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**Analysis of Land Cover and Land Use Change
in the Long Point Area from 1955 to 1990
Using Aerial Photography**



Long Point Environmental Folio
Publication Series

Technical Note 2

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.

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in the Long Point Area from 1955 to 1990
Using Aerial Photography**

Patrick L. Lawrence
and
Karen Beazley

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Heritage Resources Centre
University of Waterloo

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PREFACE

The analysis of land cover change in this report is initial and intended to be indicative rather than conclusive. In reading and thinking about the results, in terms of area and percentage change, it should be recognized that they are preliminary. Our estimates of land cover change in this study are limited by constraints of time and resources and in defining the study area for operational purposes. The results are intended to point out directions of change as a basis for discussion of regional and local planning and management and future research needs. It would be useful to try and make more detailed estimates of land cover and land use change for a larger and more significant area, such as the watersheds that form the basis for economy and environment in the region and which drain into and influence the quality of the Inner Bay.

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ABSTRACT

Aerial photography was used to determine important land cover and land use changes that have occurred in the Long Point study area from 1955 to 1990. In 1955 agriculture land use occupied 53% of the area, with wetland/marshes next at 22%. By 1990 agriculture increased slightly to 56% while wetland/marshes showed a decrease to 15% of the total area. Analysis of the preliminary results suggest that growth of marina and cottage developments has resulted in decreases in natural areas at the community of Long Point, along the north shore of the Inner Bay, and at Turkey Point. Shoreline wetlands and marsh areas have suffered the greatest impact with an approximately 1/3 loss in area within the study area since 1955. Urban growth at Port Rowan and other interior communities has reduced local agricultural land but in other locations expansion of agricultural activity in marginal lands, forest areas and wetland/marshes has offset this loss.

1.0 INTRODUCTION

An objective of the Long Point Environmental Folio project is to examine changes in land cover within the Long Point area (Nelson et al., 1993). Preliminary analysis of land cover change by the use of LANDSAT remote sensing imagery for the Regional Municipality of Haldimand-Norfolk has been completed for the period 1974 to 1984 by Yeung (1993). Further analysis was deemed necessary to determine specific land cover changes that have occurred within the Long Point area over a longer period of time.

In order to estimate important long term land cover changes in the Long Point area, aerial photography from 1955 and 1990 was used to identify and map major land cover types. This report outlines the results of that analysis including estimates of the percent change in major land cover types over the 35 year period for the Long Point area. Mapping and analysis of land cover change was also completed at five selected study sites in order to assess more detailed local land cover changes at important sites along the Long Point Inner Bay.

It is important to recognize that it is land cover change that is the primary change being mapped in this study. Land cover refers to visible elements of the earth's surface or landscape such as agricultural fields, forests, marshes and dune systems. Land use can refer to these visible elements but also to human activities that are not so visible such as dredging, fishing, boating or other uses associated with the land cover types. Some of the uses are mapped and discussed in this study mainly on the basis of field observations.

2.0 STUDY AREA

The study area for the Long Point Environment Folio consists of the designated Long Point Biosphere Reserve and surrounding zone of influence (Figure 1) (Nelson et al., 1993). For the purposes of the land cover analysis it was necessary to define a fixed set of boundaries that could easily be identified on each set of aerial photography. The Long Point study area as discussed within this report consists of an arc extending westward from the tip of the Long Point spit to the shoreline and east along the north shore of the Inner Bay to Turkey Point (Figure 2). The inland (northern) boundary is the 3rd Concession Road. The western boundary is County Road # 23 and the eastern boundary is formed by a line extending from the 3rd Concession Road to Normandale.

The study area was selected so that the analysis would focus on the critical land cover changes occurring within the Long Point Biosphere Reserve buffer zone and immediately adjacent areas where it was anticipated that land use impacts would be greatest on the Biosphere Reserve. The selection of the study area boundaries was also influenced by the limited available coverage of aerial photography and restrictions on resources and time to conduct detailed mapping of a larger area.

The study sites were selected to provide more knowledge of land cover changes occurring within the study area at specific locations along the Inner Bay and within the Long Point Biosphere Reserve buffer zone. These sites were selected to focus on locations where extensive land cover changes had been noted from 1955 to 1990. The five sites include: Long Point, the Causeway, Port Rowan, North Shore, and Turkey Point (Figure 2).

3.0 METHODOLOGY

Land cover analysis was completed for the study area from 1955 and 1990 aerial photography (Table 1). These two sets represented the most complete and accessible photography for the study area. Aerial photography from 1978 was also used to make note of major changes in the period from 1978 to 1990. Field observations completed in 1992 also provided more information on the most recent changes.

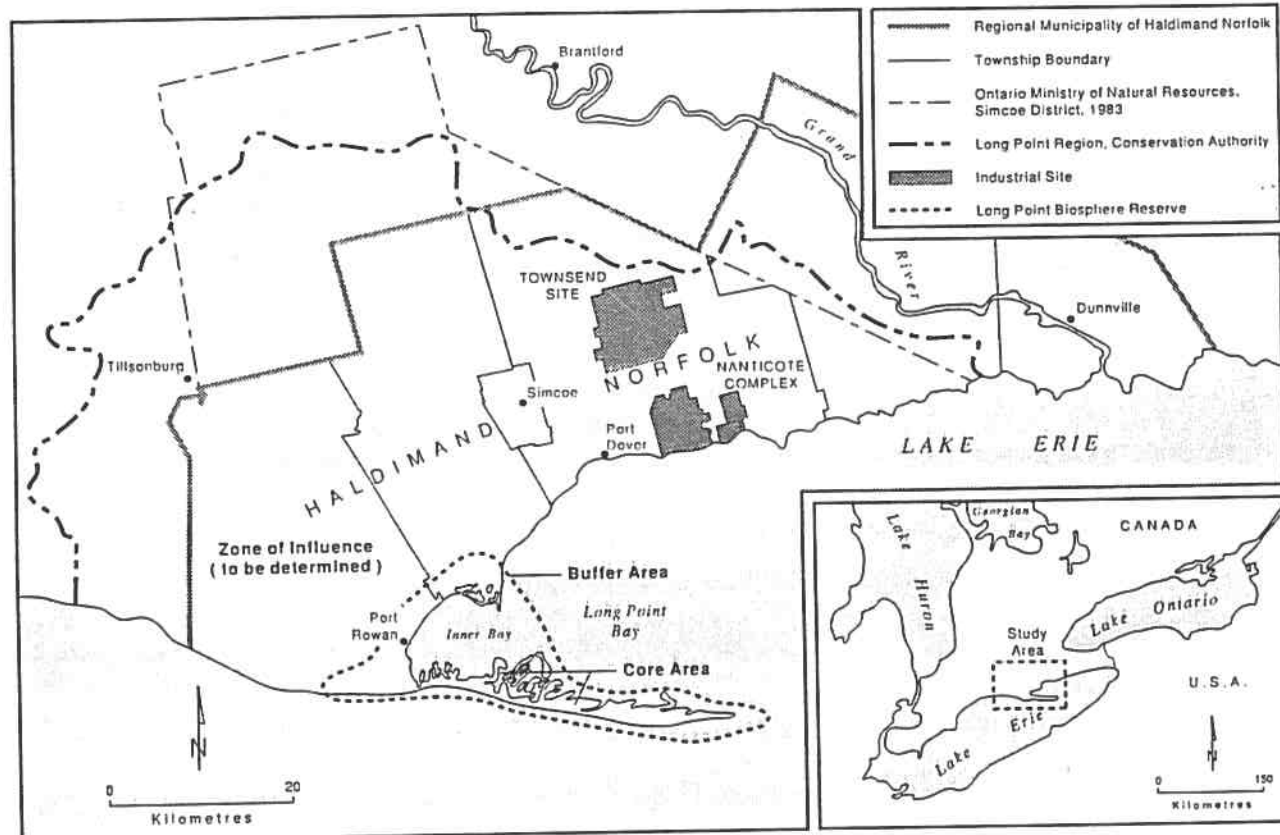


Figure 1: Study Area: Long Point Biosphere Reserve and Region

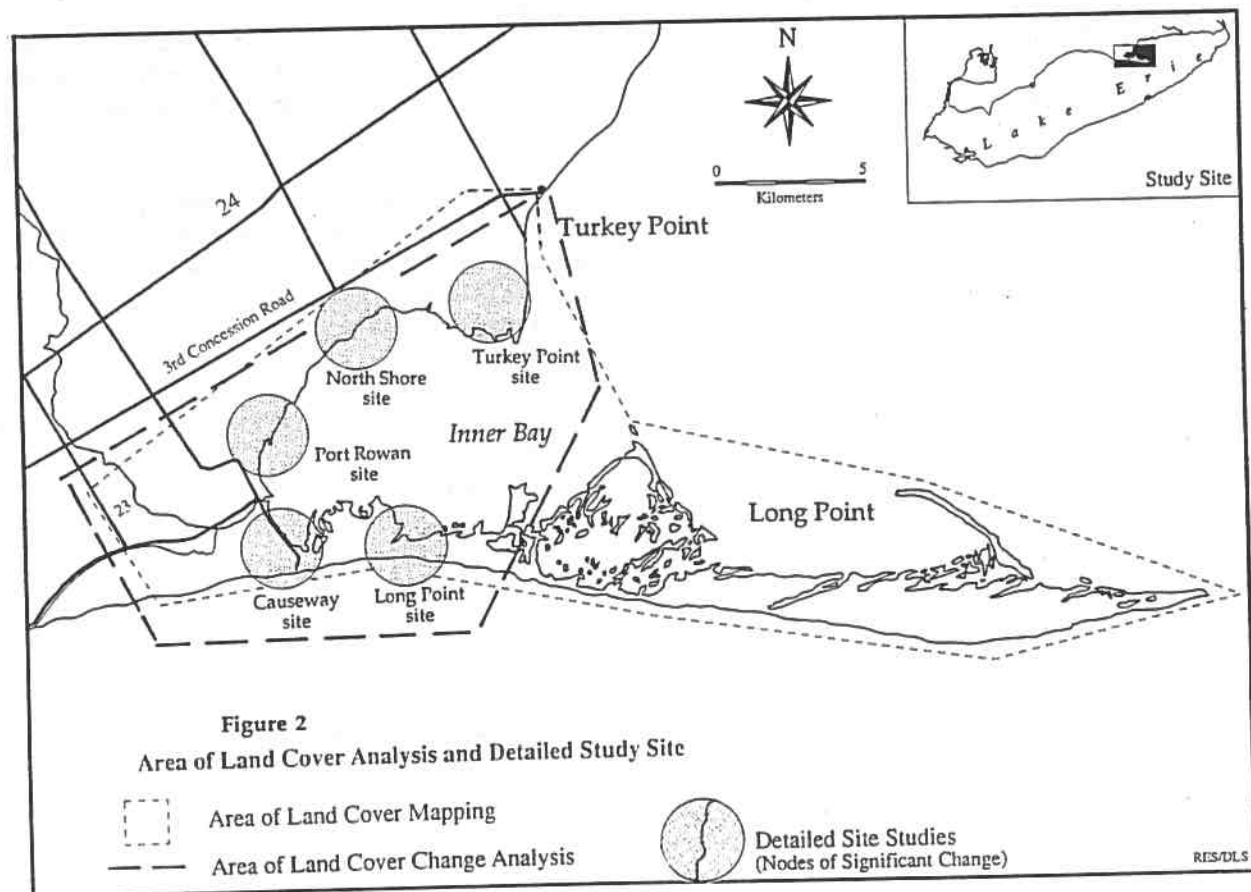


Figure 2
Area of Land Cover Analysis and Detailed Study Site

Table 1 Aerial Photography

Year	Scale	Lot	Roll	Photos	Source
1955	1:15,000	55-50	4225	179 - 192	UWaterloo
			4226	148 - 178	
			4227	122 - 142	
			4228	105 - 114	
			4229	84 - 92	
			4230	55 - 64	
		55-49	4231	265 - 270	
			4232	205 - 210	
1955	1:15,840	Mosaics	425802	UWaterloo	
			426802		
1978	1:10,000	4238	283	81 - 108	LPRCA/UWaterloo
			283	52 - 80	
			283	10 - 51	
			283	109 - 115	
			285	60 - 85	
			285	39 - 42	
			282	60 - 64	
			286	109 - 113	
			214	80 - 98	
			214	105 - 118	
1988	1:8,000	A27264	5,7,17,23,27,	LPRCA	
			36,40,44,57,		
			61,65,67,82,		
			86,125,129		
			A27266		7,11
			A27537		12 - 26
1990	1:50,000	A27537	50-70	EMR	
			79 - 93		
			A27538		22 - 42
			A27537		12 - 26
			A27544		1 - 18
	72 - 86				

A land cover classification scheme was developed after review of methods outlined in previous studies (Lake Erie Shoreline Inventory, 1969; Environment Canada/Ontario Ministry of Natural Resources, 1975; Baker, 1986; Philpott, 1990) including modification of techniques utilized in previous Great Lakes shoreline studies by the study team participants (Nelson et al., 1991; Lawrence and Nelson, 1992). Several meetings and discussions led to the development of a two tier classification scheme for land cover (Table 2).

At the medium scale of photography available for 1990 (1:50,000), seven main classes were defined for the Long Point study area: Forest, Wetland/marshes, Parkland/savanna, Agriculture, Built-Up Area, Coastal Deposits, and Open Water. Forest and Parkland/savanna are characterized by their vegetation cover types. Wetland/marshes are areas that could be identified as having dense aquatic emergent vegetation and tend to consist mainly of shoreline locations. Agriculture areas are sites predominated by open fields or cultivated fields with planted crops. Built-Up areas include all types of human development, such as urban communities, rural residential buildings (cottages), services (roadways), commercial uses, industry, marinas, dredged sites, and recreational sites (golf courses). Coastal deposits include shoreline bluffs, beaches and dunes and are found mainly on the Long Point spit. The open water class includes only enclosed ponds or inlets on the mainland and spit and not the Inner Bay or Lake Erie. The photography available for 1955 (1:15,000) and 1988 (1:8000) facilitated further division of each of the seven classes into sub-classes to be used in mapping of the study sites. Specific definitions of each of the main classes and sub-classes were developed and assisted in interpretation of the large scale aerial photography (Table 2).

Land cover types for the Long Point study area were interpreted from the 1955 and 1990 aerial photographs and drawn onto overlay sheets. Once complete, a sheet of 1 cm² grid cells was superimposed on each overlay and a count was completed of individual grid cells for each land cover type. Each land cover class was then calculated in terms of the 1 cm² grid cells as percentage of total grid cell count which covered the study area. Percentage change was calculated as the percentage of the difference between 1955 and 1990 and the original coverage (e.g. Fp class: 1955 - 1.9%, 1990 - 2.4%, difference is 0.5% divided by 1.9% = 28% change). The land cover analysis did not include the area along Long Point from the eastern boundary of the cottage area to the tip of the spit. Although the land cover was mapped for this area, resource and time restrictions did not allow for analysis. The overlay sheets were further photo-reduced and used to draw individual summary maps used in this report.

The original 1955 and 1990 land cover sheets overlaid to determine areas of significant change. From these areas a set of five study sites were selected. The purpose was to document the characteristic land cover changes that occurred along the Inner Bay at specific more dynamic local sites. The 1990 (1:50,000) aerial photography used in the study of the Long Point area was of limited use for the study sites due to lack of detail. For more accurate comparison to 1955 (1:15,840) photography, 1988 (1:8,000) coverage for the shoreline was used. Base maps for the study site maps were redrawn from the original 1955 overlay sheet. Aerial photographs from 1955 and 1988 were used to produce land cover maps for each site. Calculations of percentage of land cover types for each of the study sites were made from the original overlay sheets in terms of the 1 cm² grid cells. The maps were further photo-reduced to be placed within the report.

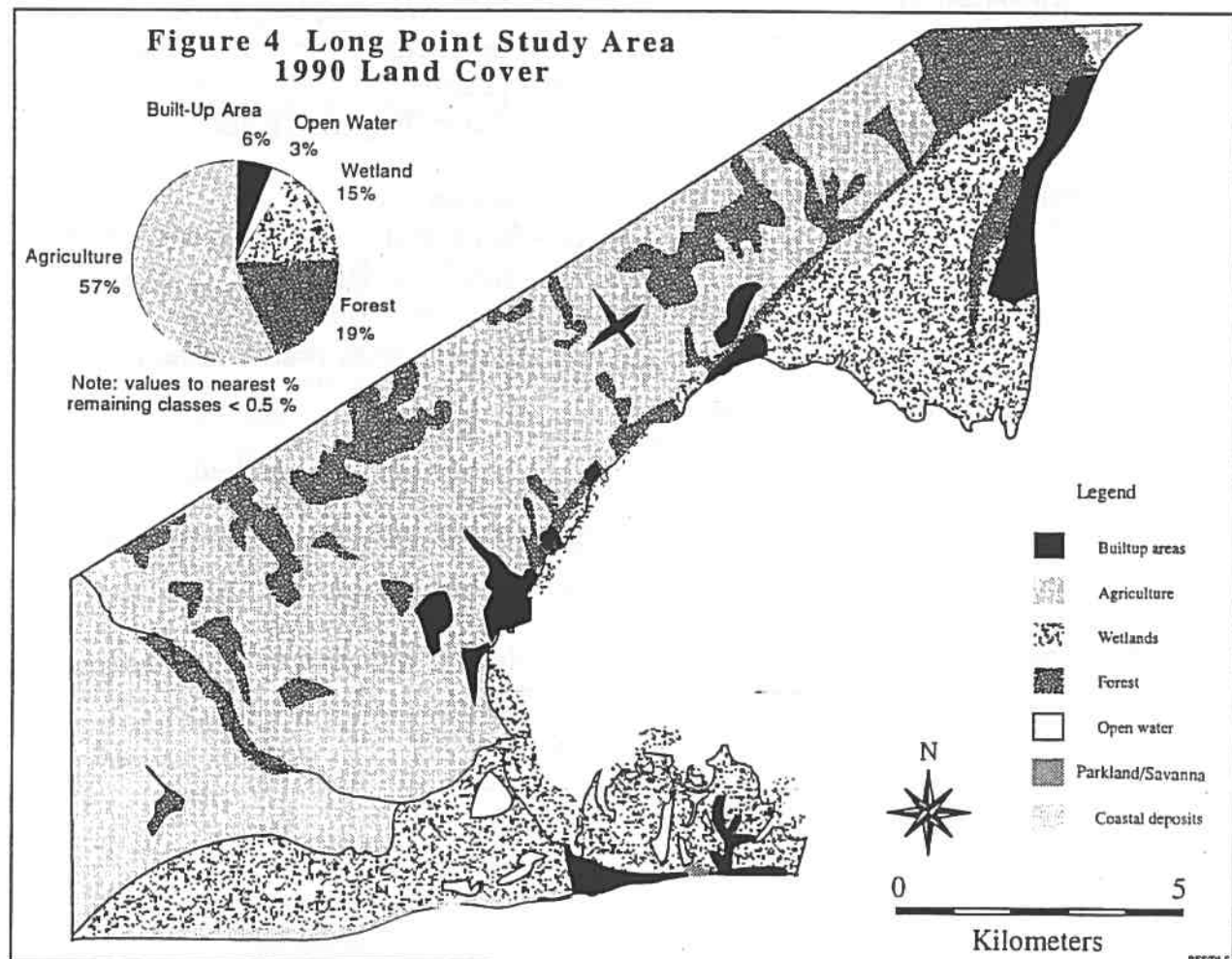
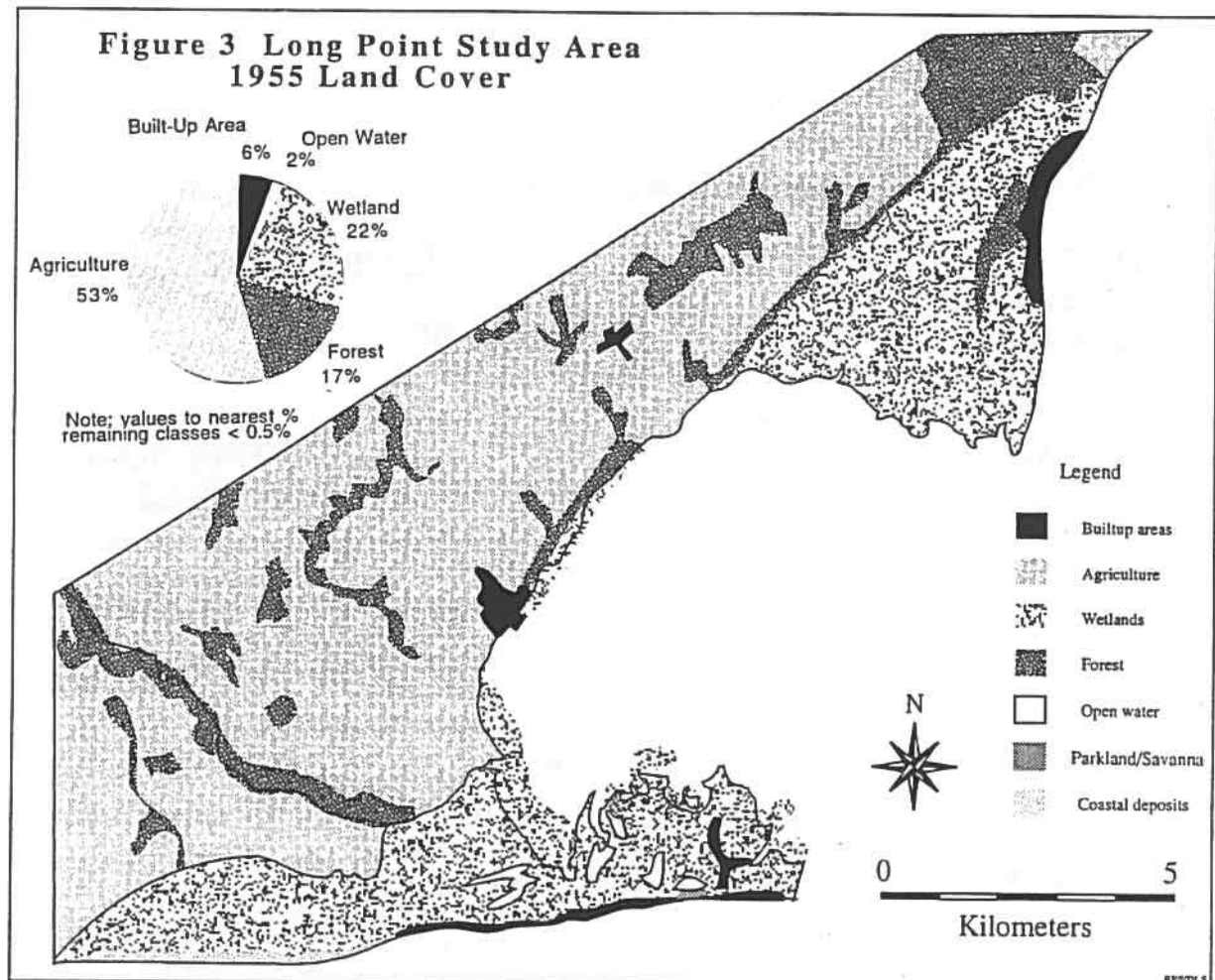
4.0 STUDY RESULTS AND DISCUSSION: LONG POINT STUDY AREA

Land Cover 1955-1990

In 1955 the dominant land cover type in the Long Point area (Figure 3) was agriculture, consisting of 53% of the total land cover area and included cultivated fields with grains, market gardens, and tobacco as the significant crop types. Wetland/marshes occupied 22% and forests 17%, with deciduous trees the most common. The other main land cover type was built-up areas with 6% coverage and included

Table 2: Land Cover Classification

<u>Biosphere Reserve Area / Coastal Zone 1:50,000</u>	<u>Nodes of Significant Potential Change 1: 10,000</u>
F - Forest/Woodland (>50% canopy)	Fp - plantation (Fpc- coniferous; Fpd - deciduous) Fd - forest (deciduous; mixed) Fs - scrubland Fh - hedgerow/windbreak Fw - woodlots Fr - riparian forest Frf - reforestation (deciduous)
W - Wetland (Coastal)	Wm - marsh Ws - swamp
S - Parkland/savanna(<50% canopy)	s - savanna Sp - parkland
A - Agricultural land	Ac - cultivated fields Ao - orchards Ap - pasture Af - succeeding/old fields
B - Built-up Area	Bu - urban Bi - industrial Br - rural residential Bs - services (communication corridors such as roads, railways, hydro R.O.W.) Bm - marina Bd - dredged and disturbed Bc - cottage/seasonal Brc - recreation (i.e., golf course) Bi - institutional
C - Coastal deposits	Cb - beach Cd - dune Ce - eroding cliff
Op - Open Water	



cottages, marinas, dredged areas, and urban developments. Open water (2%) and all other cover types, including coastal deposits and savanna/parkland (less than 0.5%) were the remaining classes.

By 1990 several land cover trends had developed (Figure 4). Agricultural land area had increased to 56%. Wetland/marshes showed a decrease to 15% of the total land cover, a loss of 1/3 in area since 1955. A slight increase occurred in forest cover with little change in the other classes. An increase in deciduous forest may represent planting initiatives. Within the Long Point study area, built-up areas have remained unchanged as a percentage of the total land cover from 1955 to 1990 with small declines in some places and limited and site specific growth in other marina, residential, urban and cottage areas. It is also possible that forest canopy cover is masking development resulting in classification of some cottage and residential areas as forest.

A comparison of the land cover mapping revealed several areas of significant land use changes from 1955 to 1990 (Figure 5). Infilling of vacant lots, roadway construction, and expansion along cottage developments have occurred in the communities of Long Point, affecting wetland/marsh areas (Photo 1). Construction of an impoundment and development of an enclosed marsh at Big Creek have led to open water and reduction in emergent vegetation. Cottages on Hastings Drive have been removed due to flooding and erosion damages (Photo 2). Urban growth along main roadways at Port Rowan and St. Williams has increased the size of these communities. Increased dredging, infilling, and channelization have continued at marina sites along the Inner Bay marshes on the north shore (Photo 3). Wetland infilling and channel dredging has resulted in increased cottage development at Turkey Point (Photo 4).

Land Cover Changes 1978-1992

Examination of the 1978 aerial photography and 1992 field observations of existing land uses allowed for notation of recent land use changes along the shoreline in the period since 1978 (Figure 6). Improvements in road networks, intensification of cottage developments, and dredging have occurred in the community of Long Point. Destruction and removal of cottages and use of shore protection structures has occurred along Hastings Drive at the western end of the community due to storms in 1985 and 1986. The Inner Bay, north shore and Turkey Point have experienced expansion of existing marina developments with accompanied dredging and infilling.

Photo 1 Long Point site, channels cut into Inner Bay marshes



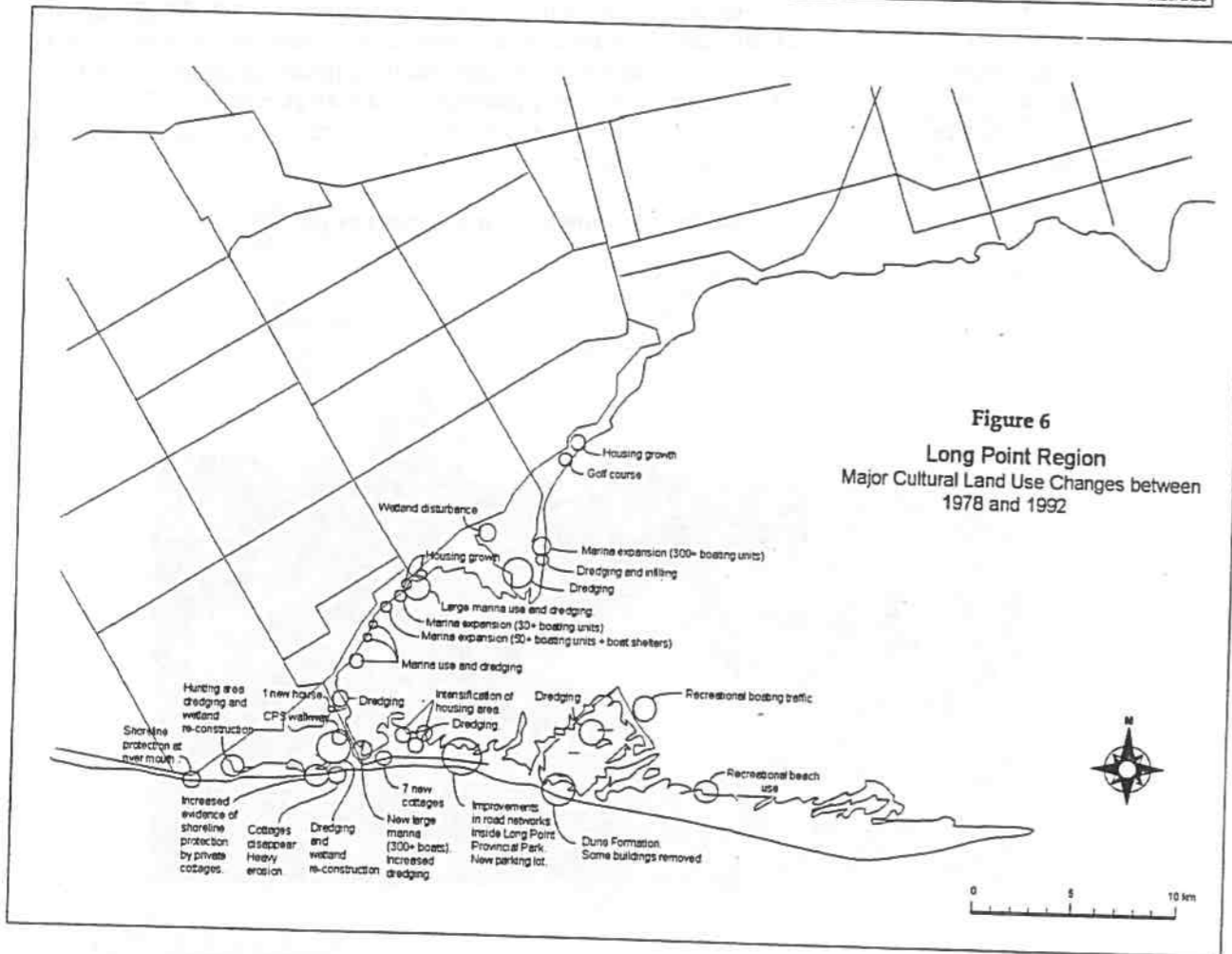
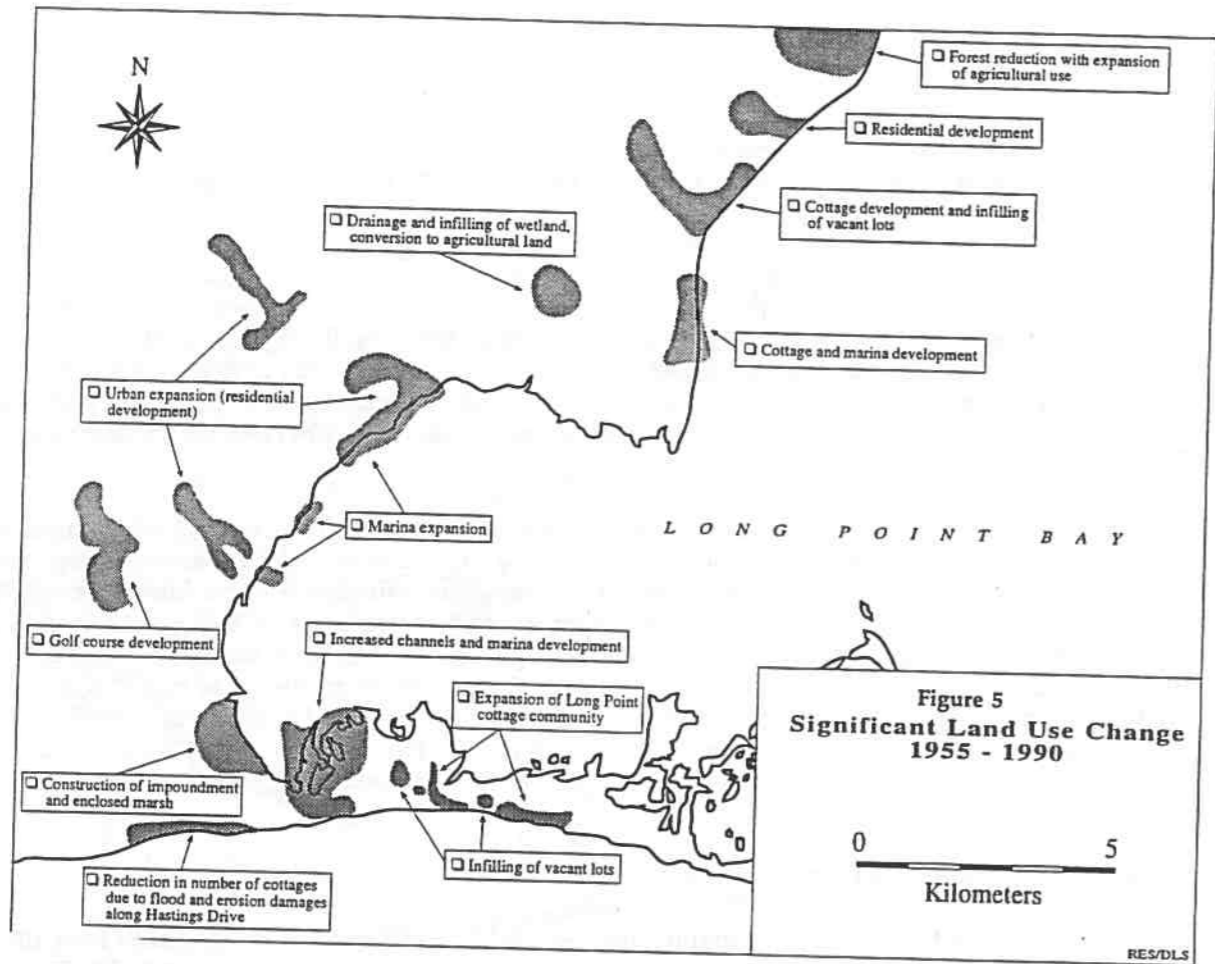


Photo 2 Causeway site, cottages at Hastings Drive



Photo 3 Port Rowan site, view east along Inner Bay shoreline



Photo 4 North Shore site, trailers at Booths' Marina



Photo 5 Turkey Point site, boat channels and cottages



5.0 STUDY RESULTS AND DISCUSSION: STUDY SITES

Long Point Site

The community of Long Point is dominated by the wetland/marsh areas of the Provincial Crown Marsh and the cottage development extending through these areas and along the Lake Erie shoreline (Figures 7 and 8). In 1988 wetland/marshes (Wm) made up 53% of the total land cover, exhibiting very little change since 1955 (Figure 9). The major changes in total percentage area from 1955 to 1988 are an increase in services (roadways) (Bs) and a reduction in open water (Op) in the Provincial Crown marsh. Built-up areas (B), including services (Bs), marinas (Bm), dredged land (Bd), and cottages (Bc) have increased from a total of 34% in 1955 to 40% in 1988, reflecting infilling and redevelopment of vacant lots and extension of roadways through cottage developments. Open water has decreased to less than 1% due to this infilling and a minor decrease in Lake Erie water levels by 0.20 metres between 1955 and 1988 (data from Great Lakes Water Level Communication Centre, Burlington, Ontario) resulting in the appearance of more emergent aquatic vegetation.

Causeway Site

Consisting of the area surrounding the south end of the Long Point causeway, this site includes the western end of the community of Long Point, Big Creek marsh and the shoreline of the Inner Bay (Figures 10 and 11). Wetland/marshes (Wm) made up the major land cover type with 71% of total land cover in 1955 (Figure 12). By 1988 that had been reduced to 55%, a loss of 1/4 over the 33 year period. That loss can be partly attributed to an increase in open water (Op) in the marshes of Big Creek following development of the impoundment and water level control structures in the early 1980's. Marina (Bm) expansion increased to 8% cover, also reducing wetlands/marshes along the Inner Bay and lakeside of the causeway. Cottage development (Bc) showed a slight decrease due to the removal of a number of cottages from Hastings Drive.

Port Rowan

In the area of Port Rowan, inland and along the shoreline, the 1955 land use was dominated by agriculture (Ac) (54%) (Figure 13). However, by 1988 (Figure 14) the urban area (Bu) of Port Rowan had more than doubled in size resulting in a 15% decline in agricultural land cover area (Ac) (Figure 15). Marina development (Bm) along the shoreline also increased resulting in a net loss of wetlands/marshes (Wm) at this site. Wetlands/marshes decreased 1/4 over the period with a 3X increase in marina area along the shoreline.

North Shore

Along the north shore of the Inner Bay (Figures 16 and 17) agricultural land cover (Ac) decreased from 58% in 1955 to 38% in 1988 a change of 20% (Figure 18). Development in the urban community (Bu) and marina site (Bm) at Booth's Harbour increased to 21% of total area, converting large areas of agricultural land (Ac) and minor areas of forest (Fd).

Turkey Point

From 1955 to 1988 extensive dredging, infilling, channelization, marina construction and cottage development considerably changed the nature of the land cover at the Turkey Point site (Figure 19 and 20). Wetland/marshes (Wm) were reduced by 60% of 1955 coverage and forest areas (Fs) also decreased (Figure 21). The cottage community (Bc) increased from 7 to 20% of the total land cover with roadways and marinas also increasing. Open water (Op) in the wetland/marshes area increased due to extensive modification, infilling, and channel development.

Figure 7 Long Point Site - Land Cover 1955

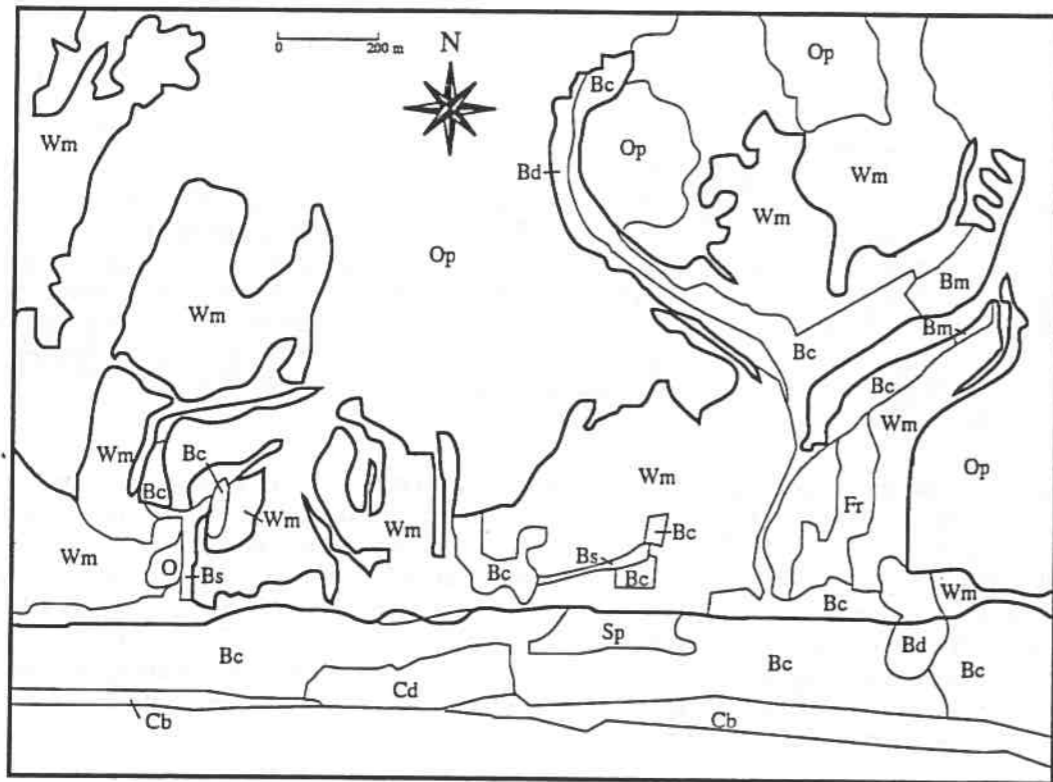


Figure 8 Long Point Site - Land Cover 1988

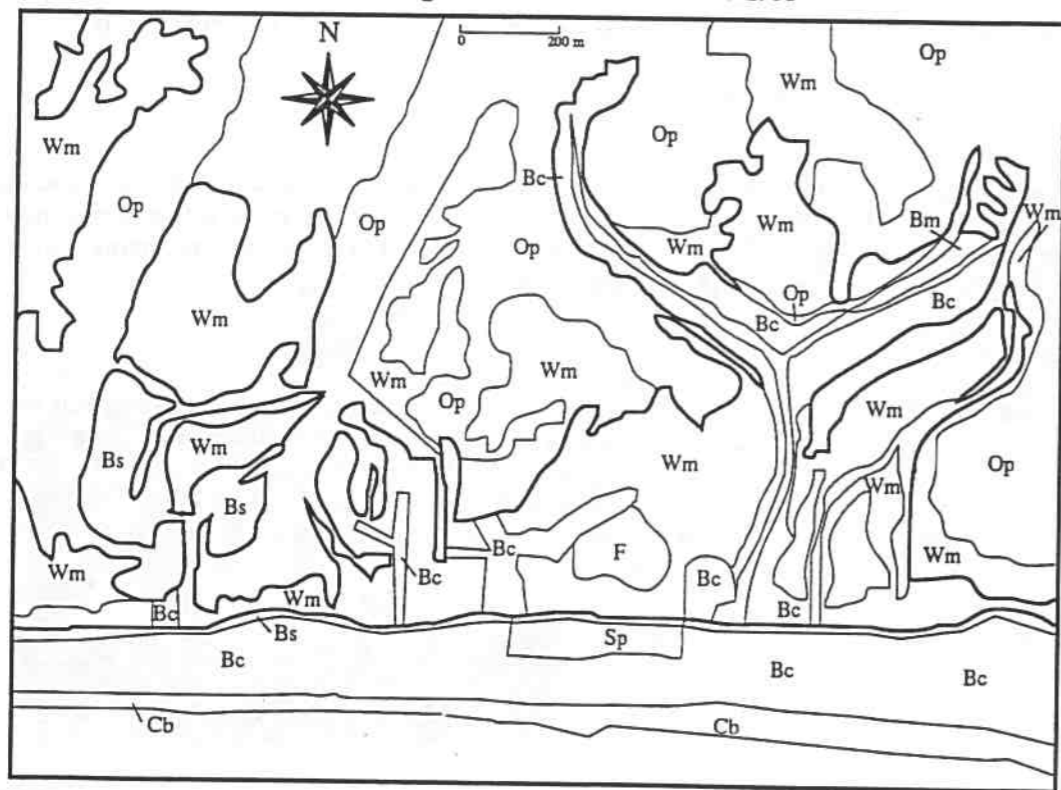
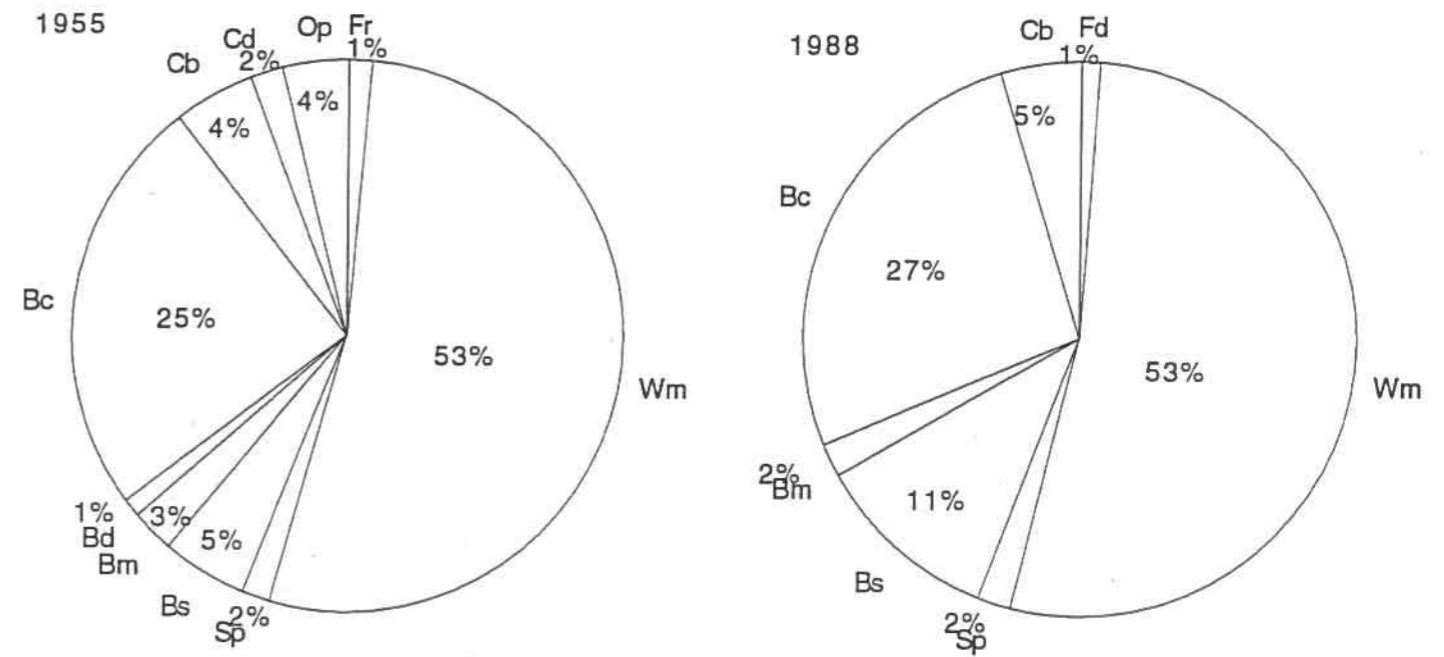
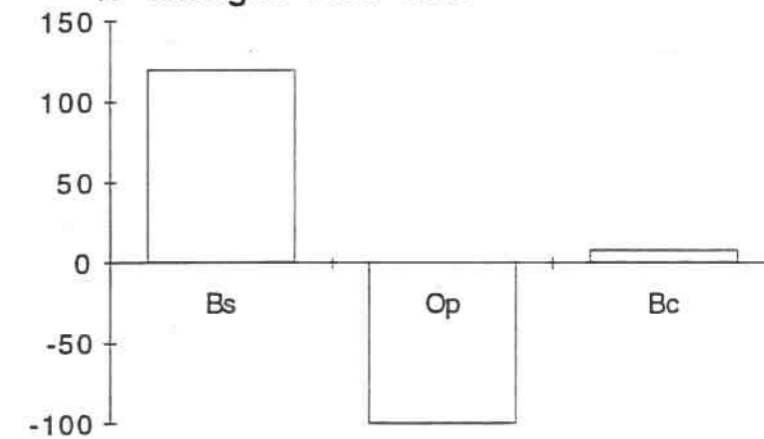


Figure 9 Long Point Site Land Cover Changes 1955 - 1988



% Changes 1955-1988



Classes used for Detailed Study of Nodes of Land Cover Change at a Scale of 1: 10,000

- Fp - plantation (Fpc - coniferous; Fpd - deciduous)
- Fd - forest (deciduous; mixed)
- Fs - scrubland
- Fh - hedgerow/windbreak
- Fw - woodlots
- Fr - riparian forest
- Fri - reforestation (deciduous)

- Wm - marsh
- Ws - swamp

- s - savanna
- So - parkland

- Ac - cultivated fields
- Ao - orchards
- Ap - pasture
- Af - succeeding/old fields

- Bu - urban
- Bi - industrial
- Br - rural residential
- Bs - services (communication corridors such as roads, railways, hydro R.O.W.)
- Bm - manna
- Bd - dredged and disturbed
- Bc - cottage/seasonal
- Brc - recreation (i.e., golf course)
- Bi - institutional

- Cb - beach
- Cd - dune
- Ce - eroding cliff

Figure 10 Causeway Site - Land Cover 1955

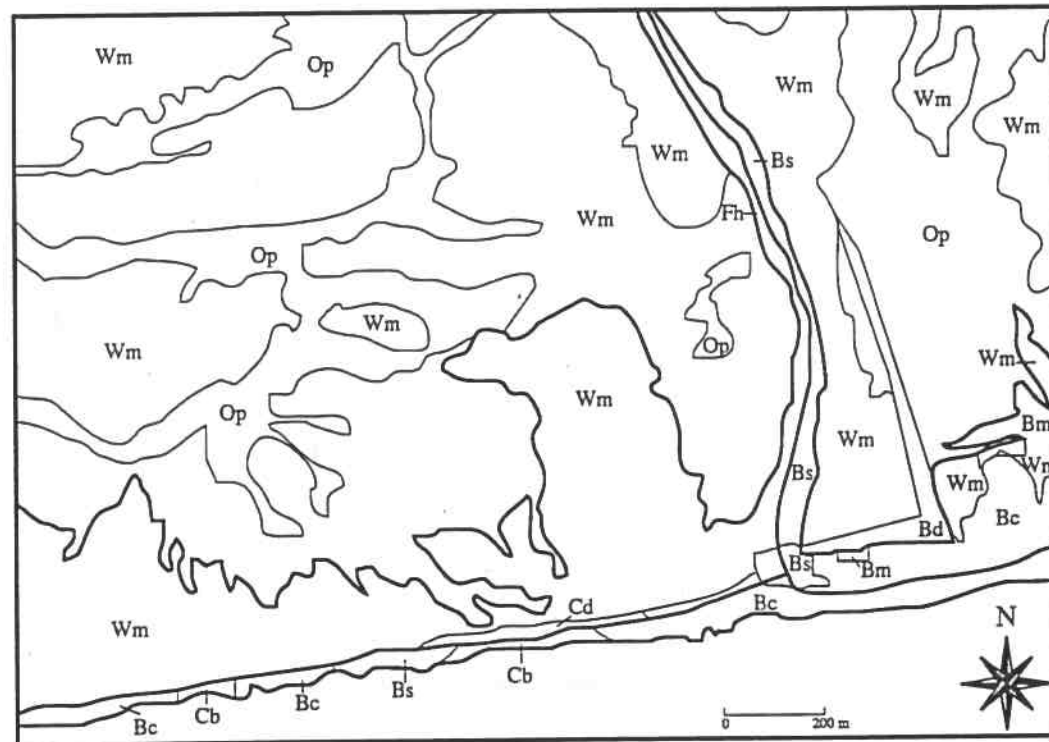


Figure 11 Causeway Site - Land Cover 1988

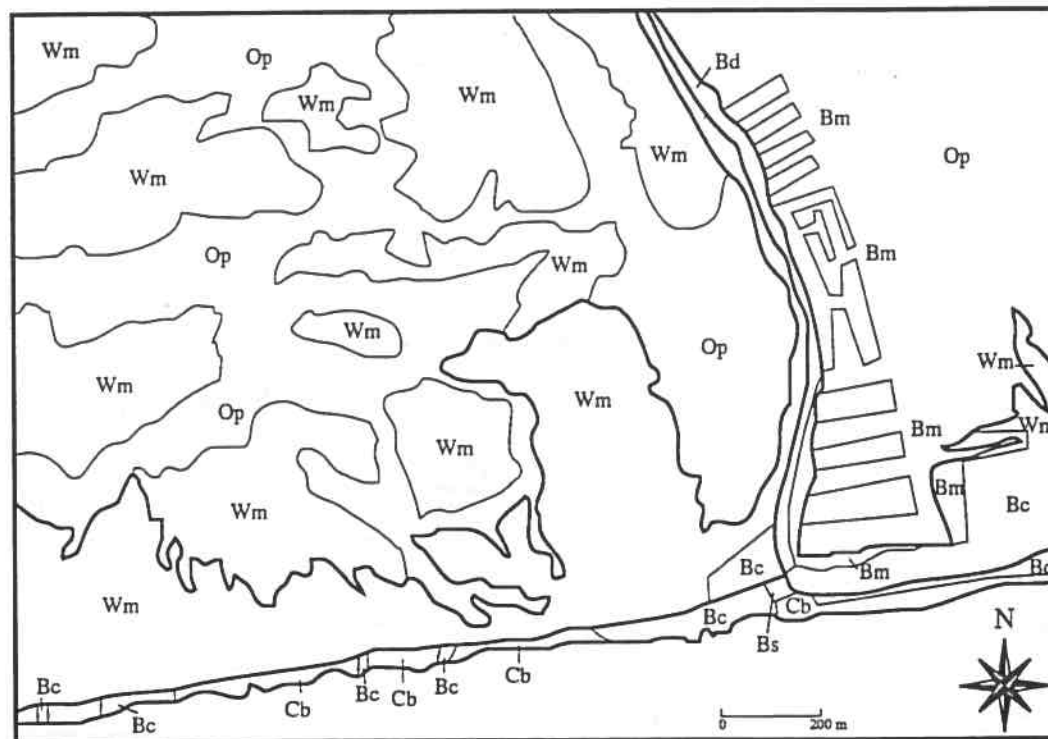
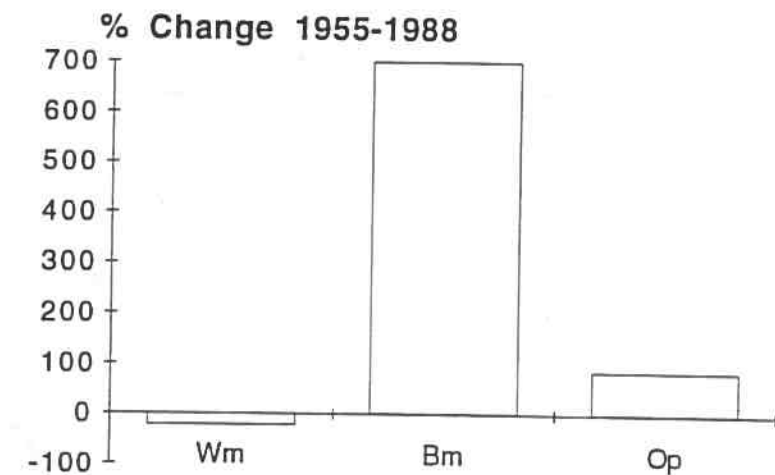
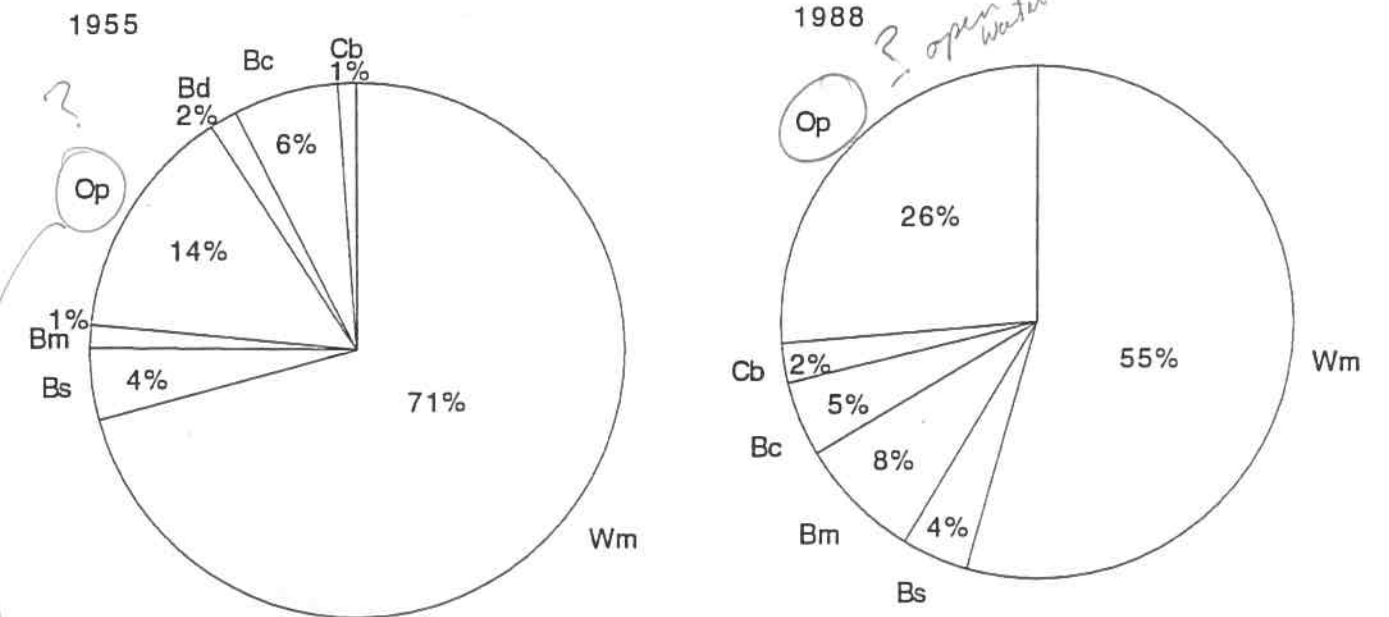


Figure 12 Causeway Site Land Cover Changes 1955 - 1988



Classes used for Detailed Study of Nodes of Land Cover Change at a Scale of 1: 10,000

- Fp - plantation (Fpc - coniferous; Fpd - deciduous)
- Fd - forest (deciduous; mixed)
- Fs - scrubland
- Fh - hedgerow/windbreak
- Fw - woodlots
- Fr - riparian forest
- Frl - reforestation (deciduous)

- Wm - marsh
- Ws - swamp

- s - savanna
- Sp - parkland

- Ac - cultivated fields
- Ao - orchards
- Ap - pasture
- Af - succeeding/old fields

- Bu - urban
- Bi - industrial
- Br - rural residential
- Bs - services (communication corridors such as roads, railways, hydro R.O.W.)
- Bm - marina
- Bd - dredged and disturbed
- Bc - cottage/seasonal
- Brc - recreation (i.e., golf course)
- Bi - institutional

- Cb - beach
- Cd - dune
- Ce - eroding cliff

Figure 13 Port Rowan Site - Land Cover 1955

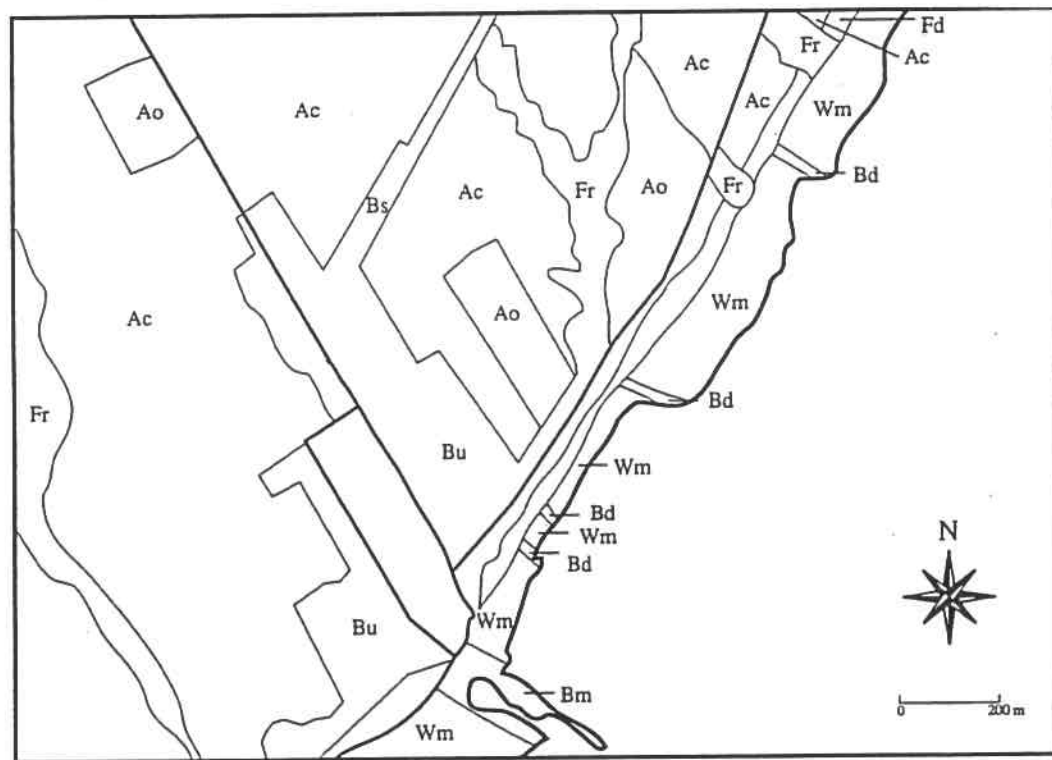


Figure 14 Port Rowan Site - Land Cover 1988

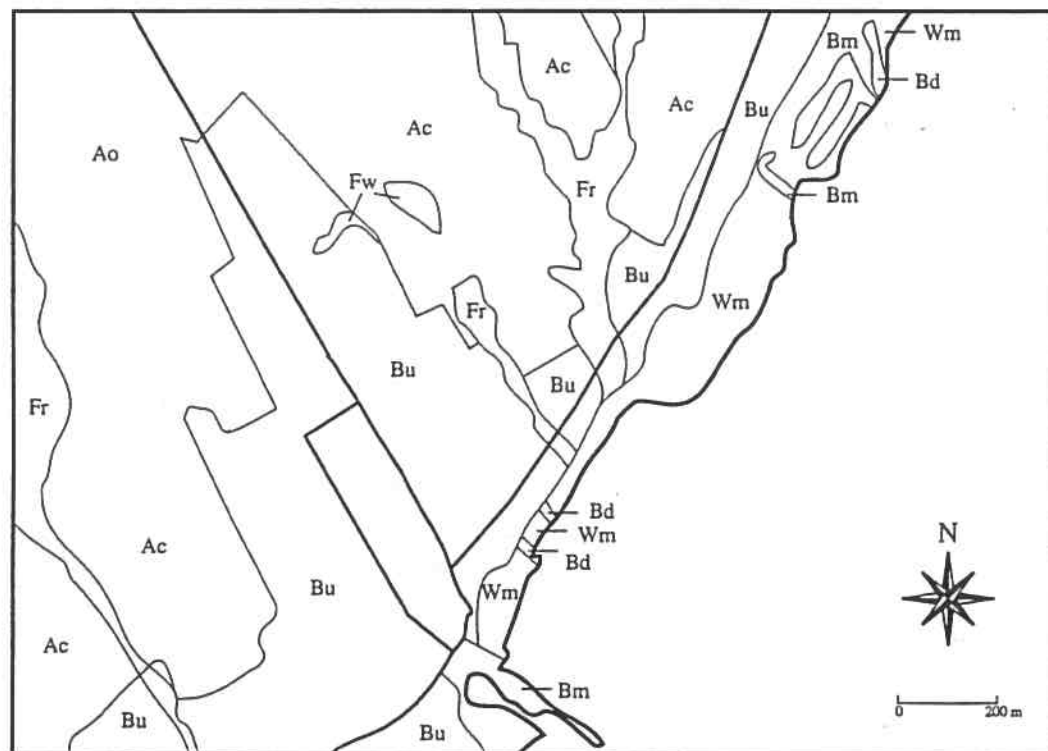
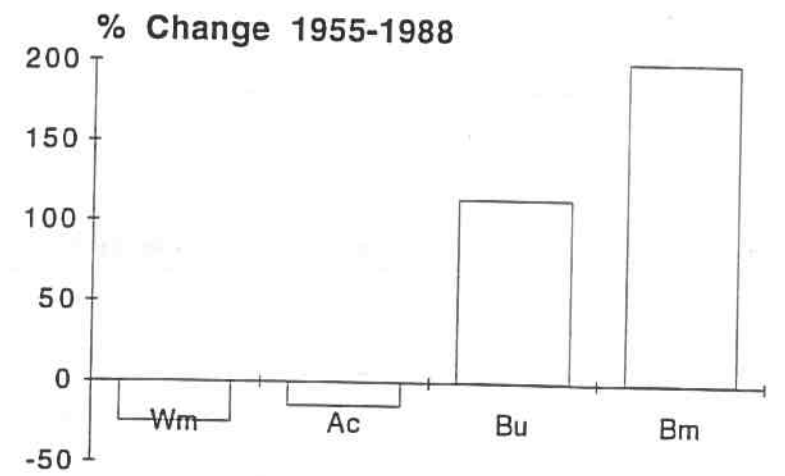
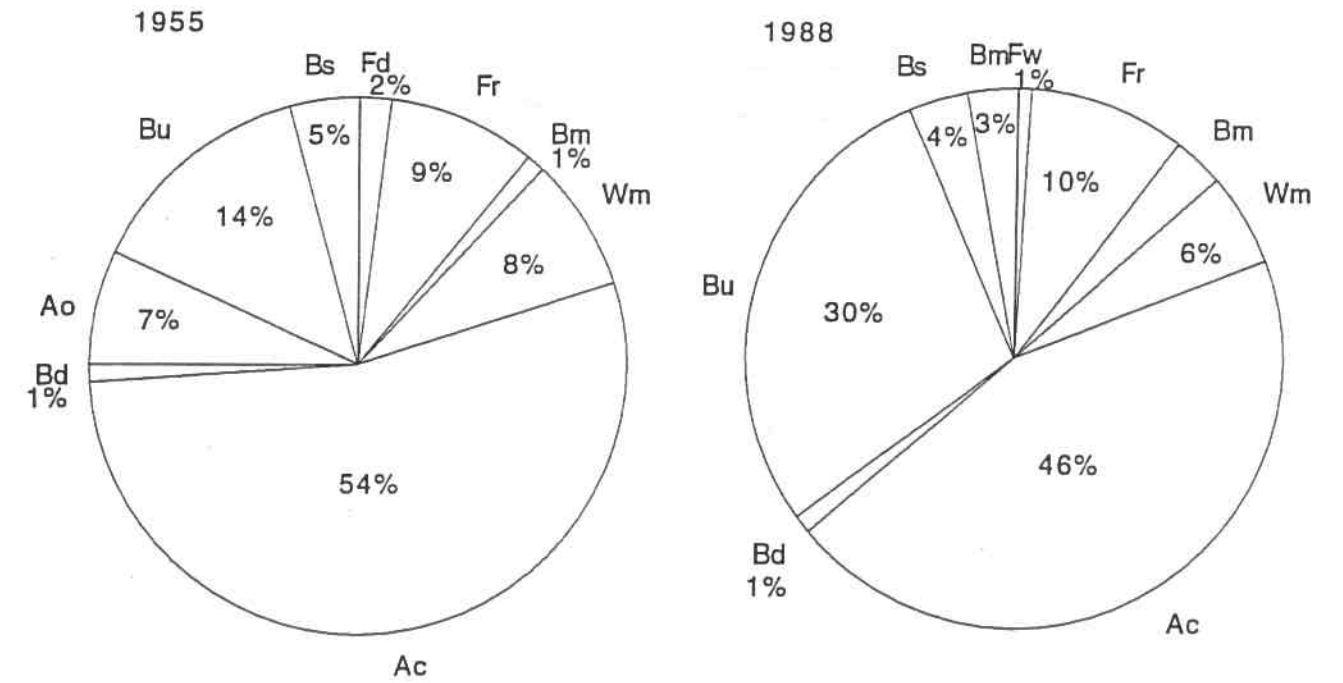


Figure 15 Port Rowan Site Land Cover Changes 1955-1988



Classes used for Detailed Study of Nodes of Land Cover Change at a Scale of 1: 10,000

Fp - plantation (Fpc - coniferous; Fpd - deciduous)
Fd - forest (deciduous; mixed)
Fs - scrubland
Fh - hedgerow/windbreak
Fw - woodlots
Fr - riparian forest
Frl - reforestation (deciduous)
Wm - marsh
Ws - swamp
s - savanna
So - parkland
Ac - cultivated fields
Ao - orchards
Ap - pasture
Af - succeeding/old fields

Bu - urban
Bi - industrial
Br - rural residential
Bs - services (communication corridors such as roads, railways, hydro R.O.W.)
Bm - manna
Bd - dredged and disturbed
Bc - cottage/seasonal
Brc - recreation (i.e., golf course)
Bi - institutional
Cb - beach
Cd - dune
Ce - eroding cliff

Figure 16 North Shore Site - Land Cover 1955

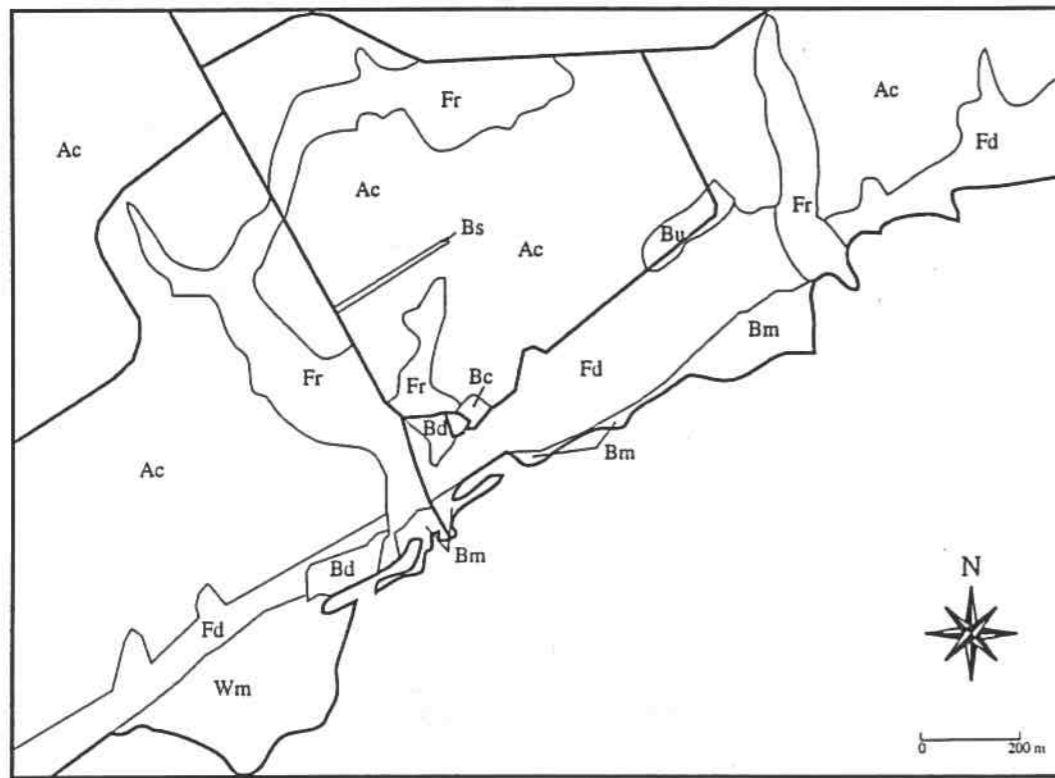


Figure 17 North Shore Site - Land Cover 1988

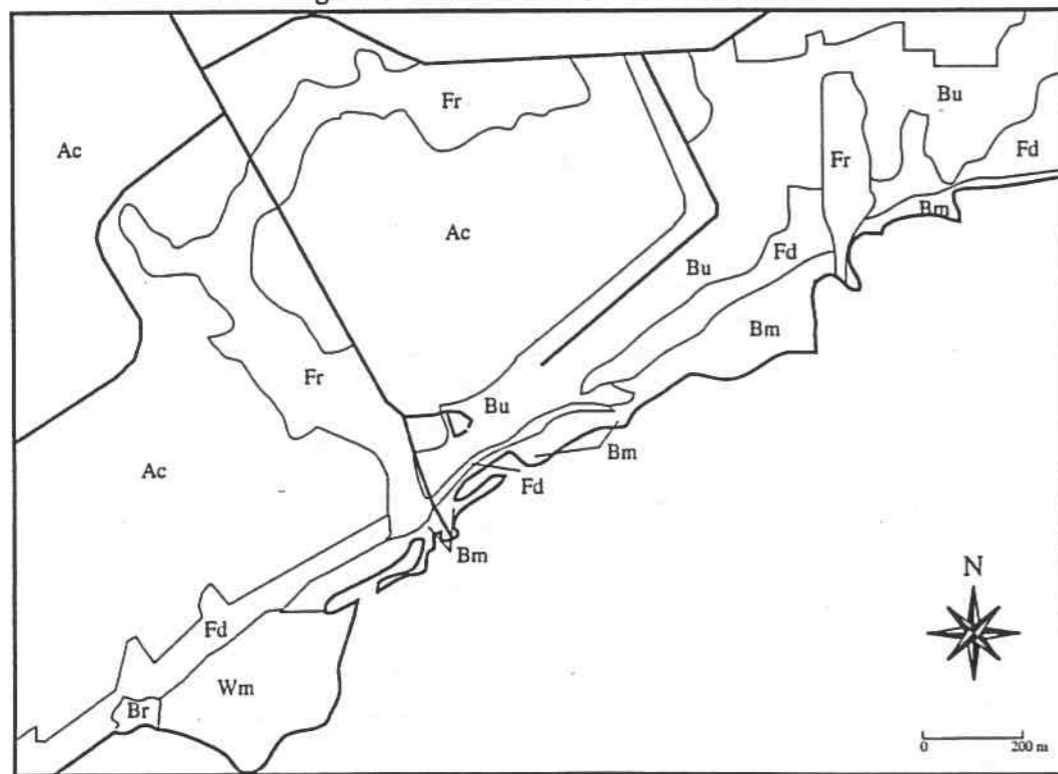
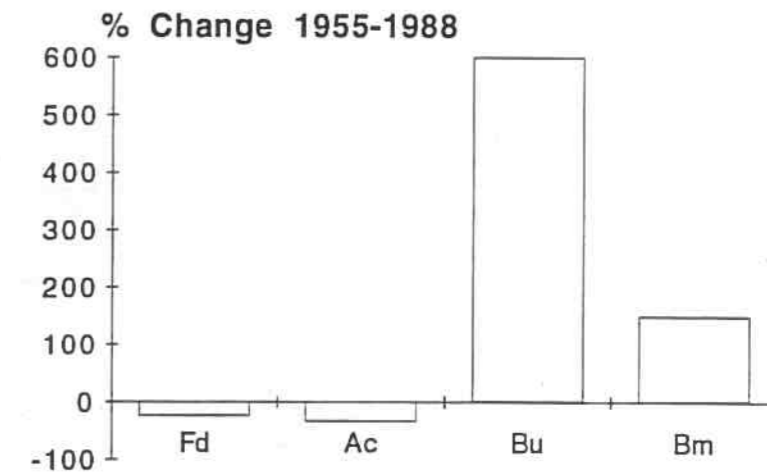
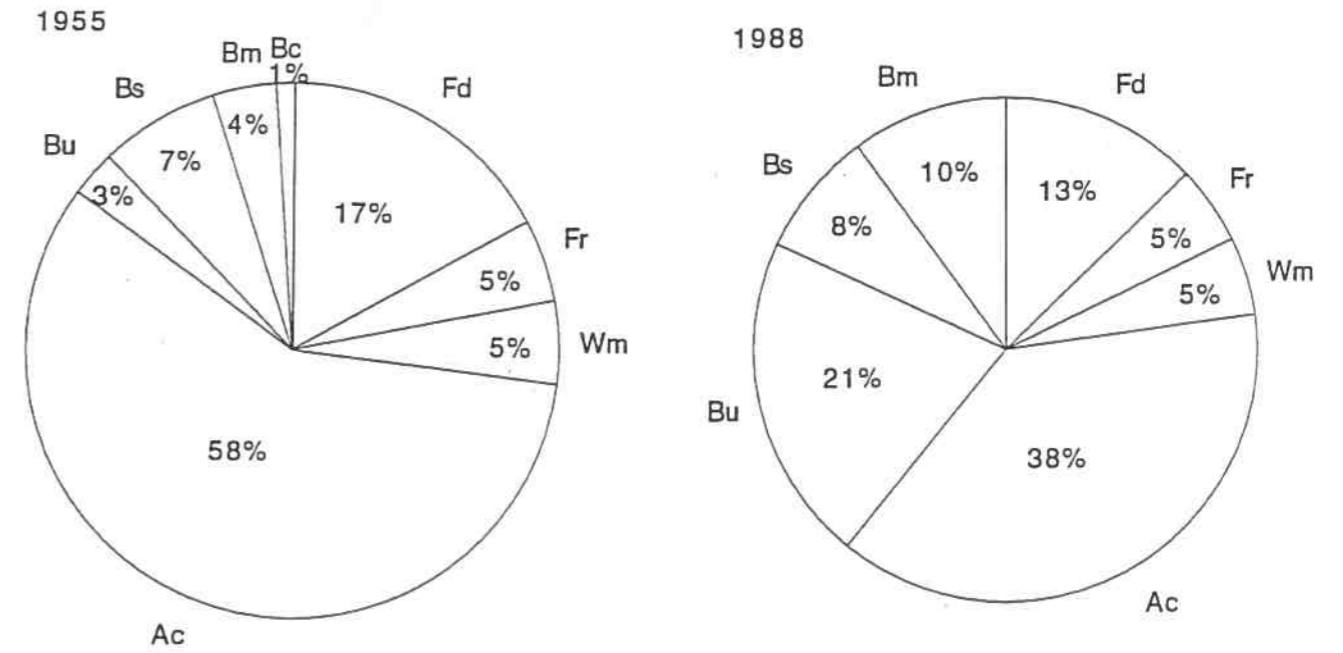


Figure 18 North Shore Site Land Cover Changes 1955 - 1988



Classes used for Detailed Study of Nodes of Land Cover Change at a Scale of 1: 10,000

Fp - plantation (Fpc - coniferous; Fpd - deciduous)
Fd - forest (deciduous; mixed)
Fs - scrubland
Fh - hedgerow/windbreak
Fw - woodlots
Fr - riparian forest
Frf - reforestation (deciduous)
Wm - marsh
Ws - swamp
s - savanna
So - parkland
Ac - cultivated fields
Ao - orchards
Ap - pasture
Af - succeeding/old fields

Bu - urban
Bi - industrial
Br - rural residential
Bs - services (communication corridors such as roads, railways, hydro R.O.W.)
Bm - marina
Bd - dredged and disturbed
Bc - cottage/seasonal
Brc - recreation (i.e., golf course)
Bi - institutional
Cb - beach
Cd - dune
Ce - eroding cliff

Figure 20 Turkey Point Site - Land Cover 1988

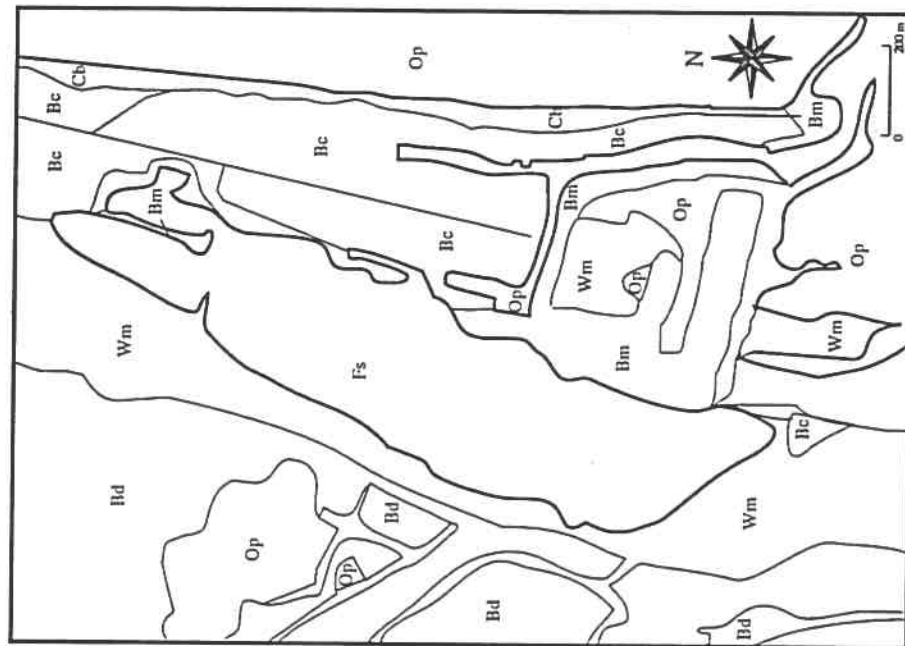


Figure 19 Turkey Point Site - Land Cover 1955

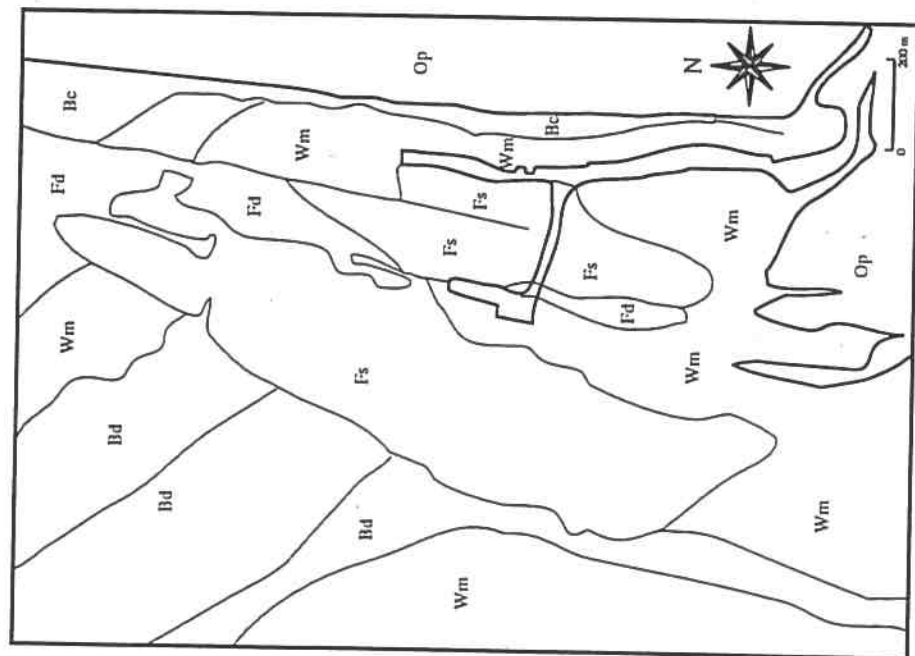
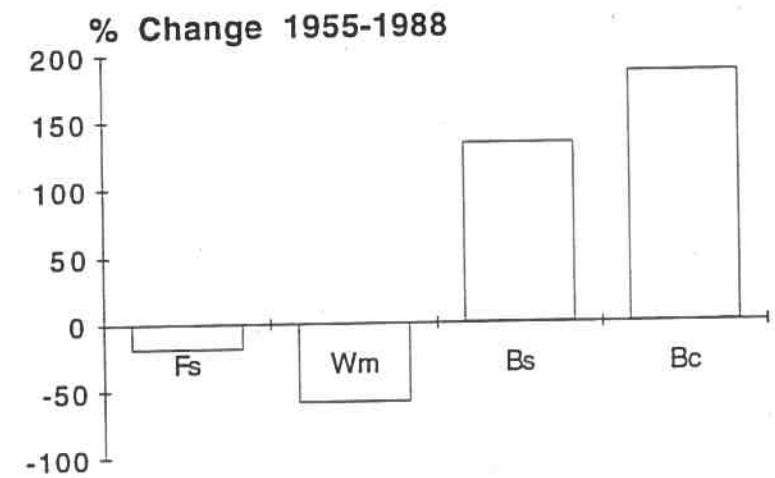
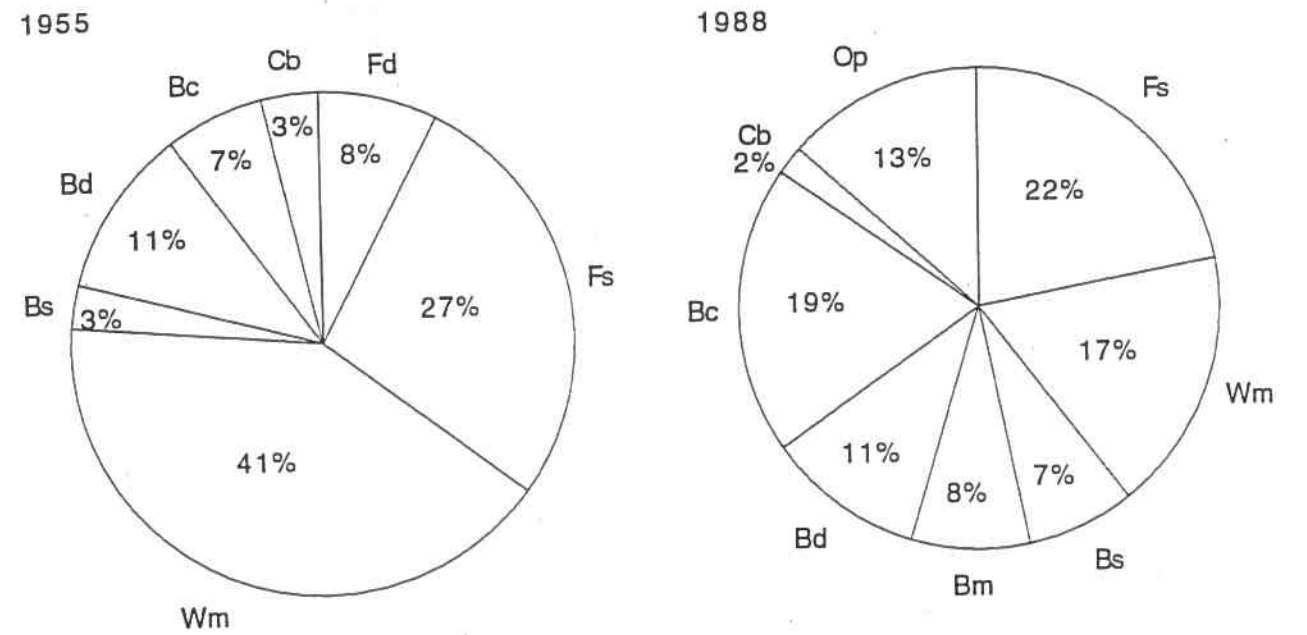


Figure 21 Turkey Point Land Cover Changes 1955-1988



Classes used for Detailed Study of Nodes of Land Cover Change at a Scale of 1: 10,000

Fp - plantation (Fpc - coniferous; Fpd - deciduous)
Fd - forest (deciduous; mixed)
Fs - scrubland
Fh - hedgerow/windbreak
Fw - woodlots
Fr - riparian forest
Frf - reforestation (deciduous)
Wm - marsh
Ws - swamp
s - savanna
So - parkland
Ac - cultivated fields
Ao - orchards
Ap - pasture
Af - succeeding/old fields

Bu - urban
Bi - industrial
Br - rural residential
Bs - services (communication corridors such as roads, railways, hydro R.O.W.)
Bm - manna
Bd - dredged and disturbed
Bc - cottage/seasonal
Brc - recreation (i.e., golf course)
Bi - institutional
Cb - beach
Cd - dune
Ce - eroding cliff

6.0 CONCLUSIONS

Our estimates of land cover change in Long Point study area are limited by constraints in time, resources, and in defining the size of the study area, however, the results indicate that since 1955 some major changes in land cover have occurred at some locations. Increased expansion of cottage and marina developments has come at the expense of shoreline wetland and marsh areas at the community of Long Point, along the north shore, and at Turkey Point. The main land cover change is the loss of shoreline wetlands and marshes, with an estimated decrease of 1/3 in the Long Point study area since 1955. Urban growth at Port Rowan and other interior communities has reduced local agricultural land but in other locations expansion of agricultural activity in marginal lands, forest areas and wetland/marshes has offset this loss. These trends are not readily apparent at the level of the study area mapping and analysis, however, examination of the study sites clearly illustrates that important shifts in land cover types have developed from 1955 to 1988. The nature of land cover changes in the Long Point area is characterized by site specific and often rapid changes at significant locations along the Inner Bay shoreline.

The results of this analysis correspond with previous studies in the area which have identified the major land cover types in the Long Point area and noted historical changes (Philpott, 1990; Triton Engineering Ltd., 1992). The accuracy of the results of a study such as this can be affected by error due to several factors including the scale of photography and mapping, interpretation of the land cover types, and manual calculations of the land cover type area coverage. It should be noted that the interpretation of land cover types from aerial photography is limited by the ability to detect and identify features that are characteristic of each land cover type. Further detailed field studies and mapping would be required to develop more specific land cover types and assist in analysis. The development of more detailed mapping and analysis methods, perhaps by digitizing the land cover maps and utilizing computer techniques (Geographic Information Systems), could reduce the margin of error in calculation of area coverage. Obtaining more precise and complete aerial photography would also allow for improved interpretation.

It is difficult to determine direct cause-effect relationships for each land cover change. Many of the changes are a result of a combination of several human land uses and/or natural processes. For example, wetland/marsh loss could be attributed to water level changes or vegetation succession leading to variations in emergent vegetation or the removal of vegetation due to channelization and infilling. In the report we attempt to highlight important land cover changes and the possible processes creating those changes. Further research on understanding the nature and rate of land cover changes is necessary especially in those areas such as Long Point that are experiencing rapid changes. The study results identify trends in land cover types and associated land uses that have occurred in the Long Point Study Area from 1955 to 1990. The results indicate the nature and magnitude of shifts in activities, development, and general utilization of the land area over the last thirty five years. No major regional changes in land cover were noted, but significant changes have occurred at sites along the Inner Bay with increased marina and cottage development. In combination with other Long Point Environmental Folio studies, the land cover analysis improves our understanding of changes in environment and development in the Long Point area and can provide the basis for discussion, planning and management responses.

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REFERENCES

- Baker, S. (1986), " Land Use and Land Cover on the North Carolina Barrier Islands: A Proposed Classification System ", *Shore and Beach* , (July, 1986), pp. 8-12.
- Environment Canada (1973), *Shore Erosion on the Great Lakes-St. Lawrence System*, Task Force on Available Shore Erosion Information on the Great Lakes-St. Lawrence System, Ottawa.
- Environment Canada/Ontario Ministry of Natural Resources (1975), *Great Lakes Coastal Zone Atlas*, Canada/Ontario Great Lakes Shore Damage Survey, Toronto, Ontario.
- Lake Erie Shoreline Inventory Task Group (1969), *Lake Erie Shoreline Inventory*. Department of Lands and Forests, Toronto, Ontario.
- Lawrence, P.L. and Nelson, J.G. (1992), *Preparing for a Shoreline Management Plan for the Saugeen Valley Conservation Authority*, A Joint Study of the Heritage Resources Centre, University of Waterloo, Waterloo, Ontario and the Saugeen Valley Conservation Authority, Hanover, Ontario.
- Nelson, J.G., Skibicki, A.J, Stenson, R.E., and Ling Yeung, C. (1991), *Urbanization, Conservation and Development: The Case of Frenchman's Bay, Toronto, Ontario* , Heritage Resources Centre, Technical Paper No. 5, University of Waterloo, Waterloo, Ontario.
- Nelson, J.G., Lawrence, P.L., Beazley, K., Stenson, R., Skibicki, A., Yeung, C.L. and Pauls, K. (1993), *Preparing an Environmental Folio for the Long Point Biosphere Reserve and Region*, Working Note 1, Long Point Environmental Folio Series, Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.
- Philpott Associates (1990), *Shoreline Management Plan*, Long Point Region Conservation Authority, Simcoe, Ontario.
- Triton Engineering Ltd. (1992), *Inventory and Assessment of Land Uses and Shoreline Management Practises*, Report for Working Committee 2, Land Use and Management Task Group, Levels Reference Study, International Joint Commission, Windsor, Ontario.
- Yeung, C.L. (1993), *Analysis of Land Use/Land Cover Change of the Long Point Region from 1974 to 1984 Using Landsat MSS Images*, Technical Note 1, Long Point Environmental Folio Series, Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

APPENDIX

TABLE 3 LAND COVER		LONG POINT STUDY AREA (TOTAL)					
CLASS TYPE		1955		1990		1955-1990	
		CELLS	PERCENT	CELLS	PERCENT	CHANGE	% CHANGE
FOREST	Fp	630	1.9%	86	2.4%	0.5%	28%
	Fd	3384	10.0%	503	13.9%	4.0%	40%
	Fs	1023	3.0%	6	0.2%	-2.8%	-94%
	Fh	300	0.9%	0	0.0%	-0.9%	-100%
	Fw	104	0.3%	0	0.0%	-0.3%	-100%
	Fr	441	1.3%	90	2.5%	1.2%	92%
	FrF	0	0.0%	0	0.0%	0.0%	0%
WETLAND	Wm	7111	20.9%	545	15.1%	-5.8%	-28%
	Ws	275	0.8%	0	0.0%	-0.8%	-100%
SAVANNA	s	0	0.0%	0	0.0%	0.0%	0%
PARKLAND	Sp	5	0.0%	1	0.0%	0.0%	88%
AGRICULTURAL	Ac	16352	48.2%	1979	54.8%	6.7%	14%
	Ao	419	1.2%	0	0.0%	-1.2%	-100%
	Ap	1063	3.1%	0	0.0%	-3.1%	-100%
	Af	24	0.1%	34	0.9%	0.9%	1233%
BUILT-UP AREA	Bu	216	0.6%	36	1.0%	0.4%	57%
	Bi	0	0.0%	0	0.0%	0.0%	0%
	Br	81	0.2%	0	0.0%	-0.2%	-100%
	Bs	666	2.0%	0	0.0%	-2.0%	-100%
	Bm	30	0.1%	40	1.1%	1.0%	1154%
	Bd	478	1.4%	43	1.2%	-0.2%	-15%
	Bc	497	1.5%	92	2.5%	1.1%	74%
	Brc	35	0.1%	0	0.0%	-0.1%	-100%
	Bl	0	0.0%	0	0.0%	0.0%	0%
	COASTAL	Cb	131	0.4%	27	0.7%	0.4%
DEPOSITS	Cd	13	0.0%	0	0.0%	0.0%	-100%
	Ce	13	0.0%	6	0.2%	0.1%	334%
OPEN WATER	Op	668	2.0%	116	3.2%	1.2%	63%
CLASS TOTALS		1955		1988		1955-1990	
		CELLS	PERCENT	CELLS	PERCENT	CHANGE	% CHANGE
FOREST		5882	17.3%	685	19.0%	1.7%	10%
WETLAND		7386	21.7%	545	15.1%	-6.7%	-31%
AGRICULTURAL		17858	52.6%	2013	55.8%	3.2%	6%
BUILT-UP AREA		2003	5.9%	211	5.8%	-0.1%	-1%
COASTAL DEPOSITS		157	0.5%	33	0.9%	0.5%	98%
OPEN WATER		668	2.0%	116	3.2%	1.2%	63%
OTHER		5	0.0%	1	0.0%	0.0%	88%

Table 4		Land Cover Data		Long Point Site	
Class Type	1955 % Cover	1988 % Cover	Change	%Change	
Fd	0	1	1	100	
Fr	2	1	-1	-50	
Wm	53	53	0	0	
Sp	2	2	0	0	
Bs	5	11	6	120	
Bm	3	2	-1	-33	
Bd	1	0	-1	-100	
Bc	25	27	2	8	
Cb	5	5	0	0	
Cd	2	0	-2	-100	
Op	4	0	-4	-100	
Table 5		Land Cover Data		Causeway Site	
Class Type	1955 % Cover	1988 % Cover	Change	%Change	
Wm	71	55	-16	-23	
Bs	4	4	0	0	
Bm	1	8	7	700	
Bd	2	0	-2	-100	
Bc	6	5	-1	-17	
Cb	1	2	1	100	
Op	14	26	12	86	
Table 6		Land Cover Data		Port Rowan Site	
Class Type	1955 % Cover	1988 % Cover	Change	%Change	
Fd	2	0	-2	-100	
Fw	0	1	1	100	
Fr	9	10	1	11	
Wm	8	6	-2	-25	
Ac	54	46	-8	-15	
Ao	7	0	-7	-100	
Bu	14	30	16	114	
Bs	4	4	0	0	
Bm	1	3	2	200	
Bd	1	1	0	0	

Table 7		Land Cover Data		North Shore Site	
Class Type	1955 % Cover	1988 % Cover	Change	%Change	
Fd	17	13	-4	-24	
Fr	5	5	0	0	
Wm	5	5	0	0	
Ac	58	38	-20	-34	
Bu	3	21	18	600	
Bs	7	8	1	14	
Bm	4	10	6	150	
Bc	1	0	-1	-100	
Table 8		Land Cover Data		Turkey Point	
Class Type	1955 % Cover	1988 % Cover	Change	%Change	
Fd	8	0	-8	-100	
Fs	27	22	-5	-19	
Wm	41	17	-24	-59	
Bs	3	7	4	133	
Bm	0	8	8	100	
Bd	11	11	0	0	
Bc	7	20	13	186	
Cb	3	2	-1	-33	
Op	0	13	13	100	

Note: All numbers are rounded to the nearest percentage and values less than 0.5% are reduced to 0.

Change is the absolute difference between the 1955 and 1988/1990 values
(e.g. Turkey Point Fs - 27% in 1955, 22% in 1988 change is -5%)

Percentage change is calculated as the proportion of the change to the original 1955 value
(e.g. Turkey Point Fs - 27% in 1955, 22% in 1988, % change = $5/27 = 19\%$)