by weight, however, they were consumed almost solely by Scaup (*Aythya affinis/Aythya marila*) and did not make up a large proportion of the other ducks' diets.

Table 1. Waterfowl Diets Examined at Long Point (Pauls and Knapton, 1993).

Common name	Scientific name	No analyzed
American Wigeon	*Anas americana*	149
American Black Duck	*A. rubripes*	33
Ring-necked Duck	*Aythya collaris*	47
Redhead	*A. americana*	38
Canvasback	*A. valisneria*	40
Lesser Scaup	*A. affinis*	49
Greater Scaup	*A. marila*	24
Bufflehead	*Bucephala albeola*	18
Ruddy Duck	*Oxyura jamaicensis*	11
Total		409

Table 2. Invertebrates Consumed by Waterfowl, Fall 1991 and 1992 (Knapton, unpublished data).

Scientific name	Common name	% Composition	
Dreissena polymorpha	zebra mussels	13.30	--------------
Gastropoda	snails	7.90	--------
Tricoptera	caddis fly larvae	3.80	----
Coleoptera	beetle larvae	1.60	--
Hemiptera	water bugs	1.00	-
Diptera	midge larvae	0.10	
Amphipoda	fresh water shrimp	0.10	
Odonata	dragonfly larvae	0.10	
Annelida	worm	0.10	
Pelecypoda	fingernail clam	0.10	
Isopoda	scud	0.10	
Arachnida	spider, mite	0.10	
Megaloptera	alderfly, fishfly	0.10	
Hymenoptera	wasp larvae	0.10	
miscellaneous invertebrates	unidentifiable insect larvae	0.10	
miscellaneous mollusc	shell fragments (likely zebra mussels)	72.00	

Table 3. Plant Material Consumed by Waterfowl in the fall of 1991 and 1992 (Knapton, unpublished).

Scientific name	Common name	% Aggregate dry Weight	
Zea mays	corn	16.85	--------------
Aven sativa	oats	14.00	------------
Chara vulgaris	musk grass	10.83	---------
Najas flexilis/guadalupensis	naiad	10.60	---------
Vallisneria americana	wild celery	6.89	-----
Elodea canadensis	water weed	3.64	--
Zizannia palustris	wild rice	2.66	--
Potamogeton richardsonii	Richardson's pondweed	2.14	--
P. gramineus	variable pondweed	1.58	-
Myriophyllum spicatum	Eurasian milfoil	1.56	-
Najas guadalupensis	northen naiad	0.95	-
Sagittaria latifolia	arrowhead	0.88	-
Nymphaea odorata	fragrant waterlily	0.83	-
Sparganium eurycarpum	burr reed	0.80	-
Scirpus acutus	hard stem bulrush	0.64	-
Potamogeton pectinatus	sago pondweed	0.50	-
Ceratophyllum demersum	coon tail	0.50	-
Pontederia cordata	pickerel weed	0.45	-
Nelumbo lutea	American lotus	0.37	-
Potamogeton natans	floating-leaf pondweed	0.30	-
Eleocharis palustris	common spikerush	0.28	-
Potamogeton spp.	pondweed	0.27	-
Polygonum lapathifolium	water smartweed	0.26	-
Scirpus spp.	bulrush	0.26	-
Utricularia vulgaris	common bladderwort	0.23	-
Leersia oryzoides	cut grass	0.01	
Scirpus validus	softstem bulrush	0.01	
Polygonum pennsylvanicum	smart weed	0.01	
Ranunculus longirostris	white water buttercup	0.01	
Polygonum spp.	smartweed	0.01	
Nuphar variegata	bulhead waterlily	0.01	
Polygonum amphibium	water smartweed	0.01	
Scirpus fluviatilis	bulrush	0.01	
Pannicum spp.	pannic grass	0.01	
Polygonum amplifolium	smartweed	0.01	
Cladium mariscoides		0.01	
Carex spp.	sedges	0.01	
Brasenia schreberi	watershield	0.01	
Potmogeton pusillus	slender pondweed	0.01	
Eleocharis spp.	spikerush	0.01	
Polygonum punctatum	smart weed	0.01	
Najas flexilis	southern naiad	0.01	
Eleocharis equisetoides	northern jointed spikerush	0.01	
Zannichellia palustris	horned pondweed	0.01	
Phragmites australis	phragmites	0.01	
undetermined seeds		0.12	
undetermined roots		0.01	
undetermined tubers		8.91	
undetermined stems and leaves		11.91	

4.2d Waterfowl Use of Long Point and the Inner Bay

Historically waterfowl have used Long Point as a stop over area during their spring and fall migration. While actual numbers of waterfowl are not well documented, past descriptions of the area indicate that Long Point was heavily used by waterfowl. Snyder, in Holroyd and Bradstreet (1982) describes waterfowl numbers at Long Point as follows:

> Since the earliest times the area has been noted as an ideal place for duck-shooting. As long ago as 1841, before the time of modern firearms, it is recorded (Godley, 1844) that four men shot 750 ducks in twelve days during the month of October. Later, on October 2, 1876, five men bagged 646 ducks there in a single day (Hallock, 1876). An editorial in Forest and Stream (1883) states that a member of the Long Point Company averaged 51 ducks per day for eleven days and another 61 ducks per day for nine days. Even with the general reduction in numbers of ducks throughout North America, Long Point still retains a reputation as one of the best situations for duck-shooting in the whole Dominion.

The Long Point Bird Observatory has prepared a seasonal checklist of waterfowl in the Long Point area (Table 4). The list provides insight for viewing and for area managers by giving the status of each waterfowl species throughout the year.

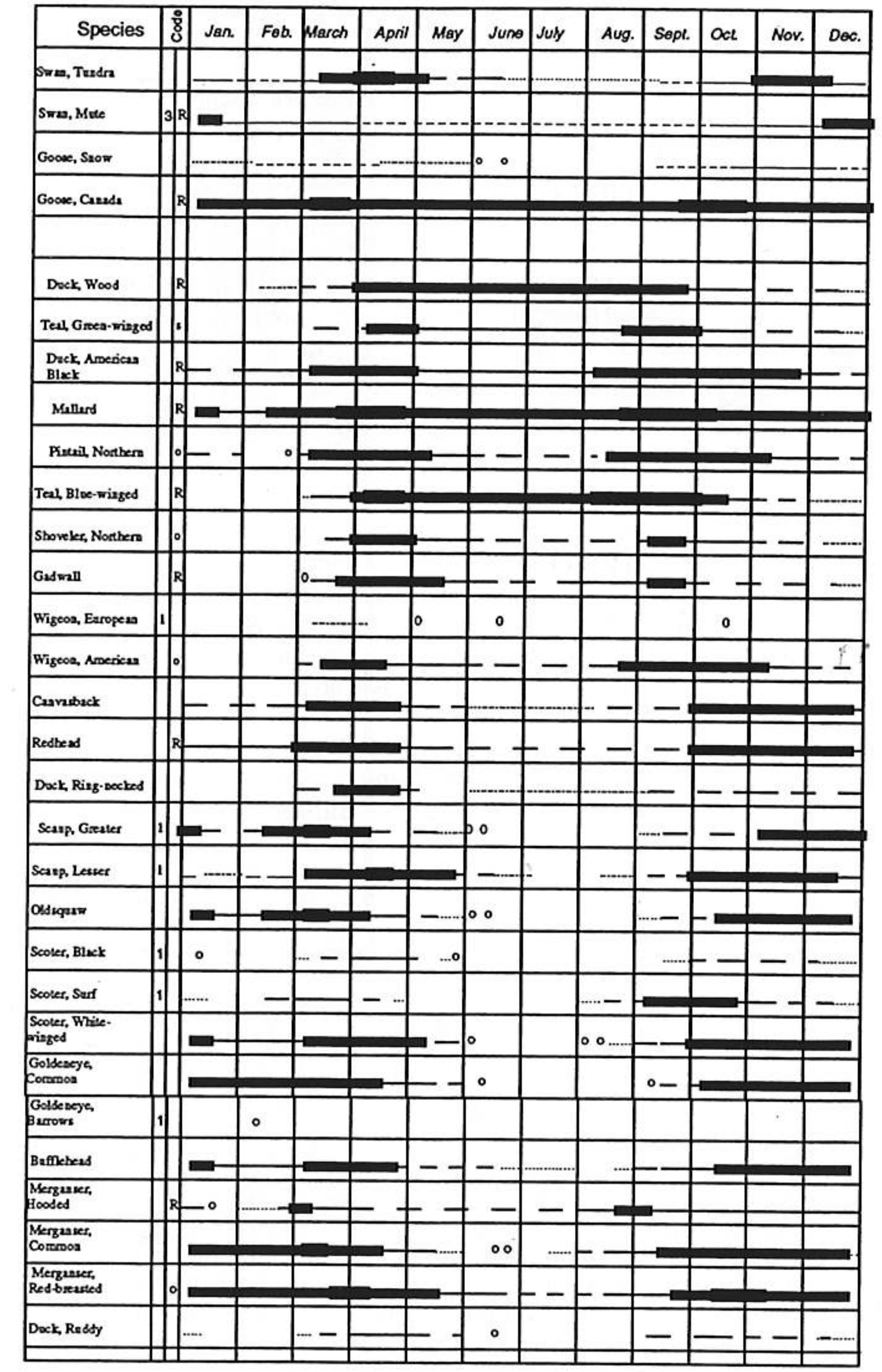
In estimating total waterfowl use of an area, it is important to recognise the methods used by waterfowl biologists. Waterfowl use is generally described using 'Waterfowl days'. Waterfowl days, as described by Dennis and Chandler (1984), are calculated by taking the midpoint of the numbers of waterfowl observed on two survey dates, then multiplying it by the number of days between survey dates, and then adding the waterfowl days together for the entire survey period.

Waterfowl use of Long Point was not monitored until 1968 when the Canadian Wildlife Service began aerial censuses of waterfowl on the Great Lakes. Survey data since then along with survey data from the LPWWRF were used to graph trends in fall waterfowl use of Long Point expressed as waterfowl days (Figure 8). Waterfowl days in fall are based on approximately 73 survey days in each year from about September 20th till December 1st in all years. Information for the years 1971 through 1987 was obtained from Canadian Wildlife Service aerial flight data, and the years 1991 and 92 from Long Point Waterfowl and Wetland's Research Fund data. Figure 9 shows trends in waterfowl use of the Long Point marshes during spring migration based on 44 survey days from approximately March 20 till May 2 in each year. Caution is advised in interpreting the results, as peaks in migration may have been missed. Figures 10 and 11 show the distribution of waterfowl at Long Point in spring and fall of 1992. Significant changes in the distribution of waterfowl are observed between spring and fall.

During spring migration, highest waterfowl days were observed in the Open Water area (353 401 waterfowl days) followed by Big Creek area (133 476 waterfowl days). The other areas all had less than 65 000 waterfowl days. During fall migration, highest waterfowl days were also recorded in the Open Water Area. Turkey Point area had the second highest use with over 48 457 waterfowl days. All other areas had less than 20 000 waterfowl days in each. Table 5 shows the composition of species observed during spring and fall of 1992. In spring, Canvasback comprised the highest portion of waterfowl at Long Point, i.e., over 170.000 canvasback waterfowl days were observed. In fall, Redhead and Canvasbacks together comprised the highest proportions of waterfowl. Waterfowl are generally resting at the time when flight surveys are completed. This suggests that flight observations are primarily of waterfowl resting or refuge areas. Many waterfowl may move into the Inner Bay to feed at night when boat traffic is minimal and hunting has stopped (Dennis and Chandler, 1974).

*Note. Data from a CWS Diving Duck survey on Nov. 6 1992 was used to replace diving duck numbers surveyed by LPWWRF on Nov. 19, 1992. It was felt that the CWS numbers more accurately reflected diving duck numbers at Long Point in the fall of 1992 due to poor weather conditions in the open waters of the Inner Bay and along the south shore of the tip during the LPWWRF survey on Nov. 19, 1992.

Table 4. Checklist of Waterfowl at Long Point (taken 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 moderat 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
- o Occasional - very few records: normally absent

Numeric and Nesting Keys

1 Identification difficult - requires careful observation

2. Secretive and or generally inaccessible habitat-may requirespecial effort or technique to observe

3 Local -may be found only at specific sites

4. Erratic-seasonal and annual frequency may vary drastically

R Nests regularly

o Nests occasionally

S Nesting suspected but not confirmed

F Nesting formerly (pre 1977)-may nest again

E Extirpated - unlikely to occur again

Table 5. Waterfowl Species Composition, Spring and Fall 1992. Source: LPWWRF.

Fall 92	Total	Spring 92	Total
Tundra Swan	153984	Tundra Swan	15958
Mute Swan	5276	Mute Swan	990
Snow Goose	0	Snow Goose	0
Canada Goose	100644	Canada Goose	53988
Wood Duck	789	Wood Duck	19
Green-winged Teal	3021	Green-winged Teal	276
American Black Duck	119620	American Black Duck	42803
Mallard	180042	Mallard	43950
Pintail	1748	Pintail	945
Blue-winged Teal	2673	Blue-winged Teal	204
Shoveler	49	Shoveller	0
Gadwall	3190	Gadwall	812
American Wigeon	309833	American Wigeon	24661
Canvasback	608457	Canvasback	172263
Redhead	655831	Redhead	42371
Ringnecked Duck	128877	Ringnecked Duck	820
Greater Scaup	22417	Greater Scaup	4570
Lesser Scaup	73080	Lesser Scaup	2673
Unidentified Scaup	537858	Unidentified Scaup	19553
Old Squaw	348	Oldsquaw	44
White-winged Scoter	1124	White-winged Scoted	618
Black Scoter	625	Black Scoter	0
Common Goldeneye	1668	Common Goldeneye	41355
Bufflehead	4883	Bufflehead	2449
Hooded Merganser	1413	Hoooded Merganser	85
Common Merganser	30	Common Merganser	17294
Red-breasted Merganser	20658	Redbreasted Merganser	13833
Ruddy Duck	76415	Ruddy Duck	729

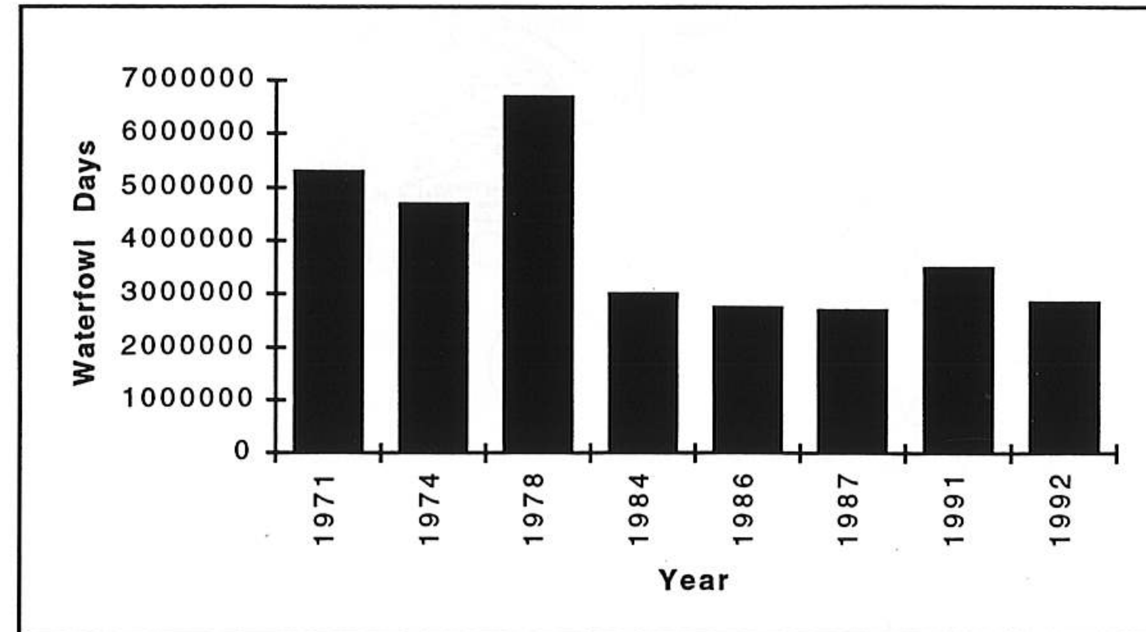
4.3 SOME CULTURAL FACTORS INFLUENCING LONG POINT'S INNER BAY

4.3a. Waterfowl Hunting

Long Point has a long history of waterfowl hunting. As early as the 1850's observations were made of the quickly growing popularity of this sport. Harry Barrett has described how "market hunters mobbed in from both sides of the lake, taking a tremendous toll each spring and fall as migrating waterfowl attempted to settle to rest and feed" (Barrett, 1977: 145)

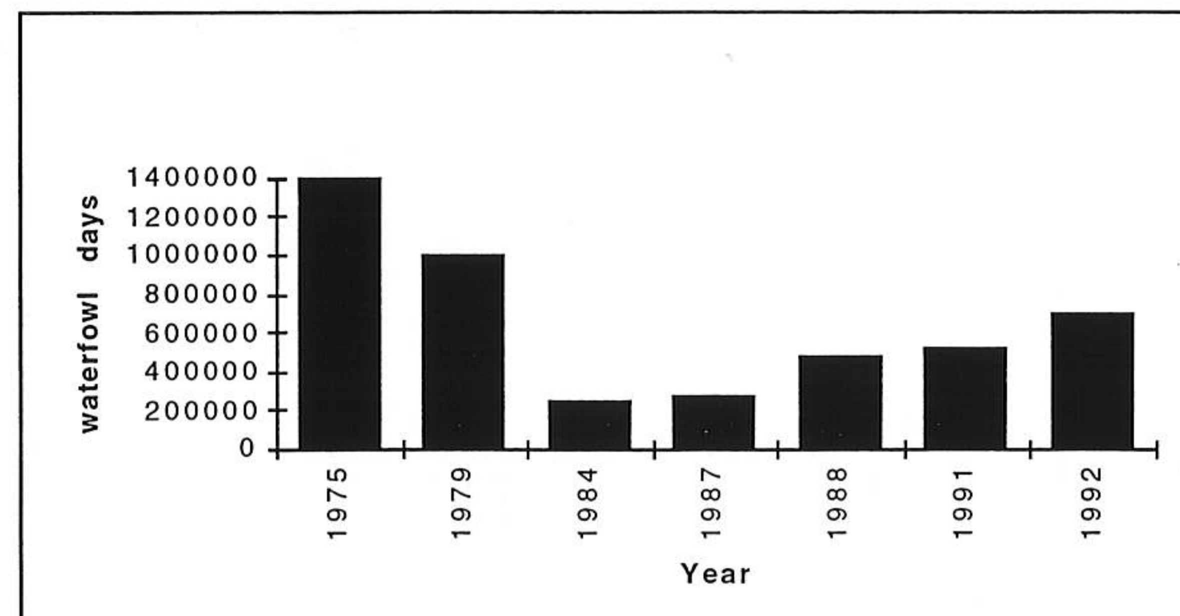
The Long Point Company, established in 1866, was the first hunting group at Long Point to practice wildlife conservation with their main emphasis on waterfowl. They stopped public hunting on the Long Point Company property and regulated the numbers and time of year that members were allowed to be on the property, to hunt, trap, and fish.

Figure 8. Fall Waterfowl Use of Long Point, Ontario.



Waterfowl day estimates are based on approximately 73 survey days from 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 9. Spring Waterfowl Use of Long Point, Ontario



Waterfowl day estimates are based on approximately 44 survey days from 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

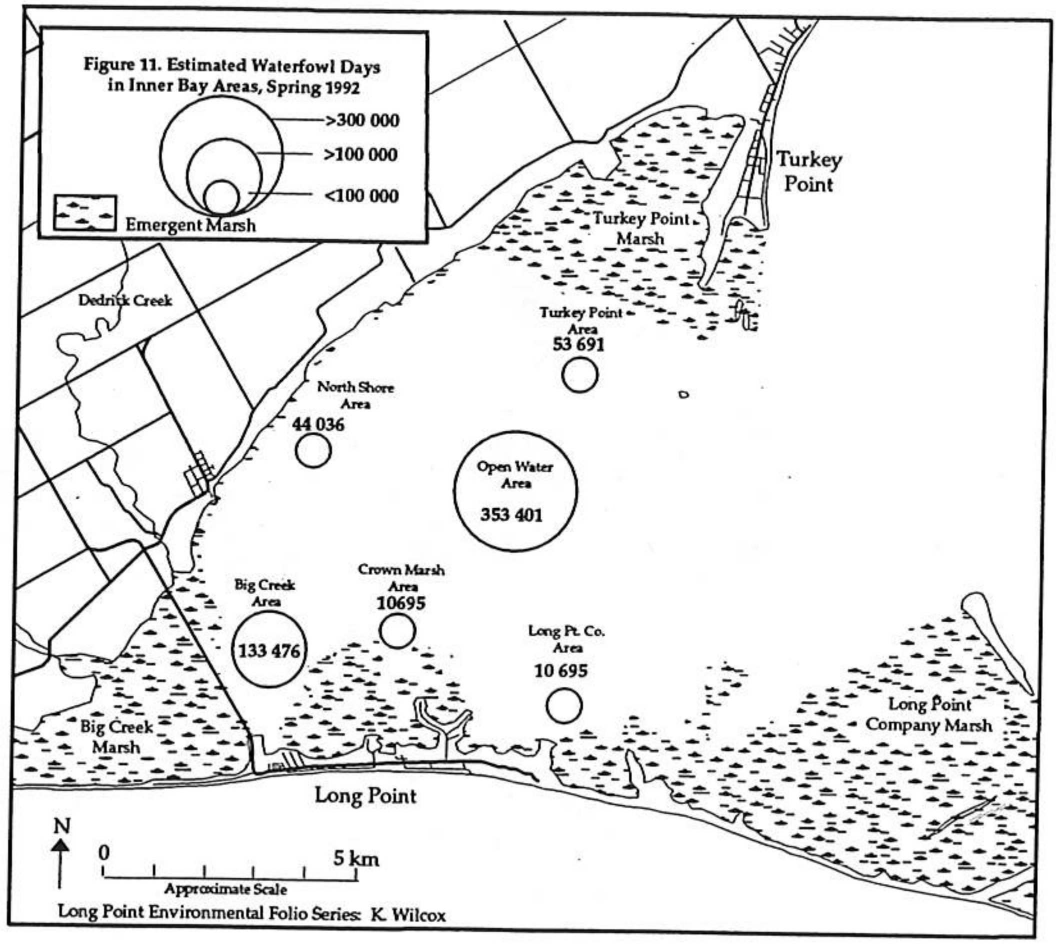


Figure 11. Estimated Waterfowl Days in Inner Bay Areas, Spring 1992

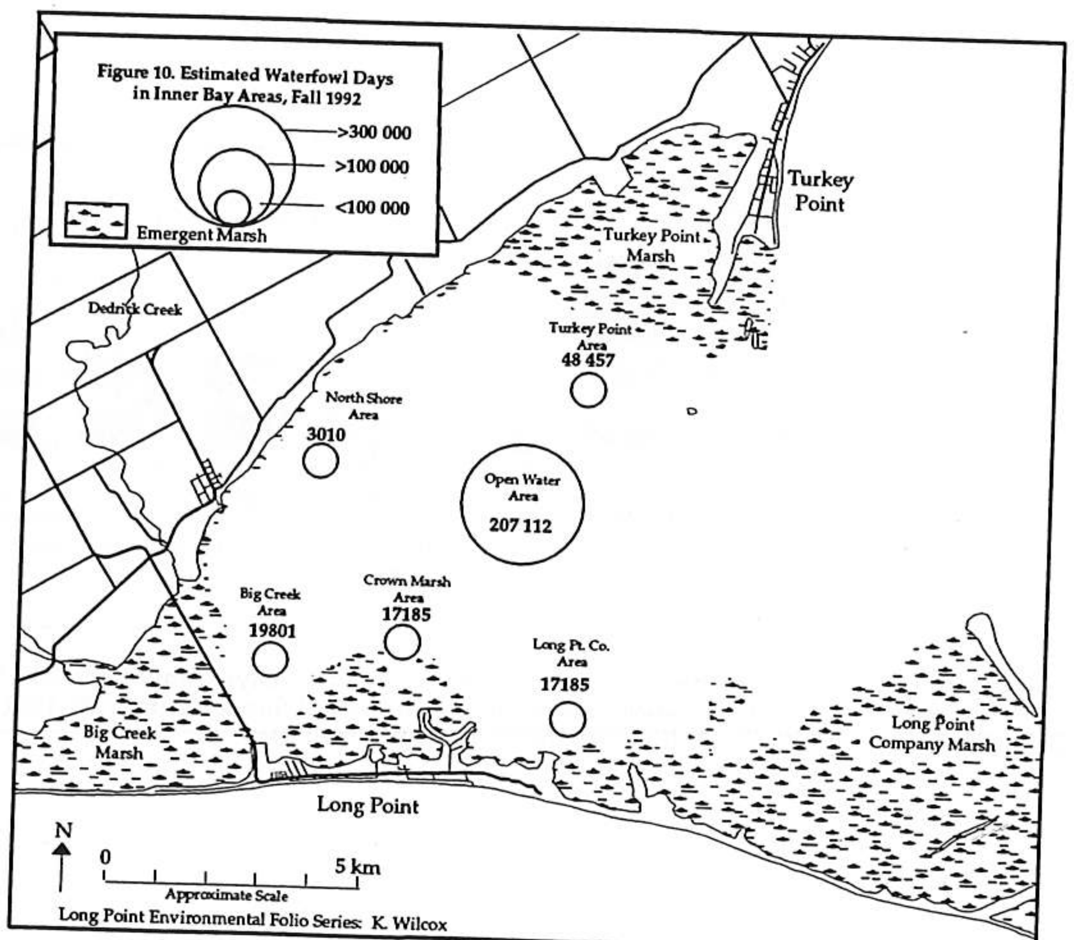


Figure 10. Estimated Waterfowl Days in Inner Bay Areas, Fall 1992

The Long Point Company was the first of a number of hunting clubs to utilize areas of the Long Point marshes. Since this time hunt clubs and hunting areas that have been established include:

Big Creek Marsh Area
- Bayou Club
- Big Creek Unit
- Flight Club
- Murray Marsh Club
- Hahn Marsh Unit
- Lee Brown Hunt Club

Long Point Sand spit
- Long Point Company
- Bluffs Club
- Thoroughfare Point Unit

Turkey Point Marsh
- Cannonball Club
- Ferris Marsh
- Maybee Club
- Mid Marsh Club
- Tepee Farms Ltd.
- Turkey Point Company

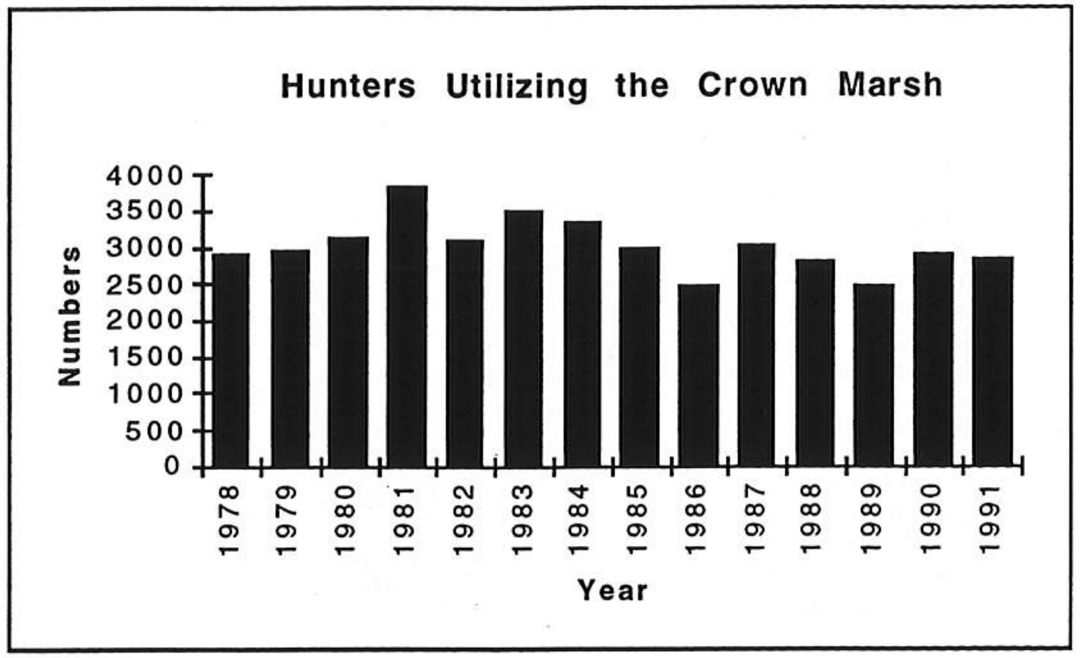
Crown Marsh
- Long Point Waterfowl Management Unit

Additional Clubs (no property)
- Castleton's Shooting Club
- Ducks Unlimited Greenwings
- Ducks Unlimited, Norfolk Chapter
- Long Point Area Fish and Game Club
- Long Point Ladies Ducks Unlimited
- Long Point Waterfowlers Association
- No Marsh Club
- St. William's Club

Actual numbers of duck hunters using the Inner Bay and its coastal marshes are not well documented historically. In 1968, 2451 hunters were accommodated by the Ministry of Natural Resources in the crown marsh (Wilcox, 1993). More recent numbers of duck hunters utilizing the crown marsh are provided in Figure 12. Locations of hunt clubs are shown in Figure 13. Data for individual hunt clubs were not available.

Hunting activities have been described as one of the 2 main activities that disturb waterfowl, the other being motor boating (Korschgen, George, and Green, 1985). Jahn and Hunt (1964) suggested that even the best habitats will be lightly, if at all, used 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 at wintering and summering areas and breeding success (Frederickson and Drobney, 1979). Recreational hunting and associated boating activities during migrations of waterfowl at Long Point may reduce its effectiveness as a staging area. More research, however, is needed to to learn more about the extent of the disturbances at Long Point and the subsequent energy costs for waterfowl.

Figure 12. Hunters Utilizing the Crown Marsh (Wilcox, 1993).



4.3b Marina, Cottage and Recreational Developments in the Coastal Marshes of Long Point's Inner Bay

The first mention of the Long Point area being used for recreational activity was during the late 1850's and early 1860's (Barrett, 1977). While the initial attraction to the area was sport hunting, people began spending summers in the area as well.

In 1956, about 450 cottages and a half dozen permanent residences existed in Long Point park (Wilson, 1974). By 1961, this number had increased to 600 cottages and 30 permanent residences. Within the Long Point Biosphere, the Regional Municipality of Haldimand-Norfolk reported 1139 cottages in 1977, 1167 in 1982, 1191 in 1987, and 1230 in 1992 (Elder, pers. comm., 1992).

The distribution of cottages and marinas at Long Point was mapped by Wilcox, (1994) (Figure 14). The map shows a concentration of marinas along the north shore of the Inner Bay and along the causeway (Highway 59). Concentrations of cottages occur at the junction of the Causeway (Big Creek Marsh study area) and the Crown marsh.

Cottage and marina developments along the shoreline of the Inner Bay may have dramatic effects on the Inner Bay as a staging area for waterfowl. These developments and associated recreation activities have been known to affect waterfowl food resources and increase disturbance. In other areas on the Great Lakes, for example, Rondeau Bay in particular, urbanization caused increased sewage inputs, increasing macrophytic biomass at first, then killing submerged macrophyte beds by shading from planktonic blooms (Crowder and Bristow, 1985). At Rondeau Bay, the loss of submerged macrophytes resulted in a drastic decline in numbers of migratory waterfowl (Dennis et al., 1984). Fragmentation of marshes for development and the removal of vegetation to create and maintain channels can contribute to sedimentation and subsequently affect food resources. Boating and other recreational activities associated with cottages and marinas may increase disturbance of waterfowl and reduce the effectiveness of the area as a staging area. While insight can be gained about the impacts of development on staging waterfowl in other areas, more research is needed to determine their impacts at Long Point.

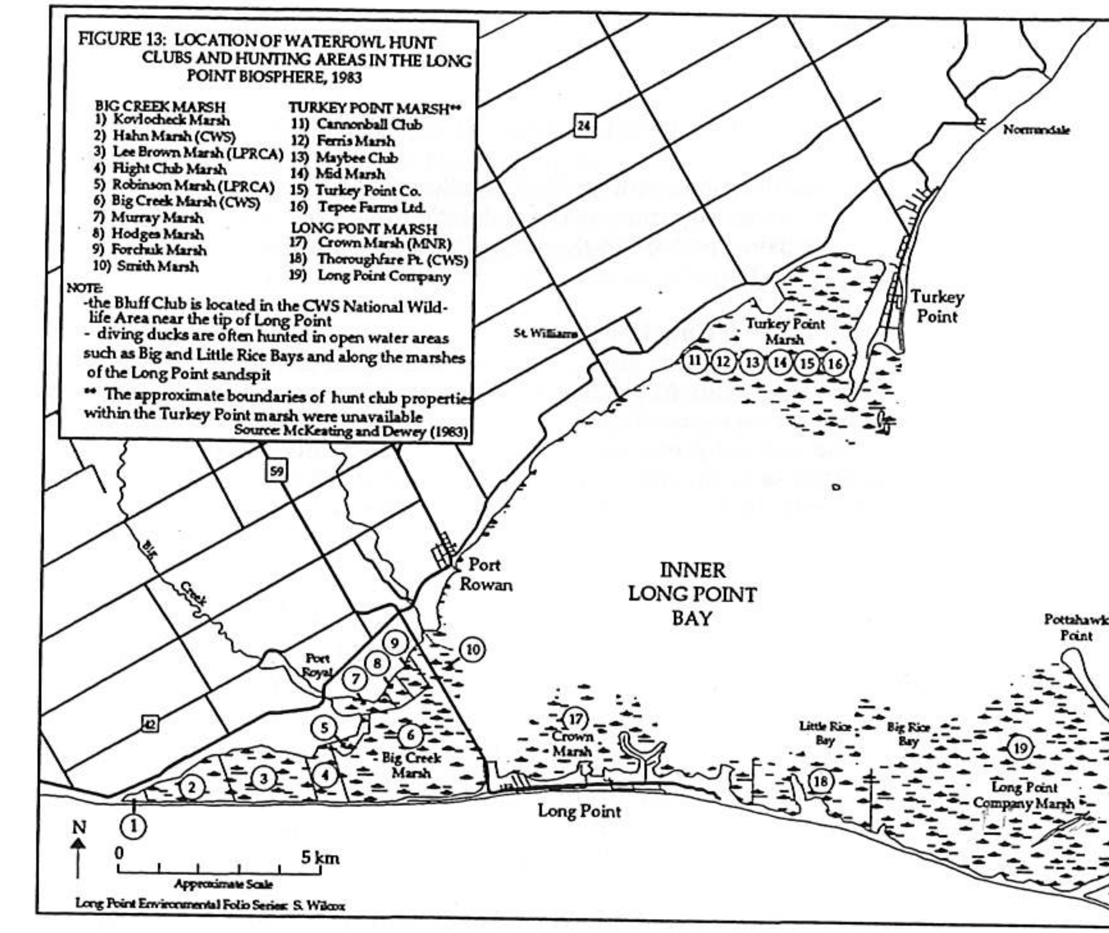


FIGURE 13: LOCATION OF WATERFOWL HUNT CLUBS AND HUNTING AREAS IN THE LONG POINT BIOSPHERE, 1983

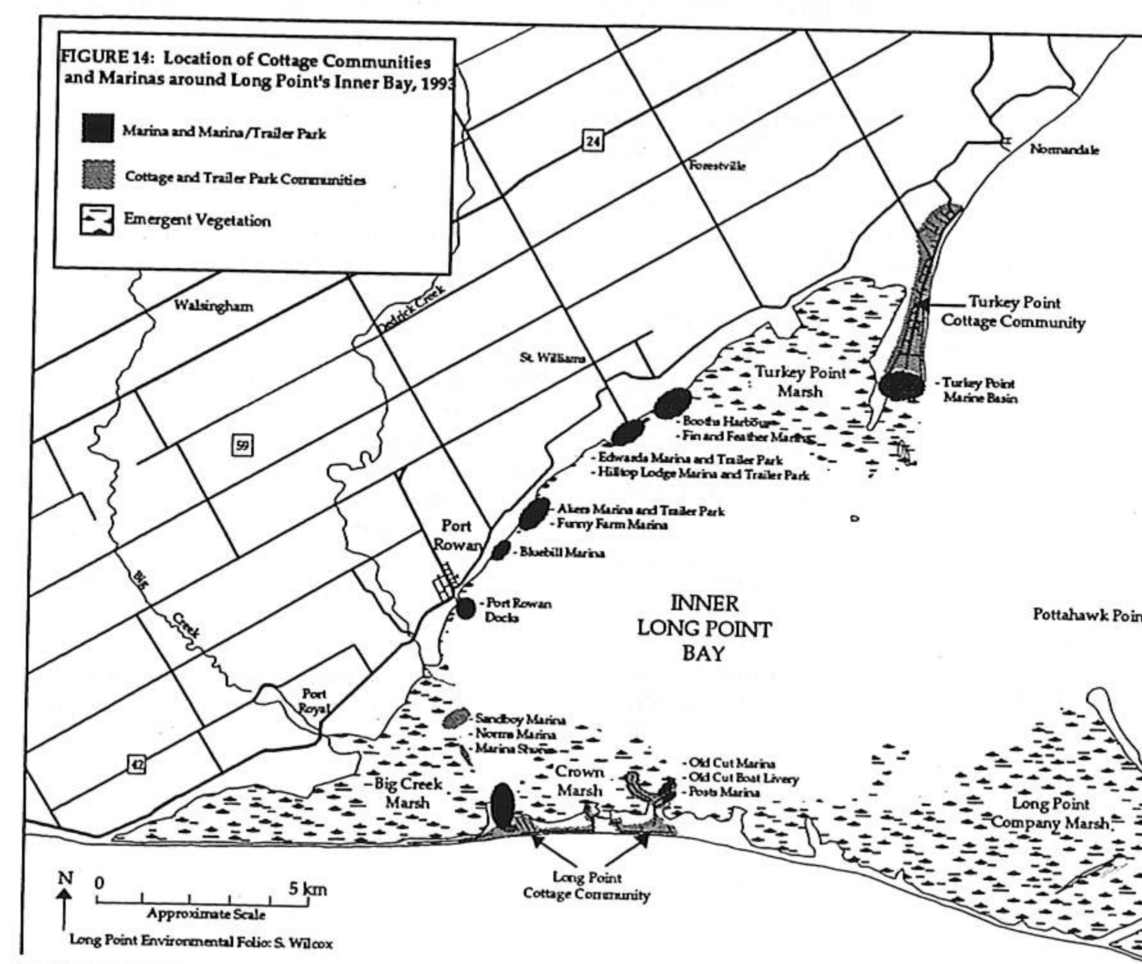


FIGURE 14: Location of Cottage Communities and Marinas around Long Point's Inner Bay, 199[3]

IDENTIFICATION OF SIGNIFICANCE AND CONSTRAINTS

Pertinent abiotic, biotic and cultural information will be assessed in terms of significance and constraints for waterfowl migration at Long Point's Inner Bay. The information is intended to assist planners and decision makers in the Long Point area and will be revised as additional information becomes available.

Criteria for Significance and Constraints

In this section, areas of biotic significance are identified and assigned values relative to a set of sustainability criteria (Table 6). Information about abiotic and cultural processes has been collected for this study, but is currently inadequate to provide values. Table 7 is a preliminary table that identifies the current presence or absence of constraints. Maps outlining the significance and constraints of the abiotic, biotic and cultural information for waterfowl staging habitat are presented separately and then combined for a more comprehensive view of the area.

Criteria for assessing Biotic Significance /Constraints

Significant biotic factors affecting waterfowl staging habitat in Long Point's Inner Bay include food resources and refuge areas (Kahl, 1991). Plant foods, invertebrate foods and waterfowl days during spring and fall are used as measures of comparison among the Inner Bay areas. Specifically, the importance of the Inner Bay areas for plant food resources was based upon the number of different plant foods (macrophyte diversity), the number of important plant foods (macrophyte productivity), and significant plant foods (significant macrophytes). The importance of the Inner Bay areas for invertebrate food resources was based on numbers (invertebrate productivity) . Areas with invertebrate densities suitable to support optimal duckling production, were identified as highly significant. The importance of the Inner Bay areas as resting or refuge areas for waterfowl was based on the number of waterfowl days observed (waterfowl productivity), the number of different species of waterfowl (waterfowl diversity) and significant species of waterfowl, observed by the Long Point Waterfowl and Wetlands Research fund in 1992. These criteria have been operationally defined for the purposes of an initial or working estimate of significance as follows:

Macrophyte Diversity Macrophyte diversity or diversity of plant food resources are based on the findings of Pauls and Knapton (1993). Diversity in this study refers to the number of dominant plants in each Inner Bay area, Figure 6. A rank of '3' is assigned to areas with a minimum of four dominant plants. For example, the North Shore area has 4 dominant plants; *Vallisneria americana, Myriophyllum spicatum, Chara vulgaris* and *Najas* spp., and thus is given a rank of '3'. A value of '2' is assigned to areas having two or three dominant plants, and a value of '1' is given to areas having a fairly uniform plant distribution with only one dominant plant.

Macrophyte productivity For the purposes of this report, macrophyte productivity refers to the importance of the dominant plant species for waterfowl in each Inner Bay area. In Martin and Uhler's (1935) study of waterfowl food habits in North America, values were assigned to individual plant species in relation to their importance for waterfowl. Their classification is used in this study to rank the importance of each area for macrophyte productivity. An area where the dominant plant species is rated as excellent for waterfowl by Martin and Uhler (1935) is given a rank of '3' in this report- meaning that it is highly productive of important plant foods. A rating of good is given a rank of 2 and a rating of fair is given a rank of 1.

Significant Macrophytes (*Vallisneria americana*) *Vallisneria* spp. is a critical food source for canvasbacks, (*Aythya valisneria*) a species of concern (Kahl, 1991). In recent years, relatively low canvasback populations have led to hunting season closures and considerable concern among biologists and hunters. The United States Fish and Wildlife Service has identified the canvasback as a priority species for increased research and management due to staging habitat loss and to hunter demand exceeding resource supply (Kahl, 1991). With this in mind, regardless of the value for macrophyte diversity or productivity, a rank of '3', or high significance, is assigned to areas in which *V. americana* is dominant because of its importance to canvasbacks. A rank of '2' is given to areas where *V. americana* is dominant but in very small sections, and a rank of 1 is assigned to areas where *V. americana* is not a dominant species.

Invertebrate Productivity For the purposes of this report, invertebrate productivity refers to the abundance of insects and insect larvae found in the Inner Bay areas, and does not include mollusks. A rank of '3' is given to areas having at least 3 sample stations with densities greater than 1000 invertebrates per square meter (areas having suitable invertebrate densities to support optimal duckling production), a rank of '2' is given to areas having at least three sample stations with invertebrate densities greater than 50 per meter square, but less than 1000, and a rank of 1 is assigned to areas having at least three sample stations with invertebrate densities lower than 50 per square meter.

Waterfowl Productivity refers to the number of waterfowl days spent in each of the Inner Bay areas during the spring and fall of 1992. Ranking of waterfowl productivity is limited to one year of data. A score of '3' (high significance) is assigned to areas that had greater than 200 000 waterfowl days during spring and fall migration. A score of '2' is assigned to areas having between 100 000 and 200 000 waterfowl days, and a score of '1' is assigned to areas having less than 100 000.

Diversity of waterfowl species refers to the number of different waterfowl species in each of the Inner Bay marshes over the entire migration period. A score of '3' (high significance) is assigned to areas with greater than 15 species of waterfowl during fall migration in 1992. A score of '2' is assigned to areas having 10-15 different species of waterfowl, and a score of '1' is assigned to areas with less than different species.

Significant Waterfowl species. Canvasback populations are used as the criterion for significance in this category, as they are experiencing declines in their North American population. A score of '3' is assigned to areas with greater than 100 000 Canvasback waterfowl days during spring and fall migration. A score of '2' is assigned to areas experiencing between 50 000 and 100 000 canvasback waterfowl days and a score of '1' is assigned to areas receiving less than 50 000.

Summary of Biotic Significance

The assessment scheme for ranking of biotic significance revealed the Open Water, the Big Creek area, and the North Shore areas as areas of high biotic importance for waterfowl. All of these areas contained valuable food resources and provided refuge from disturbance based on the high numbers of food resources and high numbers of waterfowl days observed.

Criteria for Assessing Biotic Constraints

The total number of biotic constraints for preservation of waterfowl staging habitat are unknown at this point as data is insufficient to make the assessment possible. We do not known enough about the limiting factors for waterfowl. At this stage, however, two criteria for constraints have been of interest: faunal dependency and vegetation recoverability. Only data on faunal dependency, however, are available at this time to give a partial assessment. Faunal dependency, for this report, refers to the direct relationship or dependency of canvasbacks on *V. americana*. It has been suggested that the decline in canvasbacks may be related to an overall decline in *V. americana* (Kahl, 1991). Pauls and Knapton (1993) show *V. americana* distribution to be concentrated in the North Shore area and the Big Creek area. Because this macrophyte is a major food resource for canvasbacks at Long Point, areas where *V. americana* is a dominant plant should be considered a constraint for development planning. Exotic species such as zebra mussels (*Dressena polymorpha*) and Eurasian milfoil (*Myriophyllum spicatum*) may affect the plant and invertebrate composition of the Inner Bay. At this time, however, it is not known for certain how they will affect staging waterfowl at Long Point. In other areas, Eurasian milfoil has been known to outcompete native submerged macrophytes and produce a monospecific stand of less desireable food sources for waterfowl (Crowder and Bristow, 1988). Biotic constraints for waterfowl are presented as part of the overall initial or working assessment of constraints for waterfowl in Table 7.

Table 6. Assessment Scheme for Biotic Significance in Long Point's Inner Bay
(1=low significance, 3=high)

Inner Bay Areas	Plant food diversity	Plant prod-uctivity	Plant signifi-cance	Rest Area Diversity		Rest Area Product-ivity		Rest Area Sign-ificance		Inverte-brate Product-ivity	Total
				Spring	Fall	Spring	Fall	Spring	Fall		
Turkey Point	1	2	1	1	1	1	1	1	1	3	13
North Shore	3	3	3	1	2	1	1	1	1	1	17
Big Creek	3	3	3	2	2	2	1	1	1	2	20
Crown	2	2	2	2	1	1	1	1	1	2	15
Company	2	2	2	1	1	1	1	1	1	2	14
Open Water	2	2	1	3	3	3	3	3	2	2	22

Criteria for Assessing Abiotic Significance/Constraints

Significant abiotic processes affecting waterfowl staging habitat in Long Point's Inner Bay are water levels and substrate or sediment type. Martin and Uhler (1935) described that no single factor is more potent in preventing the development of waterfowl feeding grounds than extreme or irregular fluctuations in water level. Changes in water levels can directly affect the food resources of Long Point's Inner Bay by altering the vegetation composition. For example, as water levels rise, the amount of emergent vegetation decreases, and as water levels decrease, the emergent plants increase in area and become more woody. Excessive water levels constrict the littoral zone by increasing the distance required for adequate light penetration to existing submerged macrophytes. Thus, the species composition of submerged macrophytes in all areas of the Inner Bay may be altered by significant changes in water levels. Changes in the Inner Bay Marshes' substrate type may also have an impact on vegetation composition. For example, in Pauls and Knapton (1993), macrophyte composition appeared to be directly related to substrate type with *C. vulgaris* being widespread in sandy soils and a large diversity of macrophytes in muddy substrate. At this point, it is unknown how much macrophytes would be affected by a change in substrate distribution or composition. However, with the potential for localized dredging activites that may affect substrates, this may be a important consideration.

Criteria for Assessing Cultural Significance/Constraints

There are a number of culturally significant waterfowl areas at Long Point. Most of these areas, however, are outside of this reports study area. For example, one of the most significant cultural waterfowl areas from a historic perspective may be the areas that have been controlled by the Long Point Company. Established in 1866 by a group of wealthy sportsmen, the Long Point Company is probably responsible for the preservation of the majority of the Point (Barret, 1978). Other waterfowl areas in the Long Point area that could be considered to be significant in a cultural sense are the Canadian Wildlife Service enclosure in Big Creek Marsh where habitat management to improve conditions for waterfowl is practiced, and Lee Brown Pond, where waterfowl are fed in the spring, attracting large numbers of bird watchers.

The only areas within this reports study area that could possibly be interpreted as culturally significant are within the North Shore and Big Creek areas. Regarding the North Shore area, during spring large numbers of ducks and swans concentrate in the water directly off-shore from the Port Rowan overlook. Their presence attracts large numbers of bird watchers. Waterfowl in the Big Creek area also attract bird watchers. In this area, however, they cannot be viewed as easily except if they are near the waterfowl viewing stand.

A preliminary assessment of cultural factors constraining waterfowl staging habitat in Long Point's Inner Bay reveals two concerns: marina and cottage developments in the coastal

and the locations of hunt clubs (Table 7 and Figure 16). Marina and cottage developments in coastal marshes may destroy valuable food resources and are often accompanied by activities such as boating and fishing which increasingly disturb waterfowl flocks (Dennis and Chandler, 1974). One of the key criteria for maintenance of staging habitat is refuge from disturbance (Kahl, 1991). The activities of hunting disturb resting flocks through travel to and from blinds and through actual hunting activities. Marina and cottage developments along with hunting club locations are presented in Figure 16 as cultural constraints. Marinas are concentrated on the North Shore and a large number of cottages and marinas are found along the Big Creek Marsh Shore. Hunt clubs are concentrated in Turkey Point Marsh, and in the Crown Marsh.

Figure 15. Preliminary Assessment of Biotic Significance and Constraints for Waterfowl

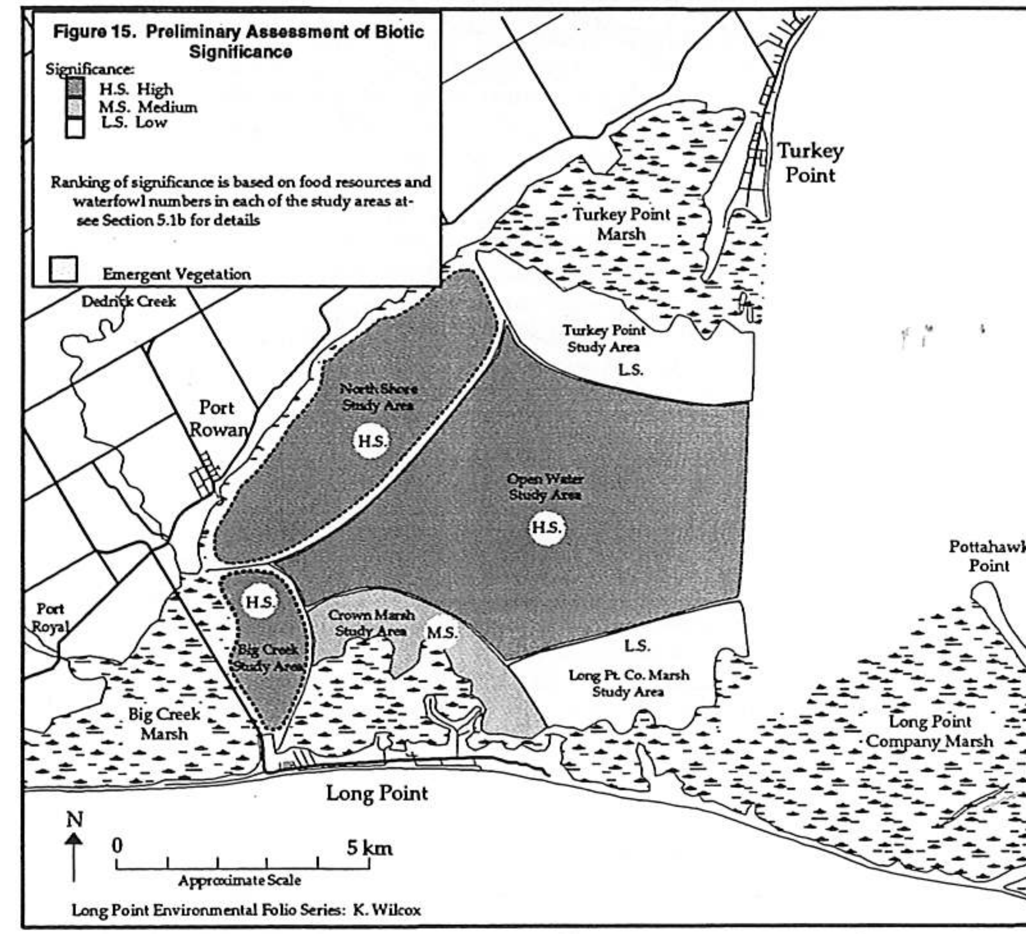


Figure 16. Preliminary Assessment of Cultural Constraints for Waterfowl

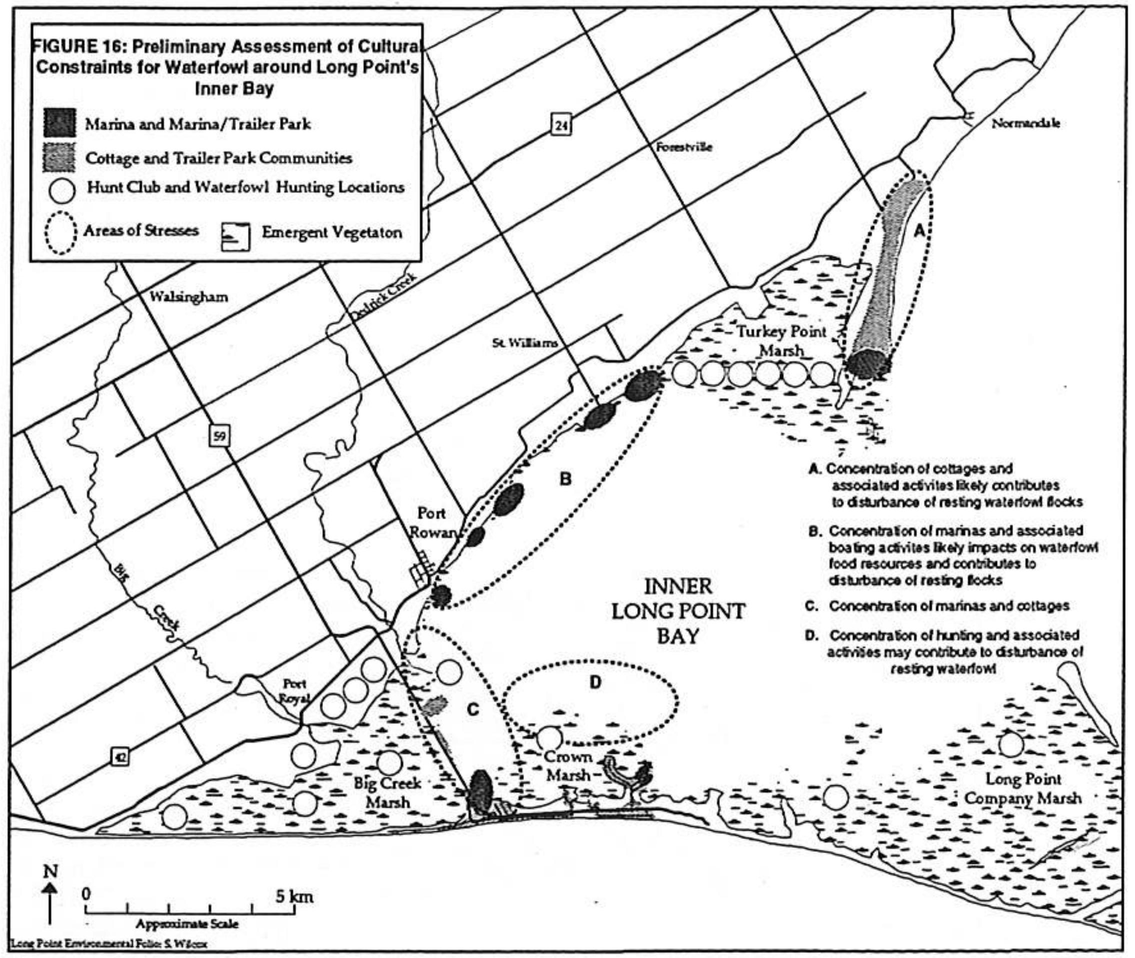


Table 7. Summary of Possible Constraints on Staging Waterfowl in each of the Inner Bay areas.

Constraint	Turkey Point Area	North Shore Area	Big Creek Area	Crown Marsh Area	Long Point Co. Area	Open Water Area
Faunal/habitat dependency		*	*			
Exotic species (*M. spicatum*)		*	*			
Cottage/Marinas		*	*			
Boat traffic						*
Hunting	*			*		
Dredging		*	*			

6.0 IDENTIFICATION OF PRIORITY AREAS FOR PLANNING AND MANAGEMENT PURPOSES

This section aims to provide information about waterfowl priority areas for planners and decision makers around Long Point's Inner Bay. Abiotic, biotic and cultural significance and constraints are presented on a single map to indicate areas of high significance for waterfowl as well as areas that are stressed or constrained by water use or other processes such as sediment movement and changes in water levels (Figure 17). Issues and areas that deserve prompt attention because of their high significance to waterfowl and because of the high levels of stress on them are defined as priority areas.

The Open Water area, the Big Creek area and the North Shore area, based on this preliminary analysis, should be considered priority areas for waterfowl planning at Long Point. These areas have high biotic significance for waterfowl and are relatively stressed or constrained. The Open Water area was found to be significant mainly because of its importance as a refuge area for waterfowl. High numbers of waterfowl days were spent in this area during spring and fall along with a high diversity of species. Both the Big Creek and North shore areas are considered to have high biotic significance, mainly due to their high productivity of plant food resources for waterfowl, high diversity of plant foods, and because significant food resources (*V. americana*) are located in these areas. Both areas, however, are being stressed by a concentration of cottages, marinas and associated boating activities. These developments may pose a threat to both plant food and invertebrate resources by contributing to sedimentation as well as noise and disturbance. A faunal dependency relationship between Canvasbacks and *V. americana* also should be considered a constraint for planning in both of these areas.

The high numbers of cottages and hunting activity adjacent to and in the Crown Marsh should be considered a constraint for waterfowl at Long Point, and the high biotic significance for waterfowl of the Long Point Company marsh should be recognized in planning for development and resource use.

Future Research Directions

In light of Long Point's importance as an internationally significant staging area, a need exists to protect this area as a critical area for North American waterfowl. Through the identification of significance and constraints for waterfowl, priority areas for planning can be identified. The need to plan for waterfowl and their ecological, tourism, recreational and other values necessitates incorporating factors bearing on significance and constraints for waterfowl into planning and management at Long Point.

Further research that would provide valuable information on the status of staging habitat in Long Point's Inner Bay and on the significance and constraints for planning and development around Long Point's Inner Bay, include:

1. Further studies on the ecology of the Inner Bay, for example on fish distribution and use of various Inner Bay areas, their relation to waterfowl patterns, or on changes in water levels and sediments and their effects on food resources, refuge areas and waterfowl. Such studies should involve an examination of both seasonal and annual changes in waterfowl use of the various areas of Long Point's Inner Bay;

2. Examination of the distribution and effects of activities in the Inner Bay (such as boating) on waterfowl staging habitat and on different waterfowl species;

3. Further development of mapping and resource survey and assessment systems for planning and management, including the identification and further understanding of biotic and abiotic significance and constraints for waterfowl.

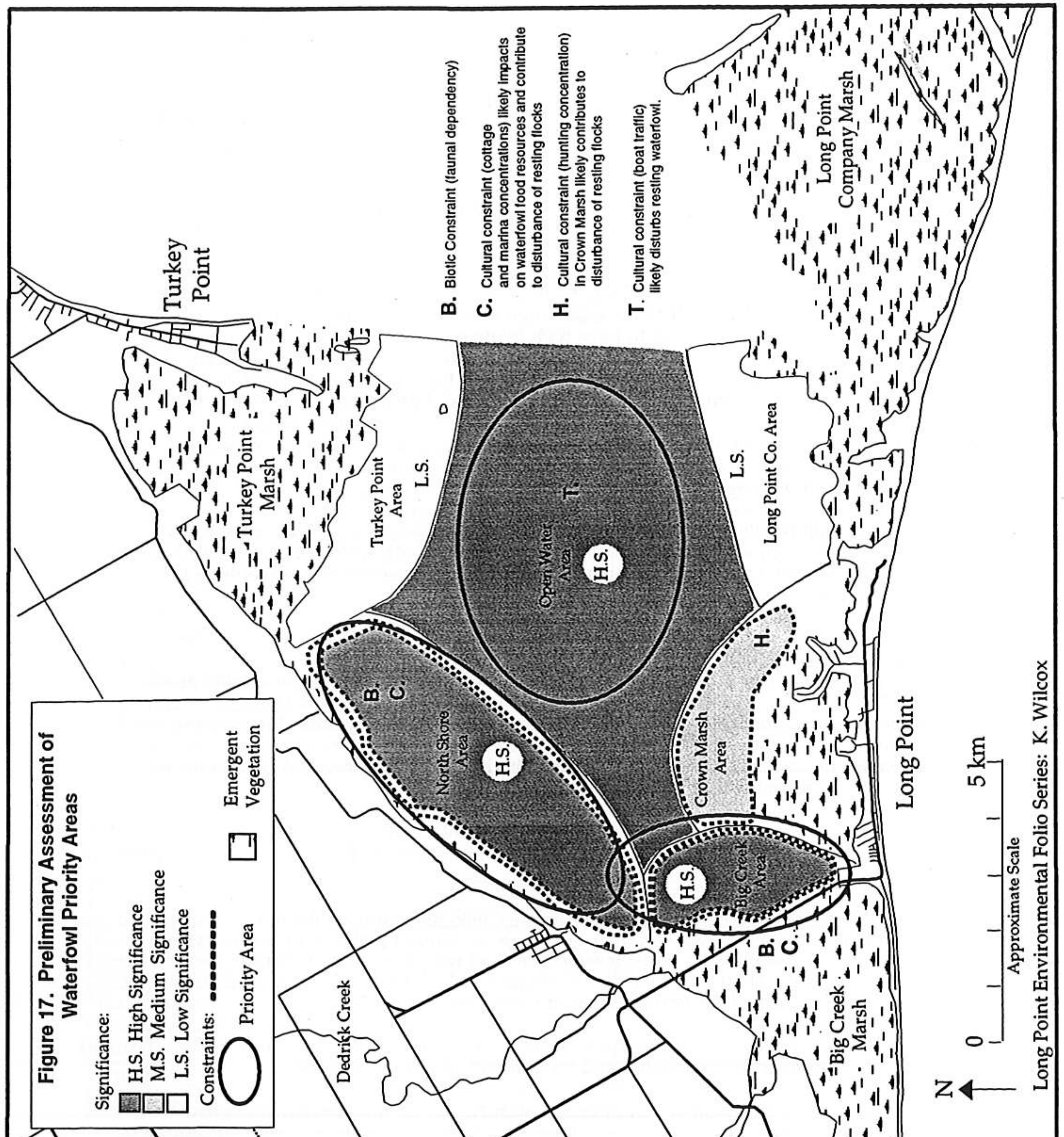


Figure 17. Preliminary Assessment of Waterfowl Priority Areas

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Appendix 1.

Turkey Point Marsh
The Turkey Point marsh is dominated (43.3%) (Whillans, 1985) by submerged macrophytes with species of *Chara, Potamogeton, Najas, Elodea, Vallisneria, Ceratophyllum*. There is also a significant proportion (32.1%) of robust emergents consisting of species of*Phragmites, Typha, Sparganium, Pontederia*. A number of the plants at this site (17.42%) are floating leaved species of *Potamogeton, Polygonum, Nymphaea*, and *Nuphar*.

North Shore Marsh
This marsh is dominated (36%) by robust emergents with species of *Phragmites, Typha, Sparganium* and *Pontederia* . It has a fairly high proportion (27.7%) of submerged bed plants with species of *Cladophora, Chara, Potamogeton, Najas, Elodea,Vallisneria, Heteranthera, Ceratophyllum, Ranunculus, Myriophyllum* , and *Utricularia*. There is also a fairly significant amount of human influence in this marsh making up 19.68% of the area with various arboreal and cultivated genera.

Big Creek Marsh
Big Creek marsh is dominated by wet meadow plants (37.9%) with species of *Calamagrostis*, and *Eragrostis* ,but also has a high proportion (27.1%) of robust plants like species of*Phragmites, Typha, Sparganium*, and *Pontederia*. Twenty-one percent of plants are in Big Creek Marsh are submerged macrophytes. Species of *Cladophora, Chara, Potamogeton, Najas, Elodea, Vallisnera, Heteranthera, Ceratophyllum, Ranunculus, Myriophyllum, Utricularia* make up this submerged macrophyte community.

Crown Marsh
Forty-three percent of the vegetation in Crown marsh is of the submergent bed type with species of *Cladophora, Chara, Potamogeton, Najas, Elodea, Vallisneria, Heteranthera, Ceratophyllum, Ranunculus, Myriophllym*, and *Utricularia*. Nineteen percent of the vegetation consists of floating leaf plants such as *Polygonum, Potamogeton, Nymphaea*, and *Nuphar*. A notable amount (17%) of robust emergents also occurs in this marsh with species of *Phragmites, Typha, Sparganium*, and *Pontederia*.

Long Point Company Marsh
This marsh has a comparatively high proportion of submerged macrophytes (64.6%). Plant types consistent with this classification are *Cladophora, Chara, Potamogeton, Najas, Elodea, Vallisneria, Heteranthera, Ceratophyllum, Ranunculus, Myriophyllum*, and *Utricularia*. Eighteen percent of the vegetation consists of floating leaf plants such as *Polygonum, Potamogeton, Nymphaea*, and *Nuphar* and 12% robust emergents such as species of *Phragmites, Typha, Sparganium*, and *Pontederia*.