Current Status, Trends and Distributions of Aquatic Wildlife along the Canadian Shores of Lake Huron

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EXECUTIVE SUMMARY

The numerous islands and extensive shoreline of Lake Huron support a wide diversity and abundance of aquatic wildlife. This report examines the current status, trends and distributions of aquatic populations of colonial waterbirds, waterfowl, birds of prey, amphibians, reptiles and fish-eating mammals such as mink and otter on the Canadian shores of Lake Huron. The status of habitat, including coastal wetlands, for some of these species is also reviewed.

Approximately 160,000 nesting pairs of colonial waterbirds (i.e., nests) were counted in surveys conducted by the Canadian Wildlife Service (CWS) from 1998-2001 on Lake Huron. Compared to previous CWS surveys conducted 10 years earlier on Lake Huron, lake-wide annual increases in nest numbers were found for Double-crested Cormorants, Great Black-backed Gulls, Black-crowned Night-Herons and Great Egrets; lake-wide annual declines in nest numbers were found for Herring Gulls, Caspian Terns, Common Terns, Ring-billed Gulls and Great Blue Herons. Declines in nesting marsh birds such as Black Terns and Forster's Terns were also found between survey periods. Significant changes in abundance and occurrence were reported for some marsh-nesting birds and amphibians, respectively, in the Lake Huron basin as identified in the Marsh Monitoring Program from 1995-2001. Amphibian populations occurring inland in the Lake Huron basin are also being monitored through the Amphibian Road Call Count and Backyard Frog Survey programs; population trends are not yet available but will be in the near future. Little information is available with regard to waterfowl usage during periods of migration and breeding along the Canadian Lake Huron shoreline. Georgian Bay is an important staging and breeding area for waterfowl on the Great Lakes. Since numbers of Bald Eagle and Osprey nests are not routinely monitored along most of the Canadian Lake Huron shoreline, changes in the population sizes of both species over the past decade are not clear at this time. Based on trapper evidence, mink and otter are generally considered common along the shoreline.

Currently, the health of populations of aquatic wildlife found on Lake Huron, to a large extent, does not appear to be impaired. However, stressors including changes in relative food availability, availability of nesting sites, interactions and/or competition among nesting species, contaminants, changes in water levels and habitat loss through development may be slowly modifying the highly diverse population structure of the Lake Huron ecosystem. Current contaminant levels in colonial waterbird eggs are likely not affecting the reproductive success of these species. Contaminants in waterfowl were below those considered harmful to wildlife and human consumption. Mercury levels in mink and otter tissues were below toxic threshold levels. While levels of contaminants are likely not high enough to elicit population-level effects in Lake Huron Bald Eagles and Osprey, factors such as limited food availability and elevated levels of metals may be of increasing concern for these top predators. There are over 200 coastal wetlands on Lake Huron and St. Marys River, many of which are located near or found in natural areas; the extent of wetland loss on the Canadian shoreline of Lake Huron is unknown. Lake Huron is one of the most diverse and important sites for provincially significant species compared to the other Ontario Great Lakes and connecting channels. It contains approximately one-half of all provincially significant coastal wetland species.

RÉSUMÉ ADMINISTRATIF

Les nombreuses îles et le long littoral du lac Huron abritent une grande diversité et une forte abondance d'espèces aquatiques. Dans ce rapport, nous examinons la situation, les tendances et la distribution des populations aquatiques d'oiseaux coloniaux, de rapaces, d'amphibiens, de reptiles et de mammifères piscivores comme le vison et la loutre sur les rives canadiennes du lac Huron. Nous examinons aussi la situation de l'habitat, notamment les marais littoraux, pour certaines de ces espèces.

Environ 160 000 couples nicheurs d'oiseaux coloniaux (c'est-à-dire de nids) ont été dénombrés dans les relevés effectués au lac Huron par le Service canadien de la faune (SCF) de 1998 à 2001. Par rapport aux relevés menés 10 ans plus tôt au lac Huron par le SCF, nous avons noté des augmentations annuelles à l'échelle panlacustre du nombre de nids de Cormoran à aigrettes, de

Goéland marin, de Bihoreau gris et de Grande Aigrette; par contre, nous avons observé des baisses annuelles à l'échelle panlacustre du nombre de nids de Goéland argenté, de Sterne caspienne, de Sterne pierregarin, de Goéland à bec cerclé et de Grand Héron. Des baisses chez les oiseaux nicheurs palustres comme la Guifette noire et la Sterne de Forster ont également été observées entre les relevés. D'importants changements dans l'abondance et l'occurrence ont été signalés respectivement pour certains oiseaux nicheurs palustres et pour certains amphibiens, dans le bassin du lac Huron, d'après le Programme de surveillance des marais, entre 1995 et 2001. Les populations d'amphibiens présentes à l'intérieur des terres dans le bassin du lac Huron sont aussi surveillées dans le cadre du Relevé des amphibiens en bordure de chemin et du Relevé des amphibiens dans l'arrière-cour; les tendances des populations ne sont pas encore établies mais le seront bientôt. On dispose de peu d'information sur l'utilisation du littoral canadien du lac Huron par la sauvagine pendant les périodes de migration et de nidification. La baie Georgienne est une importante zone d'escale et de reproduction pour la sauvagine dans les Grands Lacs. Étant donné qu'on ne surveille pas systématiquement les nids de Pygargue à tête blanche et de Balbuzard pêcheur sur la plus grande partie du littoral canadien du lac Huron, nous n'avons pas d'idée claire des changements survenus dans la taille des populations de ces deux espèces au cours de la dernière décennie. D'après les données de trappage, le vison et la loutre semblent être communs le long du littoral.

À l'heure actuelle, la santé des populations d'espèces aquatiques du lac Huron semble, dans une grande mesure, se maintenir. Toutefois, des agents de stress comme les changements dans la disponibilité relative de la nourriture, la disponibilité des sites de nidification, les interactions et/ou la compétition entre les espèces nicheuses, les contaminants, les modifications du niveau de l'eau et la perte d'habitat due au développement peuvent modifier lentement la structure très diversifiée des populations de l'écosystème du lac Huron. À l'heure actuelle, les teneurs en contaminants des œufs d'oiseaux aquatiques coloniaux ne devraient pas nuire au succès reproductif de ces espèces. Les concentrations de contaminants chez la sauvagine étaient inférieures aux niveaux jugés dangereux pour la faune et pour la consommation humaine, et les teneurs en mercure des visons et des loutres étaient inférieures aux seuils de toxicité. Si les concentrations de contaminants ne sont vraisemblablement pas assez élevées pour provoquer des effets au niveau des populations chez les Pygargues à tête blanche et les Balbuzards pêcheurs du lac Huron, des facteurs comme la limitation des ressources alimentaires et les fortes concentrations de métaux peuvent susciter des inquiétudes croissantes pour ces prédateurs supérieurs. On compte sur le lac Huron et la rivière St. Marys plus de deux cents marais littoraux qui se trouvent souvent dans des aires naturelles ou à proximité; on ne connaît pas l'ampleur de la disparition des milieux humides sur le littoral canadien du lac Huron. Le lac Huron est l'une des zones les plus diverses et les plus importantes pour les espèces présentant un intérêt à l'échelle provinciale comparativement aux autres Grands Lacs qui ont une façade en Ontario et à leurs voies interlacustres, puisqu'on y trouve près de la moitié des espèces des marais littoraux présentant un intérêt à l'échelle provinciale.

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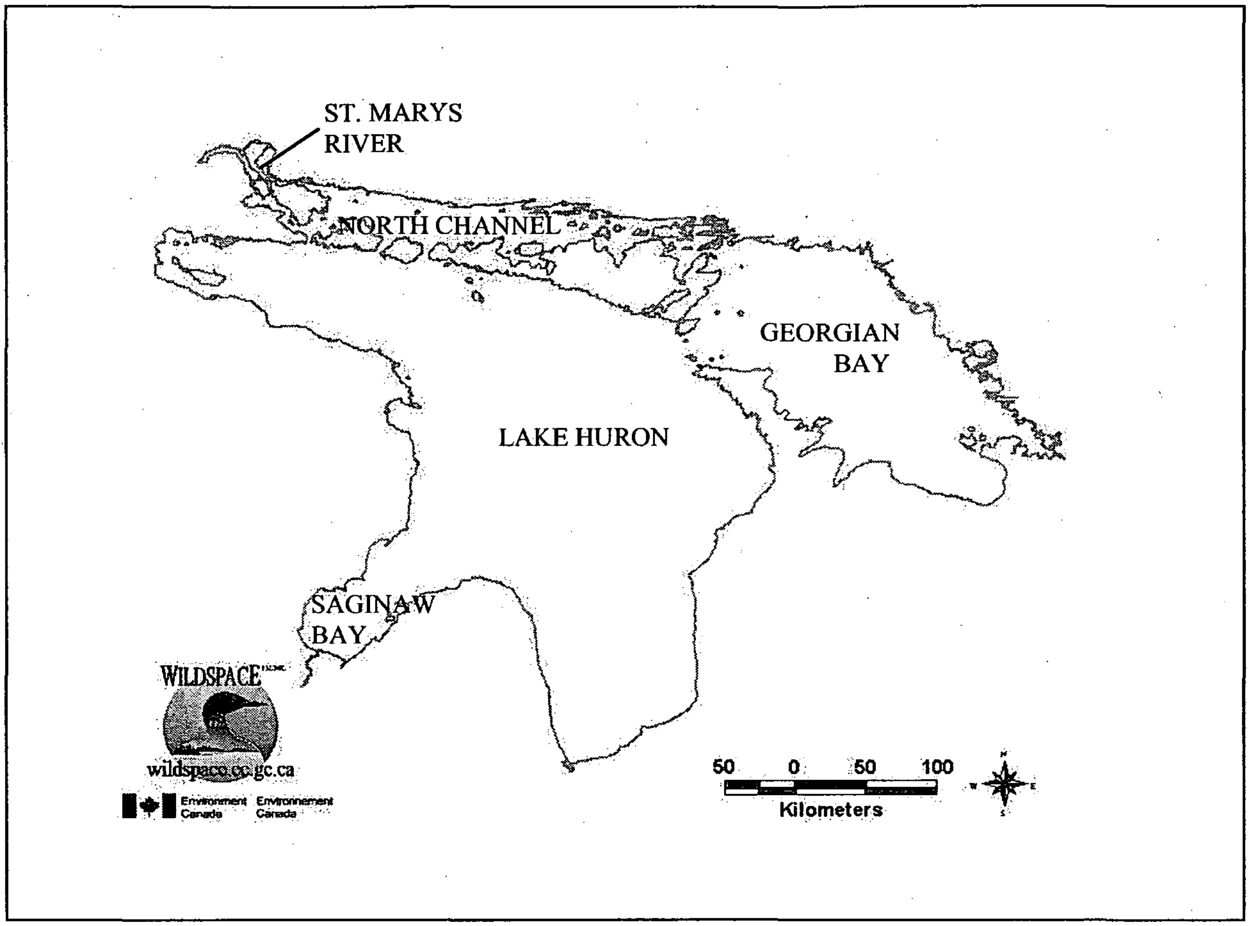
I. INTRODUCTION

Lake Huron is one of the largest of the Great Lakes in surface area and volume and is one of the largest freshwater lakes in the world. Including islands, the Canadian shoreline of Lake Huron and Georgian Bay is 4,810 kilometres in length (Environment Canada 1994). It consists of four interconnected bodies of water that include the main lake, the North Channel and Georgian Bay, and Saginaw Bay. The shoreline surrounding Georgian Bay, the North Channel and a portion of the main body of Lake Huron are found in the province of Ontario and fall within the Canadian boundary; Saginaw Bay and the remainder of the main body of Lake Huron are found in the state of Michigan and fall within the United States' jurisdiction (Figure 1). Two of the major inflows into Lake Huron are the St. Marys River from Lake Superior and the Straits of Mackinac from Lake Michigan. Lake Huron discharges at its southern end into the St. Clair River, Lake St. Clair, Detroit River and into Lake Erie. Lake Huron is unique relative to the other Great Lakes in that the shoreline is largely undeveloped and sparsely populated, with numerous islands and remote stretches of shoreline.

This report will focus on the status of aquatic-feeding wildlife on the Canadian shores of Lake Huron. In some cases, data from Saginaw Bay in Michigan have been included. Aquatic-feeding wildlife (henceforth known as "aquatic wildlife") feed predominately from the aquatic ecosystem and in this report include: colonial waterbirds, birds of prey such as the Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliaetus*), waterfowl, amphibians, reptiles such as the snapping turtle (*Chelydra serpentina*), and mammals such as river otter (*Lutra canadensis*) and mink (*Mustela vison*). The Canadian Wildlife Service (CWS) and the U.S. Fish and Wildlife Service (USFWS) have been routinely conducting 10-year surveys of colonial waterbirds nesting on the Great Lakes since the 1970s. On the Canadian portion of Lake Huron, three lake-wide censuses have been performed by CWS beginning in 1980 (Weseloh *et al.* 1986; Blokpoel and Tessier 1997; CWS unpublished). Colonial waterbirds which have been surveyed for these lake-wide inventories include Herring Gulls (*Larus argentatus*), Double-crested Cormorants (*Phalacrocorax auritus*), Caspian Terns (*Sterna caspia*), Common Terns (*Sterna hirundo*), Ring-billed Gulls (*Larus delawarensis*), Great Black-backed Gulls (*Larus marinus*), Black-crowned Night-Herons (*Nycticorax nycticorax*), Great Blue Herons (*Ardea herodias*) and Great Egrets (*Ardea alba*). Surveys of marsh-nesting colonial birds, such as Black Tern (*Chlidonias niger*) and Forster's Tern (*Sterna forsteri*), along the Lake Huron shoreline were initiated in 1991. High levels of contaminants found in colonial waterbird eggs were associated with reproductive failures reported in the Great Lakes in the 1970s (Gilman *et al.* 1977; Weseloh *et al.* 1983). While current levels of contaminants are much lower compared to historical levels, contaminant levels for aquatic species on Lake Huron, where available, are reported. The status of suitable habitat, particularly coastal wetlands, for some aquatic species is also summarized. Lists of natural areas identified along the Canadian Lake Huron shoreline and provincially significant species found in Lake Huron and St. Marys River coastal wetlands are also provided.

Figure 1. Map of Lake Huron showing the North Channel, Georgian Bay, St. Marys River and Lake Huron proper (main basin of Lake Huron). Saginaw Bay is found in the state of Michigan.



II. CURRENT STATUS, TRENDS AND DISTRIBUTIONS OF POPULATIONS ON LAKE HURON

a) Colonial Waterbirds

i) Herring Gull (*Larus argentatus*)

Herring Gulls are large, omnivorous colonial waterbirds which are widely distributed throughout the Great Lakes. They are also the only species which are year-round residents of the Great Lakes. Over the last three decades, Herring Gulls on the Great Lakes and connecting channels have formed a large, stable population of approximately 60,000 nesting pairs with the greatest number found on Lake Huron (approximately 42%) compared to the other Great Lakes (Morris *et al.* 2003). During the three periods (1976-1980, 1989-1990 and 1997-2000) when Herring Gull nests were surveyed on the Great Lakes, trends for four of the Great Lakes showed an increase followed by a decrease in nest numbers. On Lake Huron there was a steady decline in nest numbers from the first through the third census periods (Figure 2). On the Canadian side of Lake Huron, the number of Herring Gull nests declined from 24,640 nests at 441 colonies in 1989 to 22,267 nests at 410 colonies in 1999 (Blokpoel and Tessier, 1997; CWS unpublished), representing a decline of 9.6% during the 10-year period. Comparing only those colonies surveyed during both time periods, the annual rate of decline for Lake Huron was -1.6%; annual rates of decline were observed in two Lake Huron regions: Georgian Bay (-2.9%) and main basin of Lake Huron (-0.8%) while an annual rate of increase was observed in the North Channel (+0.9%). From 1980 to 1989, Blokpoel and Tessier (1997) reported a lake-wide decline of 2.4% in the number of Herring Gull nests on the Canadian side of Lake Huron; declines ranged from 1.1% to 4.0% for the three regions of Lake Huron.

Temporal trends in the number of Herring Gulls nesting on Lake Huron versus the other Great Lakes may be related to an increase in the carrying capacity for nesting Herring Gulls in response to an unusually high abundance of forage fish prey in Lake Huron in the 1970s. The abundance of alewife (*Alosa pseudoharengus*), an important food item for Herring Gulls (Fox *et al.* 1990), was relatively high in the 1970s but then declined to low levels in 1980 (Ebener *et al.* 1995). The species began to recover during the 1980s but then abundance again declined steadily from 1987 to 1991, until lake-wide abundance was equal to low levels reported in early 1980s.

Herring Gull colonies are widely distributed along the north shore of Georgian Bay and the North Channel and along the north shore of the main basin of Lake Huron (Figure 3a). In 1999, the largest Herring Gull colony was on Chantry Island off the eastern shoreline of Lake Huron (3,457 nests). The 10 largest Herring Gull colonies ranged in size from 225 to 3,457 nests and represented 41% of the total number of nesting pairs of Herring Gulls on the Canadian side of Lake Huron (Figure 3b). Canadian Lake Huron sites have more than four times the number of nesting pairs of Herring Gulls compared to U.S. sites.

Figure 2. The number of Herring Gull nests (=pairs) present during each of three census periods (1976-1980; 1989-1990; 1997-2000) (from Morris *et al.* 2003). Counts from U.S. and Canadian Great Lakes and their associated water bodies were pooled. The number above each histogram bar is the total number of sites (colonies) that contained at least one Herring Gull nest.

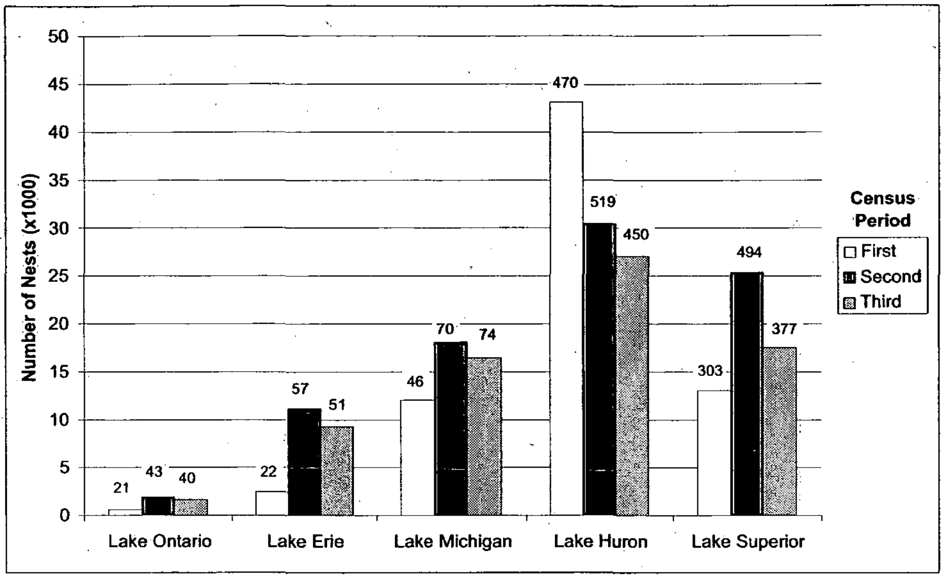
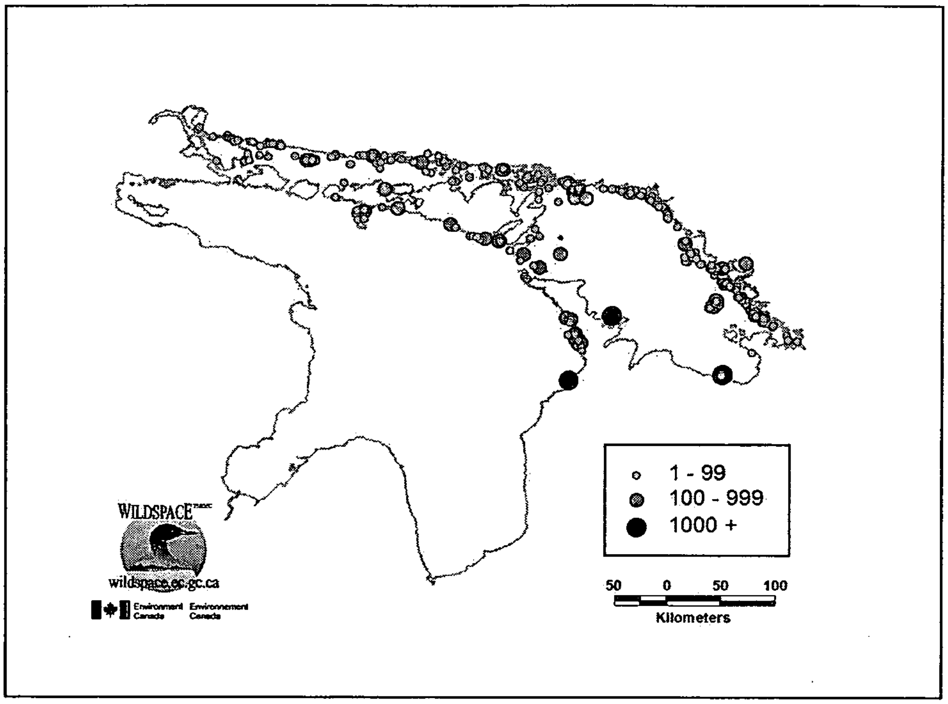
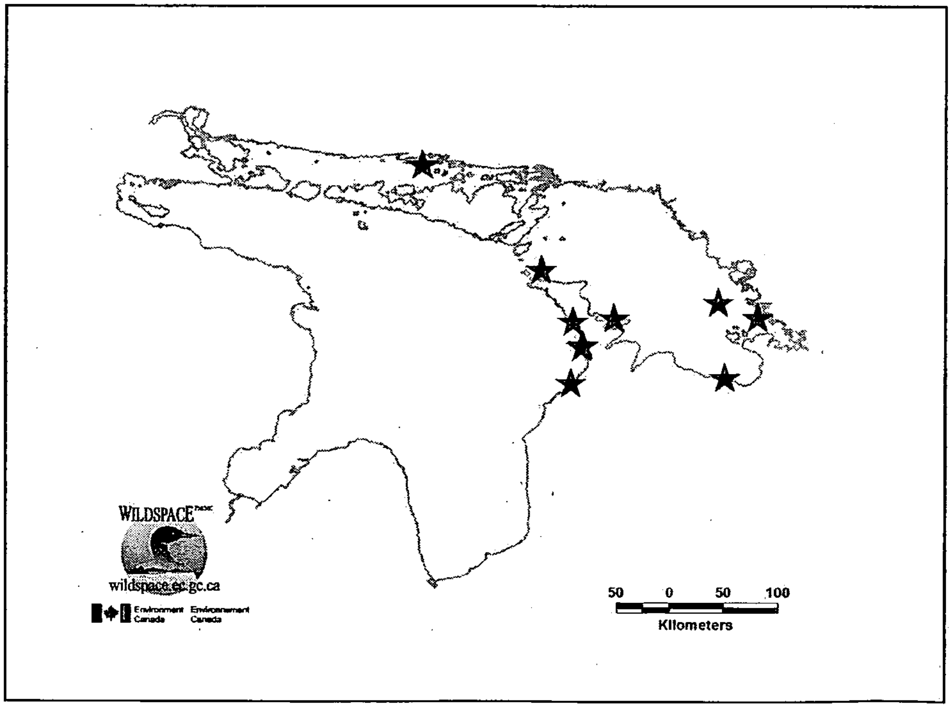


Figure 3. Distribution of 410 Herring Gull colonies, corresponding colony sizes (i.e., numbers of nests) and the location of the 10 largest colonies on the Canadian side of Lake Huron in 1999.



a) Distribution and corresponding colony sizes.



b) Location of 10 largest Herring Gull colonies. Note that two colonies on Lake Huron (main basin) are adjacent to one another and appear as one colony.

ii) Double-crested Cormorant (*Phalacrocorax auritus*)

Double-crested Cormorants are large, migratory fish-eating birds which have been very successful in recovering from the effects of contaminants in the Great Lakes since the 1970s. In 2000, the total number of Double-crested Cormorant nests (=pairs) on the Canadian side of the Great Lakes and connecting channels was approximately 76,000 (this number also includes those cormorants surveyed in immediately adjacent U.S. waters of the Great Lakes (i.e., those within foraging distance of the border; maximum feeding range is 40 kilometres for cormorants [Custer and Bunck 1992]). Lake Huron has the greatest number of nesting Double-crested Cormorant pairs with approximately 45% of the total of those found on the Canadian Great Lakes (Figure 4; Weseloh *et al.* 2002). From 1990 to 2000, the lake-wide annual rate of change for Double-crested Cormorant pairs (at sites counted in both years) on Lake Huron was +12.1%. The annual rates of change by region were as follows: +13.9% for the main basin of Lake Huron, +11.2% for the North Channel and St. Marys River and +11.9% for Georgian Bay (Weseloh *et al.* 2002). These annual rates of increase lie between rates of increase found for the other four Great Lakes during this period (range: +5.1% for Lake Superior to +22.1% for Lake Erie). From 1990 to 2000, the population increased 3.68 fold on the main basin of Lake Huron, 2.90 fold at North Channel and St. Marys River and 3.08 fold on Georgian Bay. Growth rates observed in the 1990s were less than the rates that occurred from 1980 to 1990 (range: +31.8% for Lake Erie to +39.8% for Lake Huron) (Weseloh *et al.* 2002). The precise reason(s) for this decrease in the growth rates are not known but could include: nest sites and/or food availability becoming limited at some colonies (see below) or in some areas authorized and unauthorized control measures or disturbance at selected sites, particularly in the North Channel and Georgian Bay (Weseloh *et al.* 2002).

In total, 85 Double-crested Cormorant colonies were counted on the Canadian side of Lake Huron (not including colonies in immediately adjacent U.S. waters), scattered mostly on the north and eastern shores of the main basin of Lake Huron, along the north shore of Georgian Bay and throughout the North Channel (Figure 5a). In 2000, Chantry Island had the greatest number of nesting pairs (1,429) on the main basin of Lake Huron. West Island in the North Channel had the greatest number of pairs of cormorants (1,835). South Watcher Island had the greatest number of pairs (1,839) followed by Gull Island (1,757) in Georgian Bay in 2000. The 10 largest Double-crested Cormorant colonies ranged in size from 678 to 1,835 nests and represented 40% of the total number of nesting pairs of Double-crested Cormorants on the Canadian side of Lake Huron (Figure 5b). There were only two colonies along the southern and southwestern shore of Georgian Bay.

As the number of cormorants in the Great Lakes increases annually, concerns regarding the health and sustainability of local fisheries have been raised, particularly in areas where large numbers of cormorants are nesting. While cormorant diet studies reveal that they feed only on a small percentage of commercial fish (Weseloh *et al.* 2002), fish harvesters feel cormorants are responsible for declines in once-abundant local fish populations. In 2000, the Ontario Ministry of Natural Resources (OMNR) initiated an experimental egg-oiling study to assess the impacts of cormorant predation on local fish stocks in Georgian Bay and the North Channel (D. Reid, OMNR, pers. comm.). Seven 10 x 10 kilometre sites (three sites in Georgian Bay and four sites in the North Channel) are being monitored (with six of the sites having oiling phased in) in increasing numbers over a number of years. The cormorant population will be monitored annually through nest counts and aerial surveys; fish populations will be monitored using standard assessment methods including trap netting, electroshocking and hydroacoustics.

Many factors must be considered when attempting to assess the impact of predation by cormorants on the local fish population. These factors include the number of cormorants in a given area, their residence time in that area, and the size of the fish population of concern. A satellite telemetry study by the New York State Department of Environmental Conservation at Little Galloo Island in U.S. waters of Lake Ontario in 2000 and 2001 found that while egg oiling activities did not result in complete abandonment of the colony, it may have influenced temporary relocation of some cormorants to other colony sites (Dorr *et al.* 2003), which may create a problem for other fishers.

Figure 4. The number of Double-crested Cormorant nests (=pairs) present in the Canadian Great Lakes and immediately adjacent areas in 1990 and 2000 (from Weseloh *et al.* 2002). Counts from Lake Ontario and the St. Lawrence River are pooled; counts from Lake Erie and the Niagara River are pooled. The number above each histogram bar is the total number of colonies that contained at least one Double-crested Cormorant nest.

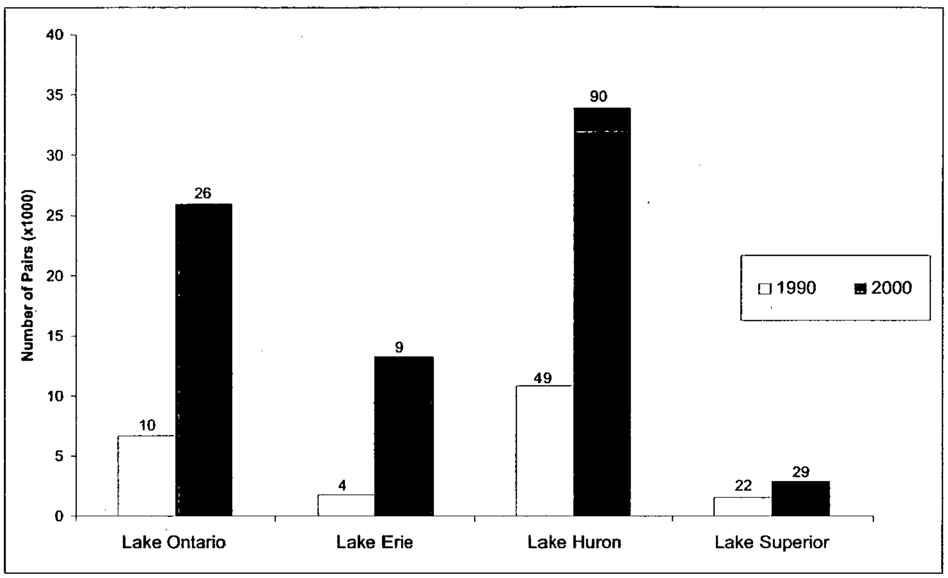
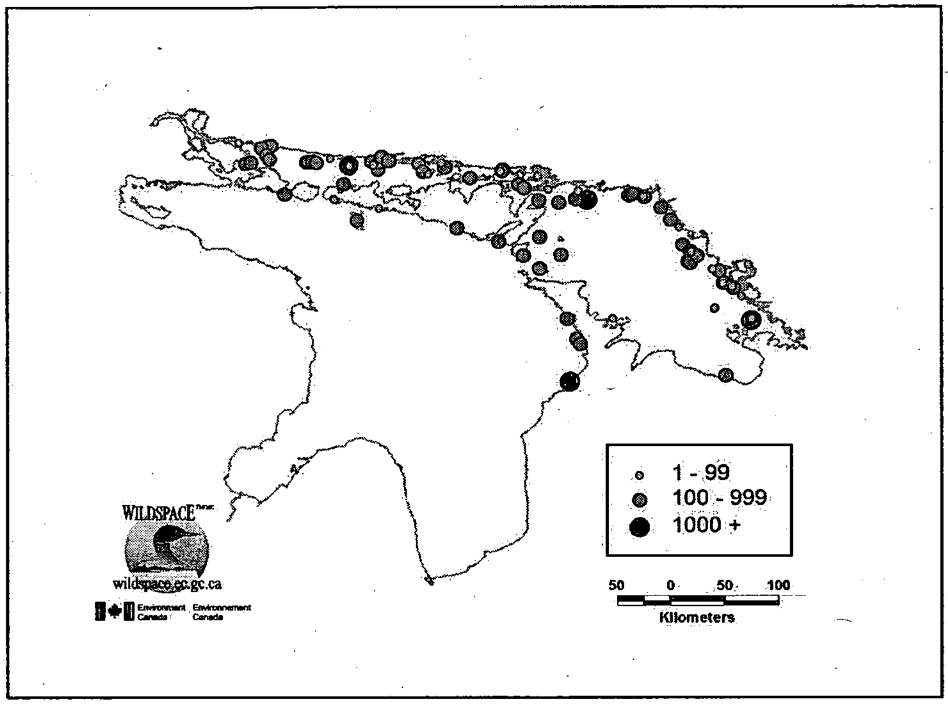
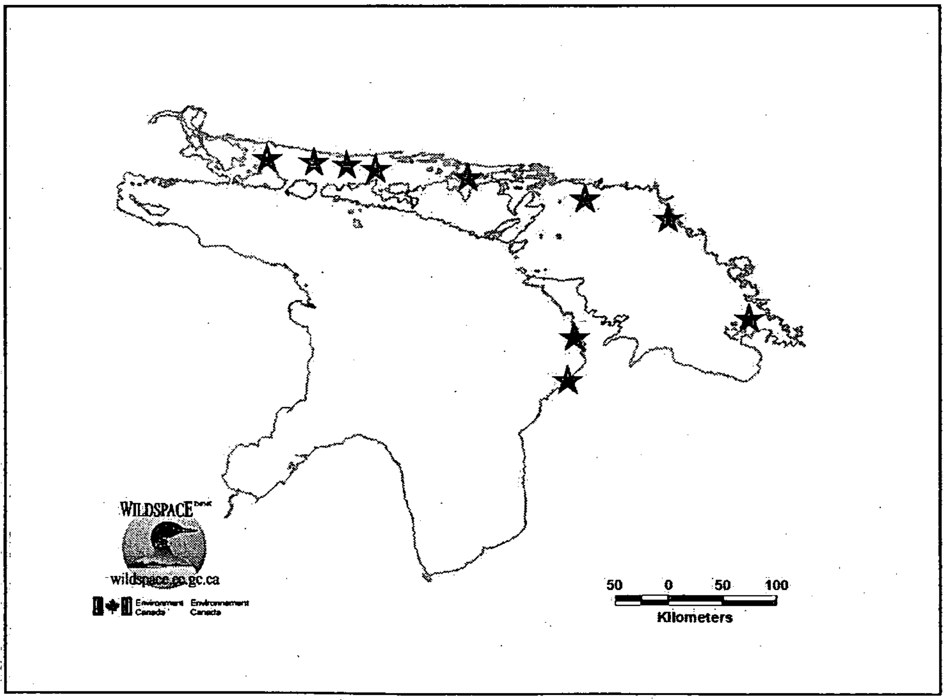


Figure 5. Distribution of 85 Double-crested Cormorant colonies, corresponding colony sizes (i.e., numbers of nests) and the location of the 10 largest colonies on the Canadian side of Lake Huron in 2000.



a) Distribution and corresponding colony sizes.



b) Location of 10 largest Double-crested Cormorant colonies.

iii) Caspian Tern (*Sterna caspia*)

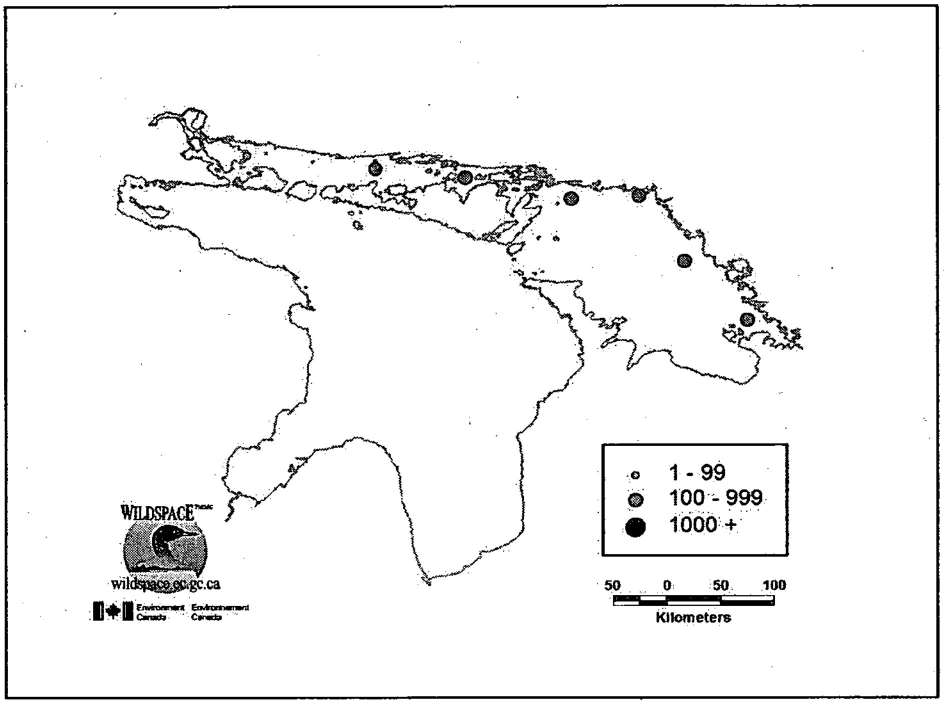
In 1998, 1,429 Caspian Tern nests were counted at seven colonies on the Canadian side of Lake Huron, four on Georgian Bay and three on the North Channel (Figure 6); no nests were reported in the main basin of Lake Huron (CWS, unpublished). In 1989, 2,295 Caspian Tern nests were reported at eight colonies on Georgian Bay and the North Channel (Blokpoel and Tessier 1997); compared to the 1998 census data, this represents a decrease of 38% in nest numbers since 1989. Comparing only those colonies surveyed in both 1989 and 1998, an annual rate of decline of -5.1% for Caspian Terns on Lake Huron is evident. Annual rates of decline were slightly higher on the North Channel than on Georgian Bay and equal to -6.2% and -4.8%, respectively. This is in contrast to nest counts in 1980 versus 1989, when the population increased slightly from 2,138 nests to 2,295 nests, representing a mean annual growth rate of +0.8% (Blokpoel and Tessier 1997).

A comparison of Caspian Tern nest numbers recorded in 1989 and 1998 reveals that at seven out of nine colonies a decrease in nest numbers is evident, with two colonies becoming inactive in 1998: Halfmoon Island and North Watcher Island, both in Georgian Bay. The largest Caspian Tern colony was on South Watcher Island (571 nests) in Georgian Bay. One new site, Ironside Island near St. Joseph Island in the North Channel, had two Caspian Tern nests in 1998. Concurrent with declines in the number of Caspian Tern nests at seven colonies from 1989 to 1998 was a decrease in the number of ring-billed nests at four of these sites from 1989 to 1999 as well as an increase in Double-crested Cormorant nests at all seven of these sites from 1989 to 2000. At islands where all three species nest, competition for nesting sites among Caspian Tern, Double-crested Cormorants and Ring-billed Gulls may be of increasing concern. These islands include: The Cousins Islands and Elm Island in the North Channel and Papoose Island, largest island of Gull Rocks, north island of South Limestone Island, and South Watcher Island on Georgian Bay.

Overall, the Great Lakes Caspian Tern population is increasing but this may be partially due to large increases in the numbers of Caspian Terns nesting on Little Galloo Island on the U.S. side of Lake Ontario (D.V. Weseloh pers. comm.; Cuthbert *et al.* 2001). In the 1997 U.S. Lake Huron census of Caspian Terns, 389 Caspian Tern nests were counted at three colonies on the U.S. side of Lake Huron; numbers of Caspian Tern nests on the U.S. side of Lake Huron have increased by 42% since the 1989 U.S. census (Cuthbert *et al.* 2001). Based on banding data, there is some speculation that there may be emigration of Caspian Terns from Canadian colonies to U.S. colonies in the Great Lakes (D.V Weseloh pers. comm).

Caspian Terns are sensitive to human disturbance which, if high enough, may cause them to abandon the colony for the year. The presence of people at a colony can cause adult terns to leave their nests unattended, thereby exposing their eggs or chicks to predation by gulls. For these reasons, colonies of Caspian Terns should be protected from human disturbance during the nesting season.

Figure 6. Distribution of seven Caspian Tern colonies and corresponding colony sizes (i.e., numbers of nests) on the Canadian side of Lake Huron in 1998.

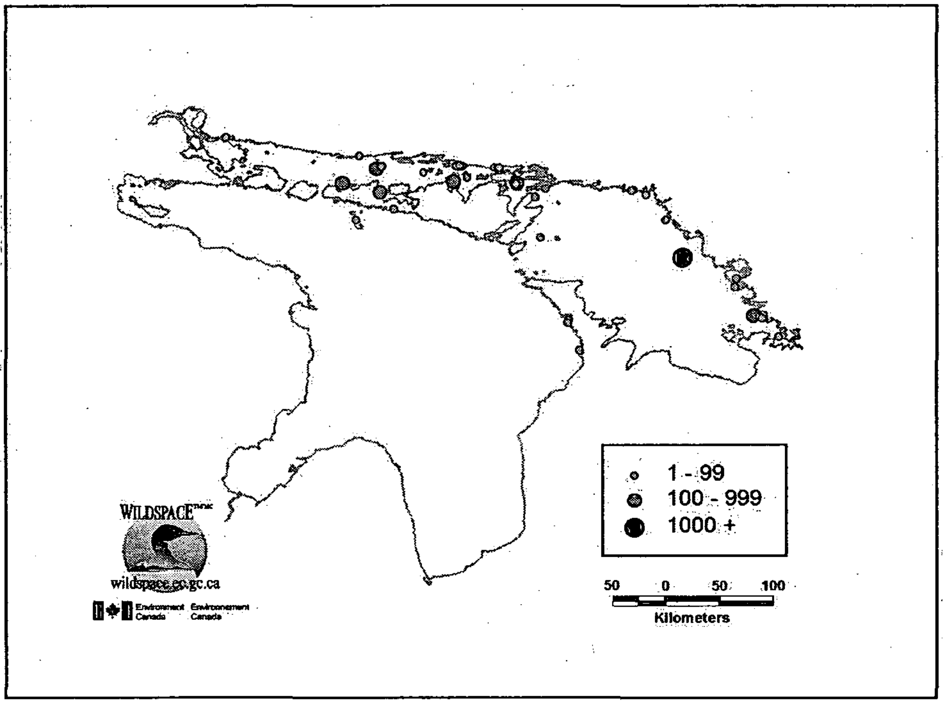


iv) Common Tern (*Sterna hirundo*)

During the 1998/99 census of Common Tern nests on the Canadian side of the Great Lakes, 44 of 62 Great Lakes colonies were found on Lake Huron (Figure 7). No Common Tern nests were found on Lake Superior during this period. In total, 3,874 Common Tern nests were counted on Lake Huron, representing 68% of the total number of nests found on the Great Lakes. Of these, 1,829 nests were found in Georgian Bay, 1,911 nests were in the North Channel and 134 nests were found on the main basin of Lake Huron. In comparison in 1989, 4,167 nests were counted at 56 colonies (Pekarik *et al.* 2003). This represents a total decrease of 7% in the overall population between 1989 and 1999. When colonies which were surveyed in both time periods are compared, the annual rate of decline for all of Lake Huron is equal to -0.4%. However, when separate regions are examined, annual rates of decline were noted for Georgian Bay and the main basin of Lake Huron of -2.3% and -8.6%, respectively, while an annual rate of increase of +3.2% was evident for the North Channel. Blokpoel and Tessier (1997) determined an annual rate of decline equal to -1.7% from 1980 to 1989 for the Canadian side of Lake Huron.

The largest colony of Common Terns was found on North Limestone Island in Georgian Bay (1,339 nests) accounting for 73% of the Common Tern nests found in that region. The largest colony in the North Channel was on Batture Island (478 nests); five islands had at least 130 nests which accounted for 82% of the nests found there.

Figure 7. Distribution of 44 Common Tern colonies and corresponding colony sizes (i.e., numbers of nests) on the Canadian side of Lake Huron in 1999.

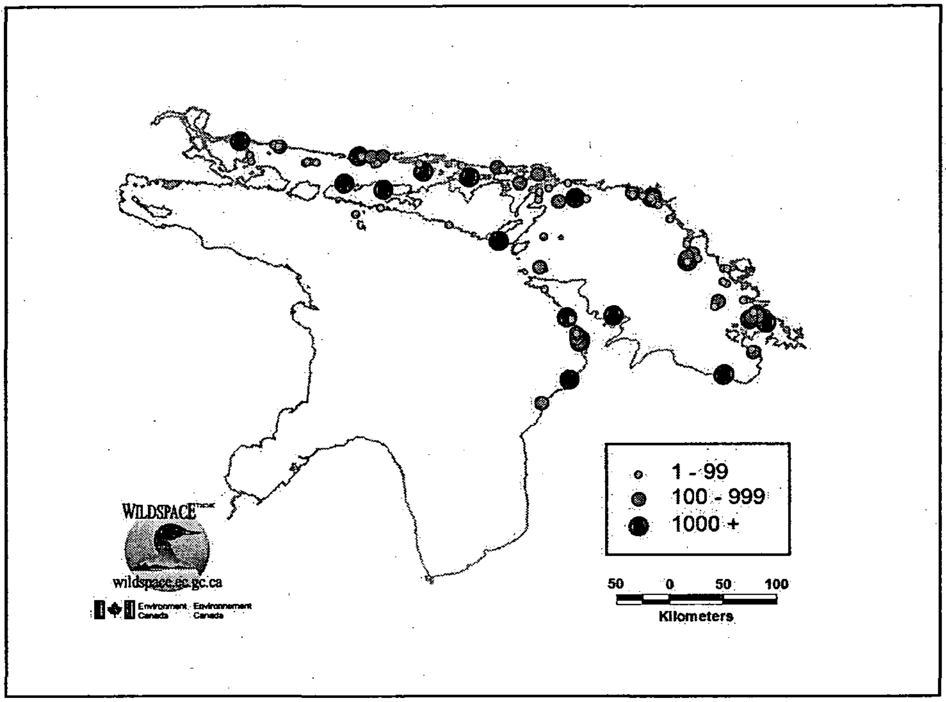


v) Ring-billed Gull (*Larus delawarensis*)

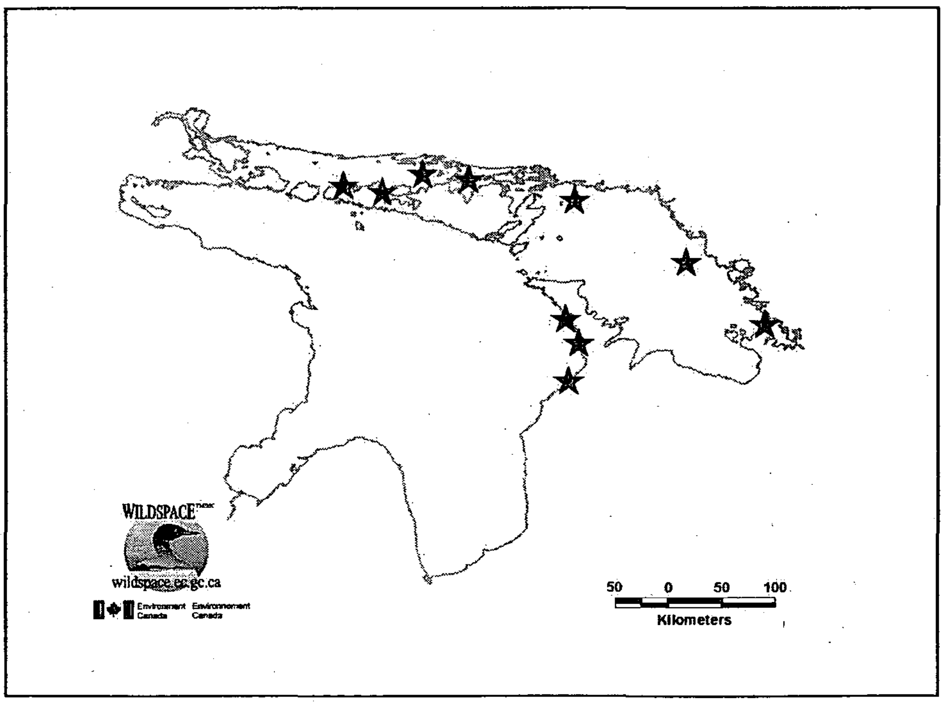
Ring-billed Gulls are opportunistic feeders, highly adaptable and are the most abundant colonial waterbird found on the Great Lakes. Unlike Herring Gulls, Ring-billed Gulls on the Great Lakes migrate to the Gulf States, primarily Florida, in the winter. During the 1999/2000 Ring-billed Gull census, 99,381 Ring-billed Gull nests at 96 colonies were counted on the Canadian side of Lake Huron making this species the most abundant colonial waterbird species on Lake Huron. Most of the nests were found on Georgian Bay (40% of the total), followed by the North Channel (35%) and the main basin of Lake Huron (25%). In 1989, 150,218 Ring-billed Gull nests were counted at 96 colonies (Blokpoel and Tessier 1997); compared to the 1999/2000 survey, this represents a 34% decrease in nest numbers since 1989. When only those colonies which were counted in both years are compared, an annual lake-wide decline of -4.6% in nest numbers is apparent. When the three separate regions of Lake Huron are examined, very similar annual rates of declines are observed on Georgian Bay (-4.9%), the North Channel (-5.2%) and the main basin of Lake Huron (-3.1%). This pattern differs from what was observed during the 1980 and 1989 census periods, when the population increased from 128,849 nests at 80 colonies to 150,218 nests at 96 colonies in 1989, representing a mean annual lake-wide growth rate of +1.7% (Blokpoel and Tessier 1997).

Colonies were distributed along Georgian Bay, the North Channel and along the western shore of the Bruce Peninsula (Figure 8a). In 2000, the largest colony was at Papoose Island on Georgian Bay (10,578). The 10 largest Ring-billed Gull colonies ranged in size from 3,667 to 10,578 nests and represented 72% of the total number of nesting pairs of Ring-billed Gulls on the Canadian side of Lake Huron (Figure 8b).

Figure 8. Distribution of 96 Ring-billed Gull colonies, corresponding colony sizes (i.e., numbers of nests) and the location of the 10 largest colonies on the Canadian side of Lake Huron in 1999/2000.



a) Distribution and corresponding colony sizes.



b) Location of 10 largest Ring-billed Gull colonies.

vi) Great Black-backed Gull (*Larus marinus*)

The Great Black-backed Gull is the largest North American gull and is essentially a maritime species breeding off the eastern coast of North America and the St. Lawrence River estuary. Since the 1950s, there has been a slow increase in numbers of nesting Great Black-backed Gulls on the Great Lakes, particularly on Lake Ontario and Lake Huron (Angehrn *et al.* 1979; Weseloh 1984; Ewins *et al.* 1992a). As a top predator, these gulls feed on fish and mammals as well as smaller birds including Herring Gulls and terns (Harris 1965; D.V. Weseloh, pers. comm.). Their status as top predators also puts them at increased risk for exposure to contaminants in the aquatic environment.

Ten single Great Black-backed Gull nests at 10 colonies were found on Lake Huron in 1999/2000: six on the main basin of Lake Huron, three on Georgian Bay and one on the North Channel (Figure 9). Two Great Black-backed Gull colonies consisting of a single nest were found on the main basin of Lake Huron in 1989; these single colonies were not recolonized in 1999/2000. This represents a 400% increase in nest numbers from 1989 to 1999/2000 and an annual growth rate on Lake Huron of 16.2%. No Great Black-backed Gull nests were found in Lake Huron in 1980.

Figure 10 summarizes the number of Caspian Tern, Common Tern, Ring-billed Gull, Great Black-backed Gull nests and colonies found during the 1989 and 1998/1999/2000 census periods in each of the three regions of Lake Huron.

Figure 9. Distribution of 10 Great Black-backed Gull colonies and corresponding colony sizes (i.e., numbers of nests) on the Canadian side of Lake Huron in 1999/2000. Note that three colonies on Lake Huron (main basin) are situated close to one another and appear as one colony.

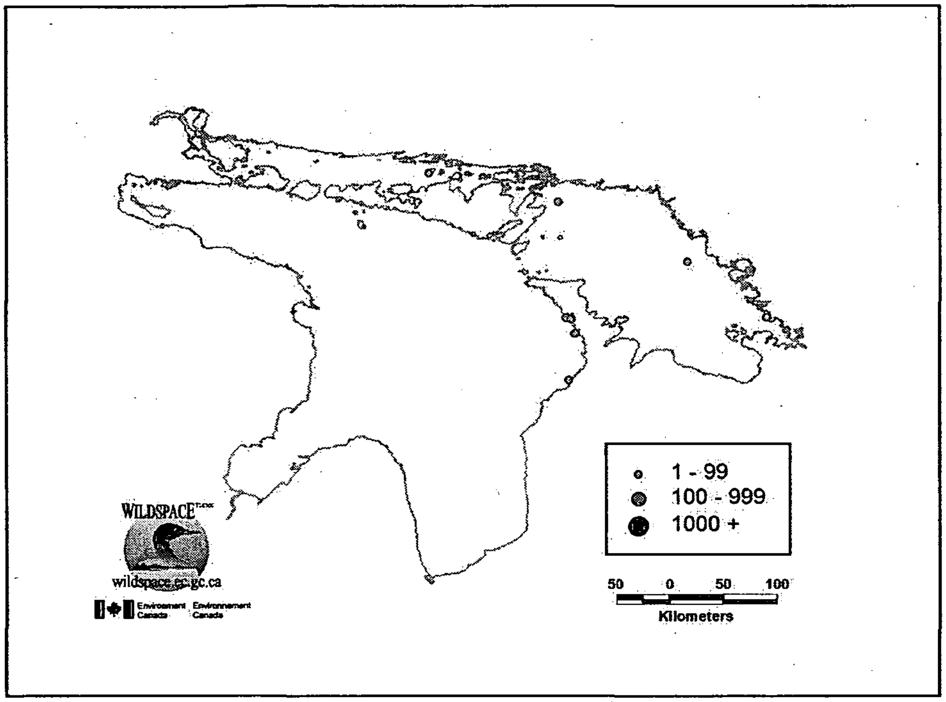
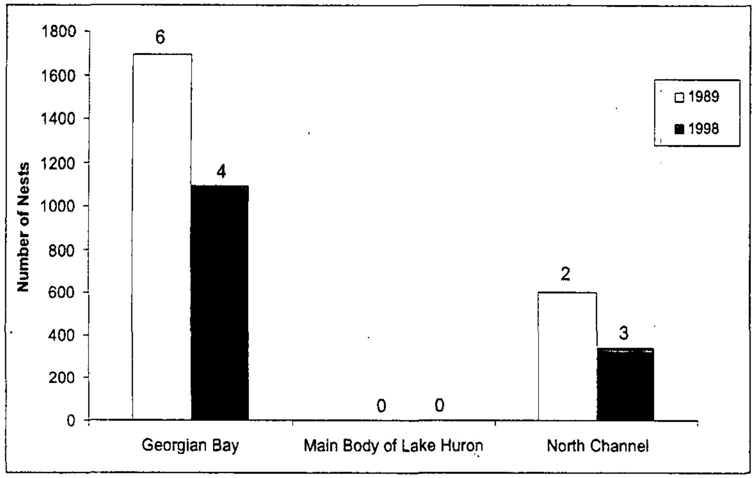
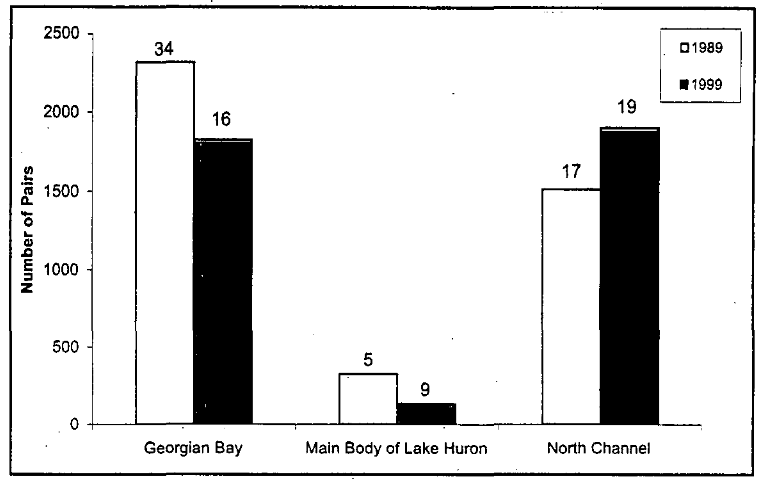


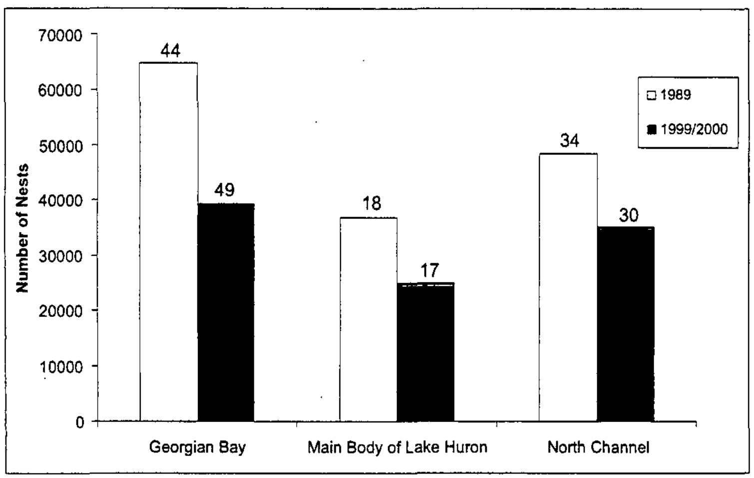
Figure 10. The number of Caspian Tern, Common Tern, Ring-billed Gull, Great Black-backed Gull nests present in the three regions of Lake Huron (Georgian Bay, main basin of Lake Huron and the North Channel) in 1989 and 1998/1999/2000. The number above each bar is the number of colonies.



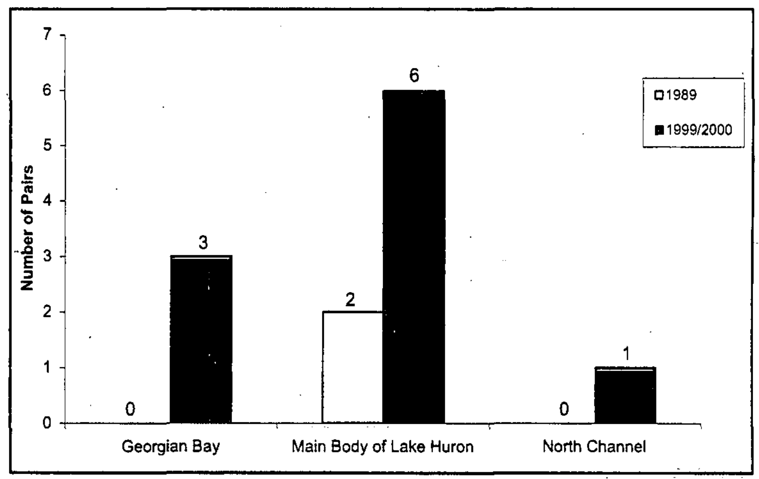
a) Caspian Tern



b) Common Tern



c) Ring-billed Gull



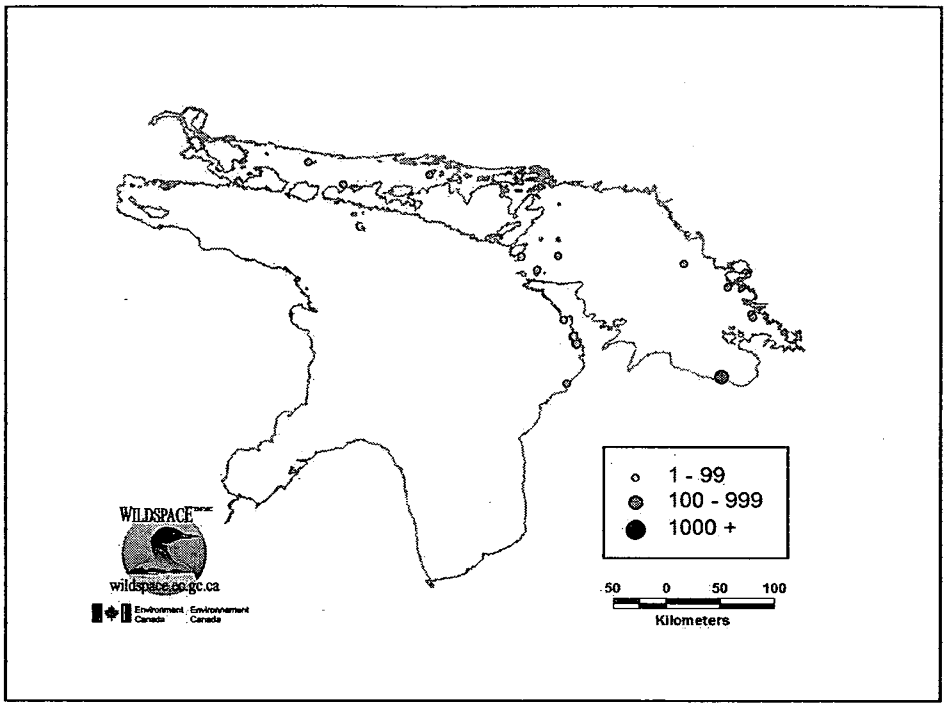
d) Great Black-backed Gull

vii) Black-crowned Night-Heron (*Nycticorax nycticorax*)

In 2001, 431 Black-crowned Night-Heron nests were counted at 22 colonies on the Canadian side of Lake Huron, eight on Georgian Bay, four on the North Channel and 10 on the main basin of Lake Huron (Figure 11). In 1991, 257 Black-crowned Night-Heron nests were reported at six colonies on Georgian Bay and the main basin of Lake Huron; none were found in the North Channel (Blokpoel and Tessier 1998); compared to the 2001 census data, this represents an increase of 68% in nest numbers since 1991. Comparing only the colonies which were surveyed in both 1991 and 2001, an annual rate of increase of +5.8% for Black-crowned Night-Herons on Lake Huron is evident. Annual rates of increase were equal to +8.4% and +2.5% for Georgian Bay and the main basin of Lake Huron, respectively. The number of nests on the North Channel increased from zero in 1991 to 12 nests at four colonies in 2001. This is in contrast to nest counts in 1980 versus 1991, when the lake-wide population decreased from 325 nests to 257 nests, representing a mean annual decline of -2.6% (Blokpoel and Tessier 1998).

The largest colony of Black-crowned Night-Heron nests was found on Nottawasaga Island in Georgian Bay (117 nests) accounting for 47% of the Black-crowned Night-Heron nests found in the region. The largest colony in the main basin of Lake Huron was on Chantry Island (48 nests); three islands had at least 30 nests which accounted for 72% of the nests found there.

Figure 11. Distribution of 22 Black-crowned Night-Heron colonies and corresponding colony sizes (i.e., numbers of nests) on the Canadian side of Lake Huron in 2001. Note that four pairs of colonies on Lake Huron (main basin) are situated close to one another and appear as two colonies. Similarly, two colonies in the North Channel are close to one another and appear as one colony.



viii) Great Blue Heron (*Ardea herodias*) and Great Egret (*Ardea alba*)

In 1999/2000, 320 Great Blue Heron nests were counted at 15 colonies on the Canadian side of Lake Huron, five on Georgian Bay, seven on the North Channel and three on the main basin of Lake Huron (Figure 12). In 1991, 378 Great Blue Heron nests were reported at nine colonies on all three regions of Lake Huron (Blokpoel and Tessier 1998); compared to the 1999 census data, this represents a decrease of 15% in nest numbers since 1991. Comparing only the colonies which were surveyed in both 1991 and 1999, an annual rate of decline of 2.1% for Great Blue Herons on Lake Huron is evident. Annual rates of increase were equal to +3.4% and +2.2% for Georgian Bay and the North Channel, respectively; an annual rate of decline in the number of Great Blue Heron nests was reported for the main basin of Lake Huron (-9.9%). This is in contrast to nest counts in 1980 versus 1991, when a mean annual growth rate of +2.7% in the breeding population was observed (Blokpoel and Tessier 1998). In 1999/2000, the largest colonies of Great Blue Heron nests were on Chantry Island (74 nests) and Nottawasaga Island (67 nests).

In 2000, 60 Great Egret nests were counted at two colonies on the Canadian side of Lake Huron: Chantry Island (20 nests) and Nottawasaga Island (40 nests; Figure 13). In 1991, 13 Great Egret nests were reported at these two colonies (Blokpoel and Tessier 1998); compared to the 2000 census data, this represents an increase of 362% in nest numbers since 1991. Comparing the two colonies, an annual rate of increase of 18.5% for Great Egret on Lake Huron is evident. Annual rates of increase were equal to +21.4% and +14.3% for Georgian Bay and the main basin of Lake Huron, respectively. No egret nests were recorded during the 1980 census on Lake Huron (Blokpoel and Tessier 1998).

Table 1 summarizes the annual rates of change for all colonial waterbirds on the Canadian side of Lake Huron on a lake-wide basis between first and second and second and third censuses.

Figure 12. Distribution of 15 Great Blue Heron colonies and corresponding colony sizes (i.e., numbers of nests) on the Canadian side of Lake Huron in 1999. Note that two colonies in the North Channel are situated close to one another and appear as one colony.

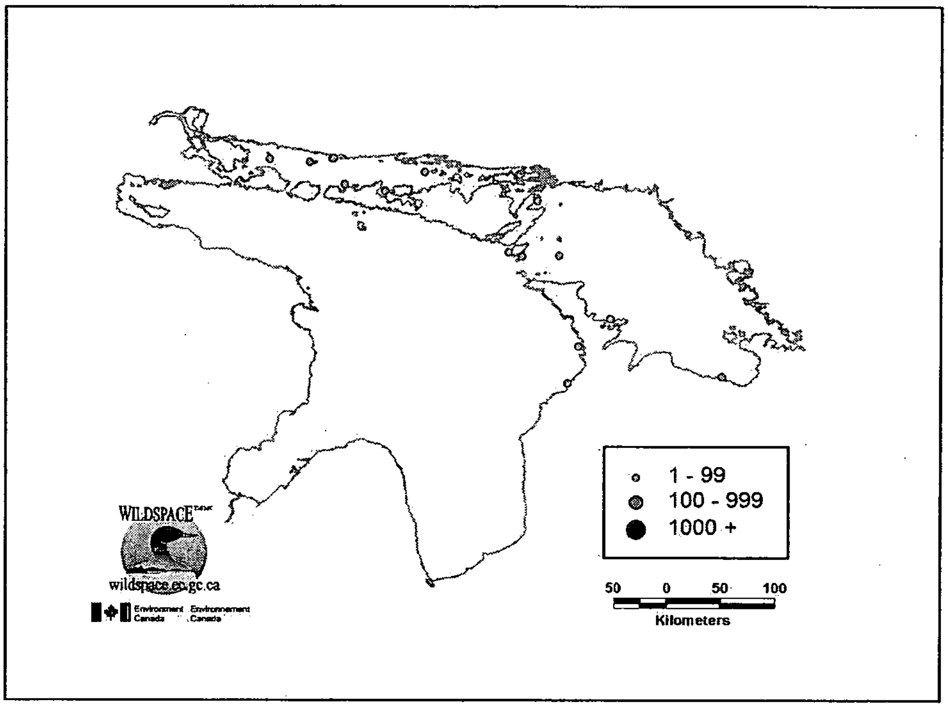


Figure 13. Distribution of two Great Egret colonies and corresponding colony sizes (i.e., numbers of nests) on the Canadian side of Lake Huron in 2000.

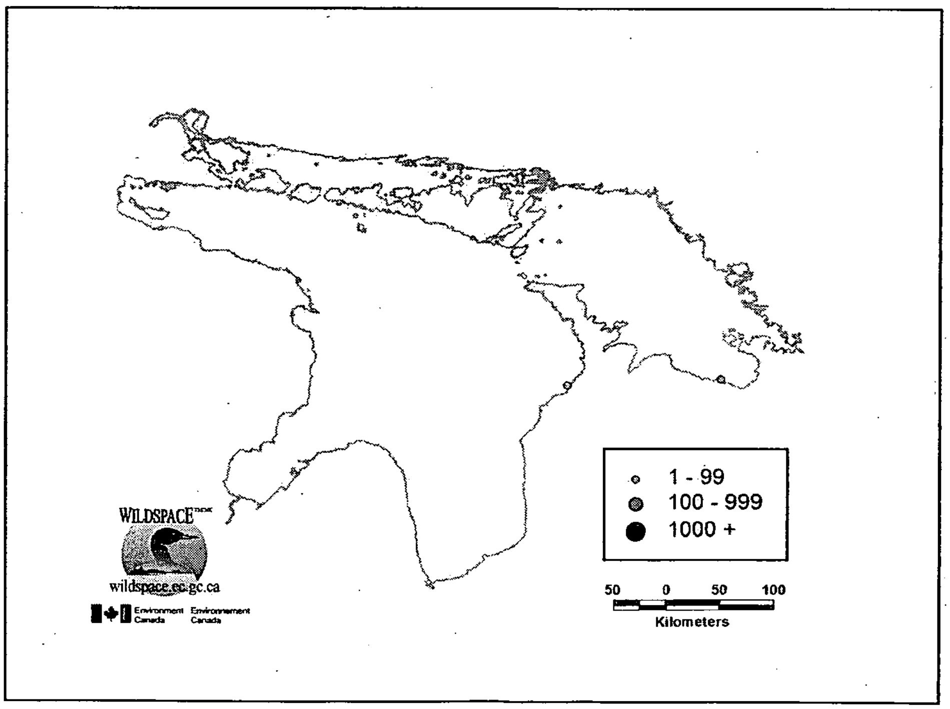


Table 1. Summary of annual rates of change for colonial waterbirds on Lake Huron on a lake-wide basis between first, second and third censuses, and as divided into three distinct regions: Georgian Bay, North Channel and the main basin of Lake Huron (for second and third censuses only). Annual rates of change have been calculated using only those colonies which were surveyed in both census periods.

Species	Lake Huron (lake-wide) 1st & 2nd Census*	Lake Huron (lake-wide) 2nd & 3rd Census**	Georgian Bay 2nd & 3rd Census**	North Channel 2nd & 3rd Census**	Main basin of Lake Huron 2nd & 3rd Census**
Herring Gull	-2.4%	-1.6%	-2.9%	+0.9%	-0.8%
Double-crested Cormorant	+37.8	+12.1%	+11.9%	+11.2%	+13.9%
Caspian Tern	+0.8%	-5.1%	-4.8%	-6.2%	-
Common Tern	-1.7%	-0.4%	-2.3%	+3.2%	-8.6%
Ring-billed Gull	+1.7%	-4.6%	-4.9%	-5.2%	-3.1%
Great Black-backed Gull	0, 2 ***	+16.2%	0, 3 ***	0, 1 ***	+11.6%
Black-crowned Night-Heron	-2.6%	+5.8%	+8.4%	0, 12	+2.5%
Great Blue Herons	+2.7%	-2.1%	+3.4%	+2.2%	-9.9%
Great Egrets	0, 13***	+18.5%	+21.4%	-	+14.3%

* First census was performed in 1980; second census was performed in 1989 for all colonial waterbirds (Blokpoel and Tessier 1997) except for Black-crowned Night-Heron, Great Blue Heron and Great Egret which was performed in 1991 (Blokpoel and Tessier 1998).

** Third census was performed in the following years: 1998: Caspian Terns; 1999: Herring Gulls; 1999/2000: Common Terns, Ring-billed Gulls, Great Black-backed Gulls and Great Blue Herons; 2000: Double-crested Cormorants and Great Egrets; 2001: Black-crowned Night-Herons.

*** Annual rates of change could not be calculated since no nests were found in the first census period; first number denotes that zero nests were found in first census period, second number denotes number of nests counted in second census period.

b) Marsh Birds

i) Black Tern (*Chlidonias niger*) and Forster's Tern (*Sterna forsteri*)

Black Tern and Forster's Tern are colonial marsh-nesting birds. Both Black Terns and Forster's Terns usually nest on floating mats of dead cattails lodged in emergent vegetation (Dunn 1979; McCracken *et al.* 1981). Nests are fragile and need protection from wave and wind action; excessive wave and wind action may result in nest and egg damage.

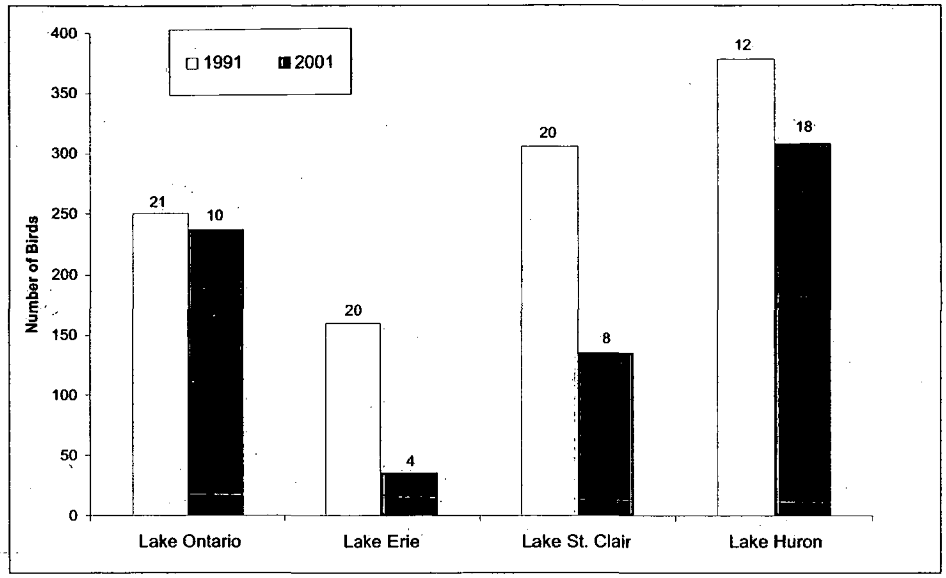
Tern surveys were performed in 1991 and 2001 with the intention that they would be replicated every 10 years as part of a joint Canadian-U.S. effort to monitor populations of colonial waterbirds along the Great Lakes (Graham *et al.* 2003). In 2001, surveyors attempted to survey all suitable marsh habitat within a five kilometre band along the Canadian shoreline of Lake Huron with the focus on marshes which had supported one or more of the target birds in the 1991 survey. Surveys for both years did not cover the entire Lake Huron shoreline but were based on a framework of 10 x 10 kilometre grid squares. In 1991, surveys were carried out as far north as McGregor Bay, near Little Current (Austen *et al.* 1996). In 2001, surveys covered squares along the St. Marys River, the North Channel and Georgian Bay, in addition to those areas surveyed in 1991.

The number of Black Terns on the Lake Huron shoreline decreased from 378 found in 12 colonies in 1991 to 309 terns at 18 colonies in 2001 representing a decline of 18.3% over the 10-year period (Graham *et al.* 2002). This decrease may be actually slightly higher given that a portion of the Lake Huron shoreline (north of MacGregor Bay) was not surveyed in 1991. A decrease was evident at other Great Lakes basin sites surveyed (Figure 14). The largest colonies on Lake Huron were at Tiny Marsh in Simcoe County (two colonies of 44 and 32 birds) and Big Mud Lake on the Bruce Peninsula (61 birds); seven of the 18 colonies (39%) had over 15 Black Terns in them.

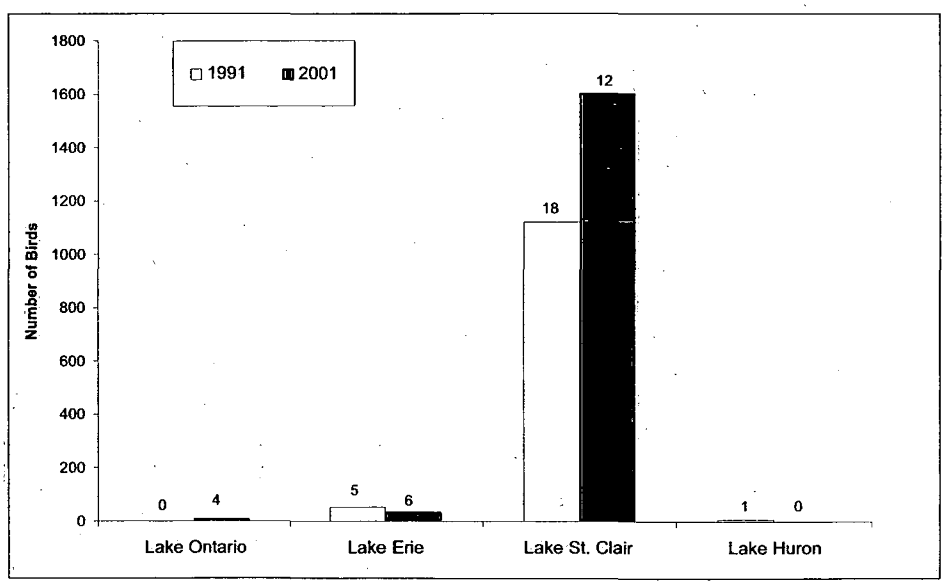
Forster's Tern were absent at Lake Huron surveyed sites in 2001; one breeding colony with six birds was identified in Kettle Point marshes in Lambton county at the southern tip of Lake Huron in 1991 (Austen *et al.* 1996; Graham *et al.* 2002). Along the Canadian Great Lakes, Forster's Terns increased in Lake St. Clair, decreased in Lake Erie and increased slightly in Lake Ontario (Figure 14). In 2001, Lake St. Clair (which includes the St. Clair National Wildlife Area) supported 97% of Ontario's known Great Lakes coastal population of Forster's Terns.

Declines in tern numbers may be related to loss of breeding ground habitat. At sites where there is a scarcity of natural nesting material, the introduction of wire mesh nesting platforms for nesting Black Terns might be successful (Alvo *et al.* 1998); however, nesting platforms provide Black Terns with only an alternate choice for nesting location but seldom serve to encourage new nesters into the area (D.V. Weseloh, CWS, pers. comm.). Given the large Forster's Tern population in Lake St. Clair and its close proximity, this population might act as a source of these terns on Lake Huron provided there are favourable nesting conditions present.

Figure 14. Numbers of Black Terns and Forster's Terns present in the Canadian Great Lakes in 1991 and 2001 (from Graham *et al.* 2002). Counts from Lake St. Clair and the St. Clair River are pooled. The number above each histogram bar is the number of colonies that contained at least one Black Tern or Forster's Tern nest.



a) Black Tern



b) Forster's Tern

ii) Other Marsh-Nesting Birds

The Marsh Monitoring Program (MMP), a bi-national Great Lakes basin-wide volunteer-based program, was launched in 1995 to monitor wetlands and inhabiting bird and amphibian populations. Using a standardized protocol, a total of 367 routes was monitored for marsh-nesting bird species in the Great Lakes basin from 1995 to 2001; fifty-eight of these routes were in the Lake Huron basin. While these results are preliminary, monitoring data collected from the Great Lakes MMP bird routes during this period (Timmermans and Craigie 2002) indicate that:

- 47% of marsh-nesting bird species (16/34) were detected more frequently in the Lake Huron basin compared to the average frequency of abundance for marsh-birds monitored in the entire Great Lakes basin;
- Virginia Rail (*Rallus limicola*), Eastern Kingbird (*Tyrannus tyrannus*), Pied-billed Grebe (*Podilymbus podiceps*), American Bittern (*Botaurus lentiginosus*), Least Bittern (*Ixobrychus exilis*), American Coot (*Fulica americana*), Common Snipe (*Capella gallinago*) and Black Tern were found more often in the Lake Huron basin compared to the other four Great Lakes basins;
- the most frequently detected marsh-nesting bird species in the Lake Huron basin were, in order of abundance, the Red-winged Black Bird (*Agelaius phoeniceus*), Swamp Sparrow (*Melospiza geogiana*), Common Yellowthroat (*Geothlypis trichas*), Virginia Rail and Marsh Wren (*Cistothorus palustris*); and
- the abundance of Black Tern, Pied-billed Grebe, Red-winged Blackbird, Common Snipe, Canada Goose (*Branta canadensis*), Mallard (*Anas platyrhynchos*) and Sora (*Porzana carolina*) decreased significantly in the Lake Huron basin from 1995 to 2001.

Sandhill Cranes (*Grus canadensis*)

Sandhill Cranes are marsh-nesting birds which have experienced a dramatic increase in numbers along the North Channel over the past twenty years. Once considered a novelty, these marsh-nesting birds are now considered common along the North Channel, east of Sault Ste. Marie (S. Elliott, pers. comm.). Two large staging areas include Massey and Iron Bridge along the North Channel, where groups as large as 200 individuals have been observed in farmers' fields. According to the *Ontario Breeding Bird Atlas*, the number of 10 x 10 kilometre squares with confirmed sightings of Sandhill Cranes (with breeding evidence) along the Lake Huron shoreline has increased from six squares reported in the first *Atlas* in 1981-1985 to 47 squares reported from 2001-2003. A large expansion of Sandhill Cranes has been observed throughout Ontario: this species was reported in 211 squares in the first *Atlas* and in 603 squares from 2001-2003 in the currently in-progress second *Atlas* (*Ontario Breeding Bird Atlas*. Draft Atlas Data Summaries. December 2, 2003. www.birdsontario.org/atlas/atlasmain.htm).

c) Waterfowl

The greatest use of Great Lakes coastal wetlands by waterfowl occurs during migration in the spring and autumn (Prince *et al.* 1992). In contrast to the lower Great Lakes, very little published information exists with regard to waterfowl migration around the Canadian shorelines of Lake Huron and Georgian Bay. Dennis *et al.* (1984) performed aerial surveys of the Ontario shorelines of the southern Great Lakes including two areas on Lake Huron in the autumn of 1973 and the spring of 1974. The first area, extending from the Bruce Peninsula to Sauble Beach had limited waterfowl use due in part to the scarcity of aquatic vegetation and also possibly due to the disturbance of motorized watercraft. The most abundant waterfowl using this area during the spring and autumn was the Common Merganser (*Mergus merganser*); several hundred American Black Duck (*Anas rubripes*) and Mallard were observed in the open water areas in the spring following the break-up of ice. The second area, extending from Sauble Beach southwards to the tip of the St. Clair River and consisting of mostly open water, also had limited waterfowl use. However, areas around Douglas Point, Kettle Point and Chantry Island had heavier waterfowl use due to the presence of small patches of aquatic vegetation. In the spring, Common Mergansers, Canada Geese, Mallards and American Black Ducks predominated; in the autumn, the most abundant species were Common Mergansers, Buffleheads (*Bucephala albeola*), Mallards and Greater Scaup (*Aythya marila)*. In general, diving ducks (including mergansers and sea ducks) utilize these survey areas more than dabbling ducks on a waterfowl days per hectare basis in the spring and autumn. During the migration period, the intensity of waterfowl use at these two Lake Huron areas ranked below the majority of other surveyed Ontario shorelines on the lower Great Lakes. Data from more recent waterfowl surveys of the Canadian Lake Huron shoreline may be available in the near future.

Ewins (1994) surveyed six locations in Severn Sound, Georgian Bay (from Matchedash Bay north to Honey Harbour) on eight dates from late March to mid April 1992. Diving ducks, including Ring-necked Duck (*A. collaris*), Common Goldeneye (*B. clangula*), Bufflehead and Common Merganser accounted for more than 80% of ducks identified during every survey date. Maximum counts for these species and Hooded Merganser (*Lophodytes cucullatus*) were higher than those recorded in the spring of 1992 at the Inner Bay of Long Point in Lake Erie; such large staging concentrations of Ring-necked Duck, Common Goldeneye and Bufflehead were not seen on Lake Erie (Ewins 1994). Early spring numbers of dabbling ducks were low compared to counts at lower Great Lakes sites. If inner Matchedash Bay had been surveyed, Ewins (1994) speculated that, once free of ice, greater numbers of dabbling ducks would have been identified, where shallow water provides more favourable feeding conditions for dabbling ducks. Severn Sound in Georgian Bay appears to be one of the most important spring staging areas for diving ducks in the Great Lakes (Ewins 1994).

To a lesser extent, Great Lakes coastal wetlands also provide important breeding habitat for waterfowl. The current status of breeding waterfowl on Lake Huron is unclear. Based on area size and average densities of breeding dabbling ducks along the southern Ontario shoreline (Dennis 1974; Ross *et al.* 1984; Duffy *et al.* 1987), Prince *et al.* (1992) estimated that coastal wetlands on the St. Marys River and Georgian Bay support at least 9% of all breeding pairs of dabbling ducks on the Great Lakes.

d) Birds of Prey

i) Bald Eagle (*Haliaeetus leucocephalus*)

Due to the its high degree of sensitivity to contaminants, the Bald Eagle was proposed by the International Joint Commission as an ecosystem monitor of water quality (International Joint Commission 1989). No Bald Eagle nests were reported on the shores of Lake Huron prior to 1980 when the Ontario Ministry of Natural Resources (OMNR) began monitoring Bald Eagle nests along the Lake Huron shoreline (P. Hunter, OMNR, pers. comm). In 2003, the total number of Bald Eagle nests recorded within five kilometres of the Lake Huron shoreline was equal to 15, according to the Natural Resources Values Information System (NRVIS), a wildlife and natural areas management database used by the OMNR. Each of the Sault Ste. Marie, Sudbury, Parry Sound and Midhurst district offices were contacted and numbers of nests were tallied. The Midhurst district office does not track nest numbers in their database; however, four nests were recorded in Bruce, Grey and Lambton counties in 1993 (see below). The status of whether the nest was active was not determined. No estimates of productivity were measured.

Currently, the Southern Ontario Bald Eagle Monitoring Project (a joint operation among the Ontario Ministry of Natural Resources, Environment Canada (CWS) and Bird Studies Canada) monitors the status of Lake Huron nests as far north as Bruce County, along the eastern shore of Lake Huron. In total, six Bald Eagle territories (nesting sites) have been routinely monitored in Bruce County, Lambton County and Grey County since as early as 1992 (Badzinski and Richards 2002). In 2003, a total of five young were produced at three nests (including three triplets at one nest); at the other three territories, one nest was occupied but no eggs were laid and two territories were considered as inactive nesting sites (D. Badzinski, Bird Studies Canada, pers. comm.). In 2004, one eaglet from the Lambton County nest will be banded, have blood drawn and be tagged with a satellite transmitter to monitor its movements (P. Martin, CWS, pers. comm.).

ii) Osprey (*Pandion haliaetus*)

In the period of 1985 to 1993, Ewins *et al.* (1995) determined that there were at least 177 occupied Osprey nests found within five kilometres of the Lake Huron shoreline (including nests counted on the U.S. side of the St. Marys River). They estimated that the entire Lake Huron population numbered no more than 200 occupied nests in 1993. There are no detailed records of Osprey breeding prior to the 1970s. In Georgian Bay, the Osprey population increased from four occupied nests in 1975 to 43 known nests in 1993, representing a mean annual increase of 13.2% (Ewins *et al.* 1995). The two largest concentrations of nests were found in the St. Marys River (Canadian and U.S. sides) and in southeastern Georgian Bay. More widely scattered nests were found in the Straits of Mackinac, along the North Channel, on Manitoulin Island and on the Bruce Peninsula.

In 2003, the total number of Osprey nests recorded within five kilometres of the Canadian Lake Huron shoreline was equal to 43, according to the NRVIS database. The Ontario Ministry of Natural Resources do not routinely survey the Lake Huron shoreline for Osprey nests and only incidental sightings of nests are recorded and entered into the NRVIS database. Each of the Sault Ste. Marie, Sudbury, Parry Sound and Midhurst district offices were contacted and numbers of nests were tallied. The Midhurst district office does not track nest numbers in their database and B. Grey (OMNR, Owen Sound, pers. comm.) provided the number of Osprey nests known to him. The status of whether the nest was active was not determined. No estimates of productivity were measured. Of the 43 Lake Huron nests counted in 2003, 25 were found in Georgian Bay (total number of nests in Sudbury and Parry Sound districts); this represents a decrease of 18 nests in this region since nests were counted in 1993 (Ewins *et al.* 1995). It is difficult to ascertain whether numbers of Osprey have truly declined over this period, since numbers of Osprey nests are not regularly monitored and therefore the data may be incomplete. Local naturalists and interest groups could provide additional information with regard to locations and numbers of nests along the shoreline. A similar decline has been noted in Ospreys from the Kawartha Lakes region of Ontario since 1992 (DeSolla *et al.* 2003). Reasons for a decline in Osprey on Lake Huron could be related to limited food availability, predation on Osprey eggs by other birds such as ravens and great-horned owls, and changes in overwinter survival.

e) Amphibians and Reptiles

In addition to monitoring marsh bird populations, the Marsh Monitoring Program (MMP) monitors amphibian populations in the Great Lakes basin. Using a standardized protocol, a total of 412 routes were monitored for amphibian species in the Great Lakes basin from 1995 to 2001; eighty-one of these routes were in the Lake Huron basin. While these results are preliminary, monitoring data collected from the Great Lakes MMP amphibian routes during this period (Timmermans and Craigie 2002) indicate that:

- 54% of amphibian species (7/13) were detected more frequently in the Lake Huron basin compared to the entire Great Lakes basin average frequency of occurrence for amphibian species;
- spring peeper (*Hyla crucifer*), green frog (*Rana clamitans*), wood frog (*Rana sylvatica*) and mink frog (*Rana septentrionalis*) were found more often in the Lake Huron basin compared to the other four Great Lakes basins;
- the most frequently detected amphibian species in the Lake Huron basin were, in order of occurrence, spring peeper, green frog, grey treefrog (*Hyla versicolor*), American toad (*Bufo americanus*) and wood frog;
- bullfrog (*Rana catesbeiana*) occurrence increased significantly in the Lake Huron basin from 1995 to 2001; and
- American toad, chorus frog (*Acris crepitans*), green frog and spring peeper occurrences declined significantly in the Lake Huron basin from 1995 to 2001.

Since many factors can contribute to inter-year variation in species occurrence, additional years of monitoring data are required to reliably estimate population trends.

Amphibians in the Lake Huron basin are also being monitored through the Amphibian Roadcall Count and Backyard Frog Survey programs, which were initiated by the Canadian Wildlife Service in 1992 and are currently managed by the Ecological Monitoring and Assessment Network (www.eman-rese.ca/). While the Marsh Monitoring Program focuses on amphibians in coastal wetlands along the shores of the Great Lakes, these two programs focus on habitat further inland and monitor both common and more rare amphibian species. Population trends of these species will be available in the near future. Very little is known regarding the abundance of reptiles found along the Lake Huron shoreline.

In terms of distributions of reptiles and amphibians along the shores of Lake Huron, a listing of species native to the four Areas of Concern (two of which have been delisted) on the Canadian side of Lake Huron is shown in Table 2 (Shirose and Bishop 1995). Species which were reported to the *Ontario Herpetofaunal Atlas* until 1994 are included. Comparisons of historical records versus more recent records provide evidence of trends in biodiversity. Species which have been reported prior to but not after 1984 are shown; this may indicate species which have been extirpated from the Area of Concern (AOC). Species whose range historically encompass the AOC are also indicated; while range maps are often patchy and habitat requirements are specific, it is not certain that the species in question was ever present in the AOC. This listing is designed to indicate which species might be expected in which regions along the shoreline of Lake Huron and the species that may require more intensive monitoring and remediation efforts.

Table 2. A complete listing of amphibians and reptiles native to the four current and delisted Areas of Concern (AOC) on the Canadian side of Lake Huron (Shirose and Bishop 1995).

"1" in the table denotes that the species was sighted from 1969 to 1994 and reported to the *Ontario Herpetofaunal Atlas*; "*" denotes that the sighting was reported prior to, but not after, 1984. "2" in the table denotes that the species' range historically includes the AOC, but that it was not reported to the *Ontario Herpetofaunal Atlas*. "NE" denotes that there is no evidence, using the above methods, to suggest that the species might/would be present in the AOC.

	St. Marys River AOC	Spanish River AOC	Collingwood Harbour AOC (delisted)	Severn Sound AOC (delisted)
Eastern Newt	1*	2	2	1
Jefferson Complex	1*	NE	NE	1*
Blue-spotted Salamander	2	2	2	1*
Yellow-spotted Salamander	2	2	2	1
Eastern Redback Salamander	1*	2	2	1
Four-toed Salamander	2	2	2	1*
Mudpuppy	2	2	2	1
American Toad	1	1	1	1
Spring Peeper	1	2	1	1
Midland Chorus Frog	NE	NE	1	1
Tetraploid Gray Treefrog	1	2	2	1
Wood Frog	1*	1	2	1
Pickerel Frog	NE	NE	2	1*
Mink Frog	2	2	2	1*
Northern Leopard Frog	1*	2	1*	1
Green Frog	1	2	1	1
Bullfrog	1*	2	2	1
Common Snapping Turtle	2	2	2	1
Stinkpot Turtle	NE	2	2	1*
Map Turtle	NE	NE	2	1
Blanding's Turtle	NE	NE	2	1
Wood Turtle	NE	NE	2	1*
Spotted Turtle	NE	NE	2	1*
Midland Painted Turtle	1*	2	2	1
Five-lined Skink	NE	NE	2	1
Northern Ribbon Snake	NE	NE	2	2
Eastern Garter Snake	1*	2	1*	1
Northern Water Snake	2	2	2	1
Eastern Smooth Green Snake	2	2	2	1*
Redbelly Snake	1*	2	2	1
Brown Snake	NE	NE	2	1
Eastern Milk Snake	1*	2	2	1
Eastern Hognose Snake	NE	NE	2	1*
Eastern Fox Snake	NE	NE	2	2
Eastern Massasauga Rattlesnake	NE	NE	2	1*
Northern Ringneck Snake	2	2	2	1

f) Mammals – River Otter (Lutra canadensis) and Mink (Mustela vison)

River otter feed on mainly fish, amphibians, crayfish and other invertebrates, live close to water and prefer lakes, marshes and streams. Mink feed on a variety of items including fish, small mammals, crayfish, birds and amphibians. Mink prefer waterbodies such as streams, ponds and lakes, and build dens in forested, log-strewn or thicketed areas. Cottage development can negatively impact mink numbers because it diminishes forested habitat along shorelines.

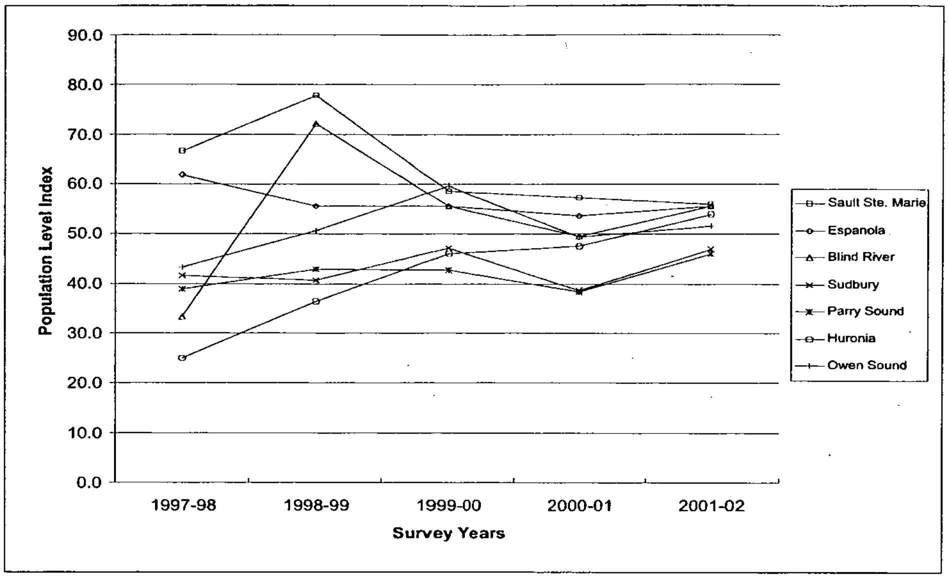
Information from trappers and trapping records are two methods which have been used to examine relative changes in harvested mink and otter populations. Since 1997, annual estimates of mink and otter abundance on the Lake Huron shorelines have been determined using survey information from trappers through the Ontario Trapper Questionaire developed for the Ontario Ministry of Natural Resources (OMNR) Wildlife Assessment Program (N. Dawson, OMNR, pers. comm.). A Population Level Index (PLI) was calculated using a formula and based on trapper response to whether species were absent or very scarce (<5.6), scarce (5.6-33.2), common (33.3-77.6) or abundant (>77.7). A PLI was determined for both mink and otter in seven OMNR districts bordering the Lake Huron shoreline annually from 1997-2002 (Figure 15). The average number of responses for a given year was equal to 32 for both species (range=2-92 responses). In general, the abundance of mink and otter was rated as common in all districts, with the exception of Owen Sound where otter abundance was considered scarce. There also appears to be more variability in the abundance of otter compared to mink among OMNR districts compared.

Trapping records provide information on apparent changes in the population of fur-bearing animals to ensure that the wild fur harvest is conducted on a sustainable basis. Harvested animals are caught along registered traplines on Crown land. Thirty-six registered traplines along the Lake Huron shoreline are found between Sault Ste. Marie and south of Parry Sound. Table 3 shows the harvest numbers for mink and otter collected from Lake Huron traplines over the past four decades. On a broad-scale level, it is very difficult to speculate on changes in population abundance using trapping records since a number of factors, including changes in prey density, species demand and trapper effort (influenced by fur prices), can explain yearly changes in harvest numbers; a more detailed analysis under controlled conditions is required to investigate regional population changes. Throughout Ontario, while harvest numbers of otter have generally been stable, harvest numbers of mink have been declining since the 1970s (C. Heydon, OMNR, pers. comm.). Currently, there has been some evidence of the giant kidney worm affecting the mink population in Ontario (C. Heydon, OMNR, pers. comm.).

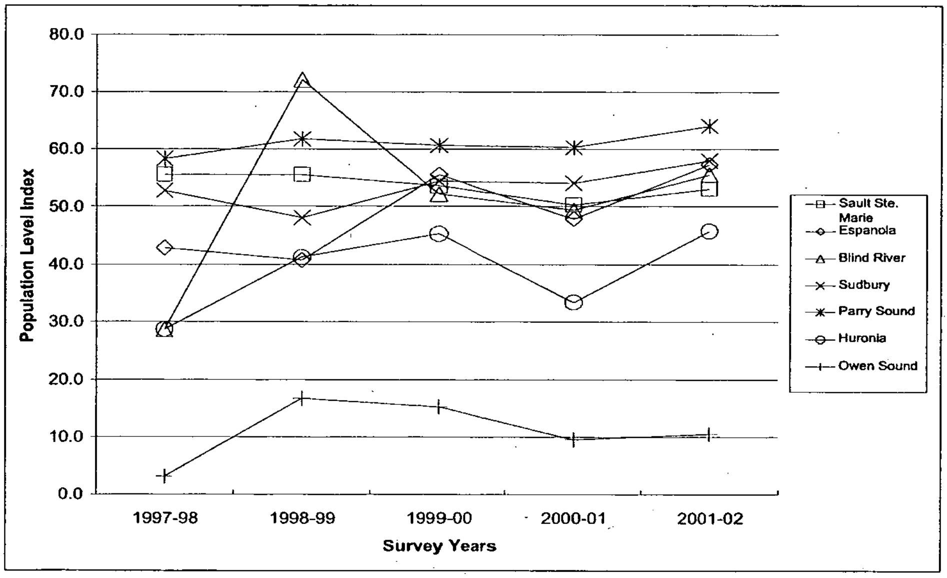
Table 3. Harvest numbers of mink and otter caught in 36 registered traplines on the shoreline of Lake Huron over the past four decades.

Harvest Year	Number of Mink	Number of Otter
1972-1973	68	56
1982-1983	102	89
1992-1993	40	33
2002-2003	11	41

Figure 15. Population Level Index (PLI) calculated for mink and otter in seven Ontario Ministry of Natural Resources districts from 1997 to 2002 (N. Dawson, OMNR, pers. comm.).



a) mink



b) otter

III. CONTAMINANTS – CURRENT STATUS

a) Colonial Waterbirds

i) Herring Gull

The Canadian Wildlife Service has been monitoring levels of contaminants in Herring Gull eggs at 15 sites, known as Annual Monitor Colonies (AMCs) throughout the Great Lakes since the early 1970s (Figure 16). Contaminants which are known to bioaccumulate and which have been associated with reproductive impairments in colonial waterbirds include DDE (dichlorodiphenyldichloroethylene, a breakdown product of DDT), PCBs (polychlorinated biphenyls), total chlordane (sum of concentrations of oxychlordane, cis-chlordane, trans-chlordane, cis-nonachlor and trans-nonachlor), heptachlor epoxide, mirex and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Levels of these contaminants found in Herring Gull eggs in 2002 at AMCs in the Great Lakes are shown in Figure 17 (Jermyn-Gee *et al.* 2005). Levels of DDE, sum PCBs and 2,3,7,8-TCDD were lower on the Canadian side of Lake Huron (Double Island and Chantry Island) versus those found in Saginaw Bay, Michigan (Channel Shelter Island). The concentration of mirex detected in Herring Gull eggs was highest at Chantry Island compared to other Lake Huron sites suggesting that these Herring Gulls may spend a greater time on Lake Ontario or the Niagara River during the winter or pre-breeding season (Ewins *et al.* 1992b). Generally, levels of contaminants on the Canadian side of Lake Huron are lower or similar to levels of contaminants at other Great Lakes sites; these levels are also below those considered to elicit population-level effects in Herring Gulls.

Declining levels of contaminants have been observed at all three Lake Huron AMCs since monitoring began in 1974 (Figure 18). While major point sources of chemical contaminants are not found on the Canadian side of Lake Huron, atmospheric deposition, agricultural run-off, resuspension of sediments and leaching of soils from landfill sites may contribute to the steady state that has been evident since the 1990s. Reasons for large year-to-year fluctuations in contaminant levels may include changes in the abundance of food supply associated with changes in weather conditions (Fox *et al.* 1990; Ewins *et al.* 1992b; Hebert *et al.* 1997). Eggshells from colonies in Lake Huron in 1980 were on average 6.1% thinner than the pre-DDT 1947 mean value of 0.375 mm (Anderson and Hickey 1972; Ewins *et al.* 1992b).

High concentrations of brominated diphenyl ethers (BDE) in the Great Lakes Herring Gulls have recently been identified as a concern (Norstrom *et al.* 2002). Total BDE in Herring Gull eggs sampled from AMCs in 2000 were found at concentrations ranging from 192-1,400 μg/kg, with a mean concentration for all colonies equal to 662 + 368 μg/kg. These concentrations rank total BDE behind concentrations of total PCBs and DDE in Herring Gull eggs in 2000 but higher than chlordanes, chlorobenzenes and dieldrin (Norstrom *et al.* 2002). At selected AMCs, temporal trends of BDE, notably the penta-BDE formulation which is used as a flame retardant in North America, indicate dramatic increases over the past 20 years with continuing increases projected. Total BDE concentrations at Double Island and Chantry Island were equal to 320 μg/kg and 308 μg/kg, respectively, and were low in comparison to other Great Lakes sites, largely due to their remoteness from large urban and/or heavy industrial centres. In contrast, eggs from Channel Shelter Island in Saginaw Bay, a colony near chemical industry, had a total BDE concentration which was higher (652 μg/kg). Little is known with regard to the toxic effects of BDEs in humans and wildlife.

Figure 16. Location of the 15 Herring Gull Annual Monitor Colonies on the Great Lakes.

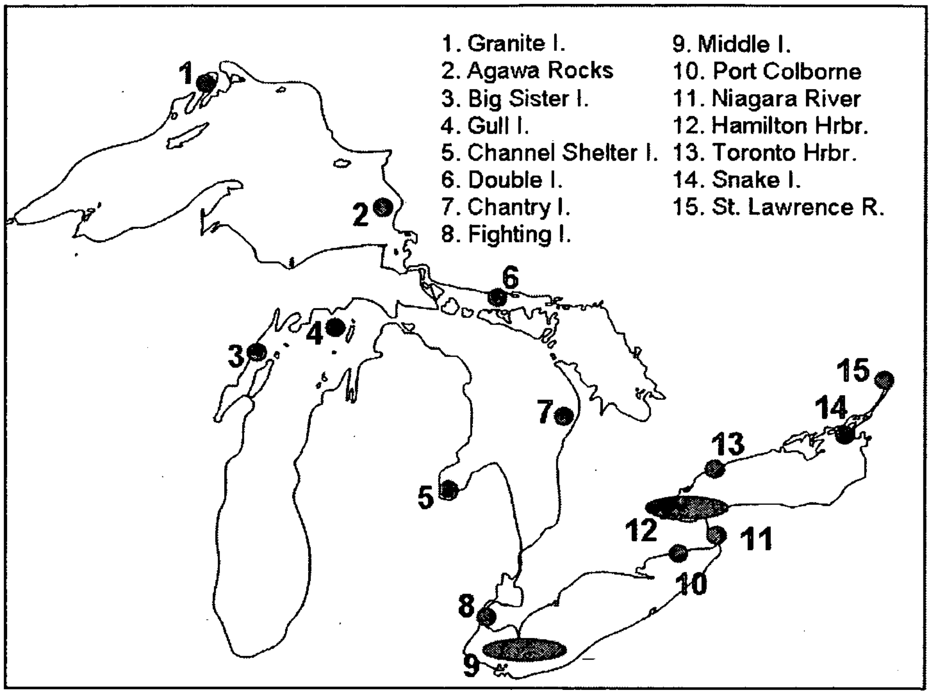
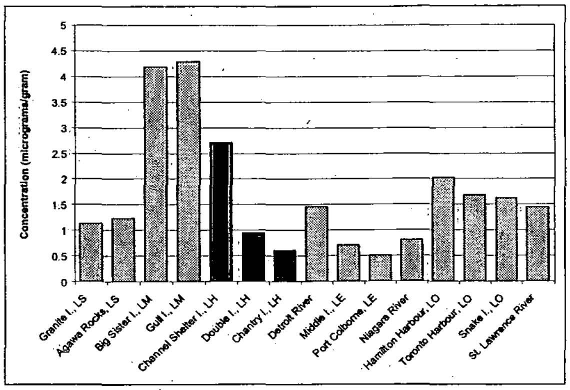
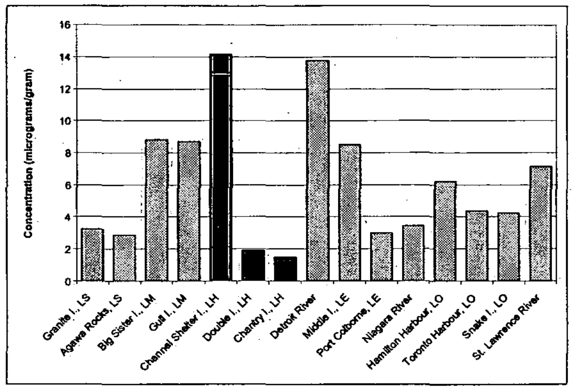


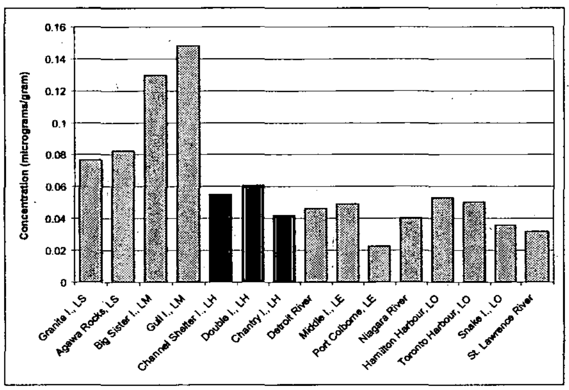
Figure 17. Contaminant levels in Herring Gull eggs collected in 2002 at Annual Monitor Colonies on the Great Lakes (Jermyn-Gee *et al.* 2005). The bold bars indicate sites on Lake Huron and the sites are arranged from west to east.



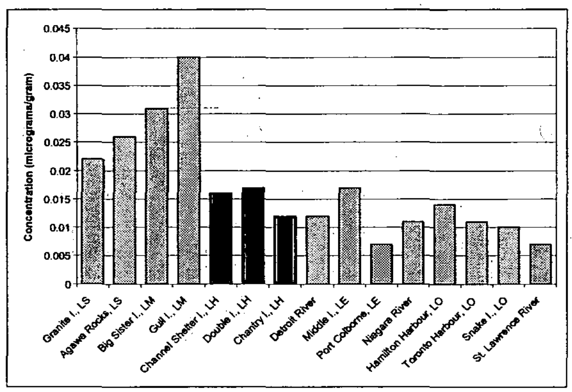
a) DDE



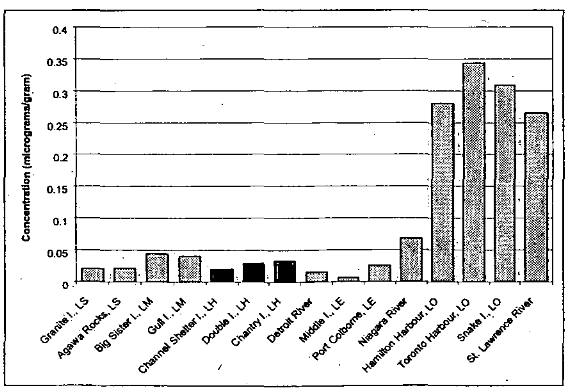
b) Sum PCBs



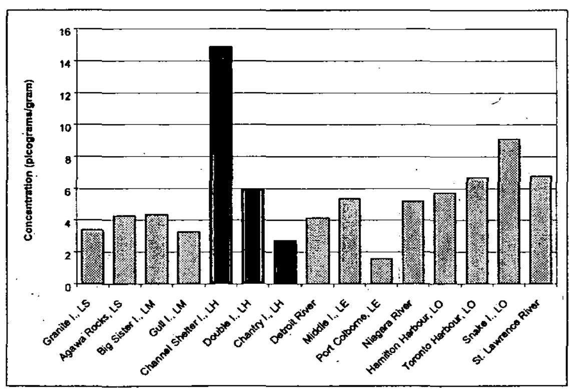
c) Total chlordane



d) Heptachlor epoxide

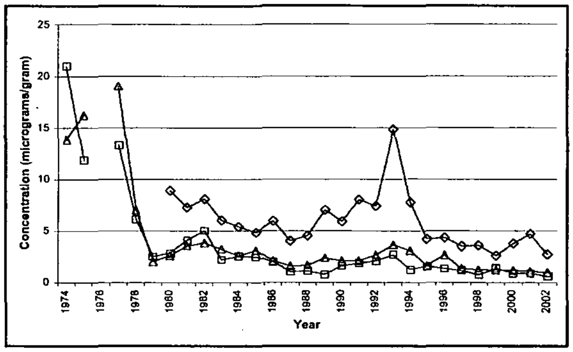


e) Mirex

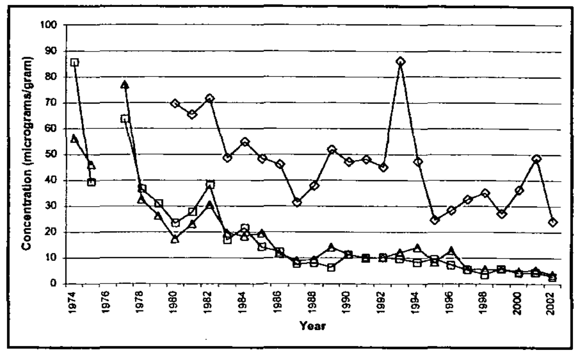


f) 2,3,7,8-tetrachlorodibenzo-p-dioxin

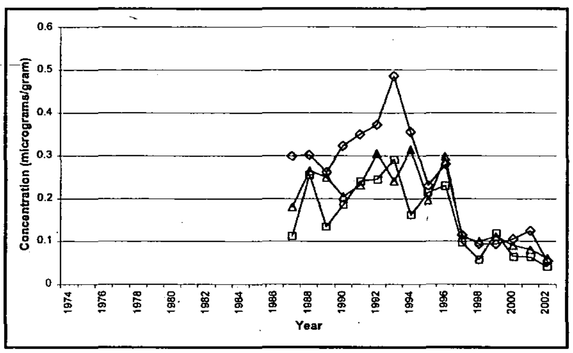
Figure 18. Temporal trends in levels of contaminants in Herring Gull eggs at three Lake Huron Annual Monitor Colonies. "□" and "Δ" denotes Chantry Island and Double Island, respectively, on the Canadian side of Lake Huron. "◊" denotes Channel Shelter Island on the U.S. side of Lake Huron.



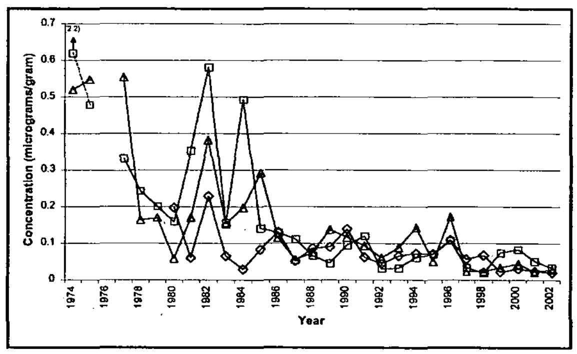
a) DDE



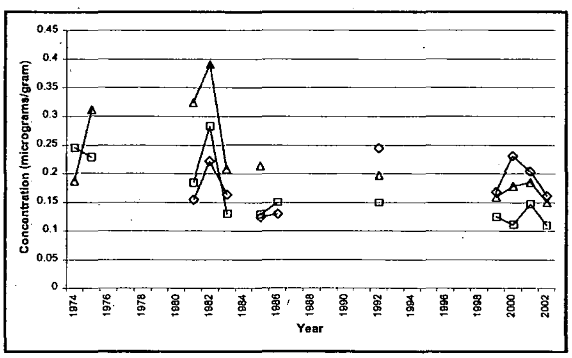
b) PCB 1254:1260



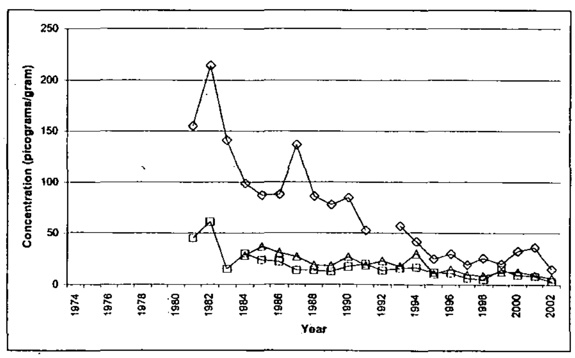
c) Total chlordane



d) Mirex



e) Mercury



f) 2,3,7,8-tetrachlorodibenzo-p-dioxin

ii) Double-crested Cormorant, Ring-billed Gull, Black-crowned Night-Heron and Great Black-backed Gull

Generally, levels of DDE, sum PCBs, dieldrin, heptachlor epoxide and mirex detected in Double-crested Cormorant eggs from Lake Huron sites (Georgian Bay and North Channel) in 1984 to 1995 were found to be low relative to other Great Lakes sites (Ryckman *et al.* 1998). From the early 1970s to 1995, significant declines in DDE and dieldrin levels were found in eggs from Georgian Bay and the North Channel; a significant decline in heptachlor epoxide levels was also found in eggs from Georgian Bay, and; a significant decline in PCB levels was detected in eggs from the North Channel (Ryckman *et al.* 1998). Contaminant levels in Double-crested Cormorant eggs collected from two sites, Wallis Rock (Georgian Bay) and Africa Rock (North Channel), in 1995 are shown in Figure 19. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) was last measured in pooled samples of cormorant eggs collected from West Island (North Channel) and Blackbill Island (Georgian Bay) in 1989 and were found to be equal to 14 pg/g and 18 pg/g, respectively (Pettit *et al.* 1998).

The prevalence of bill defects observed in cormorant chicks was equal to 2.6 and 1.5 per 10,000 young examined from 1988 to 1994 at North Channel and Georgian Bay colonies, respectively (Ryckman *et al.* 1998). Furthermore, the prevalence of bill defects at these sites were not significantly different from those observed at colonies on Lake Ontario, Lake Superior and reference sites in northwestern Ontario. A significant decline in the prevalence of deformities was found in Georgian Bay colonies sampled from 1979 to 1987 (6.1 per 10,000 young) versus those sampled from 1988 to 1995 (1.5 per 10,000 young); a significant decline was not found in North Channel colonies during this time period (Ryckman *et al.* 1998). In 1995, mean eggshell thickness in cormorant eggs from colonies on the North Channel was 2.5% thinner than the pre-DDT 1947 mean value of 0.440 mm (Anderson and Hickey 1972); mean eggshell thickness in eggs from Georgian Bay was equal to the mean pre-DDT 1947 value. Given the dramatic rise in the size of the Lake Huron population of Double-crested Cormorants since the 1970s and concomitant with a decline in contaminant levels in eggs, contaminants no longer appear to affect the reproductive success of this highly prolific species.

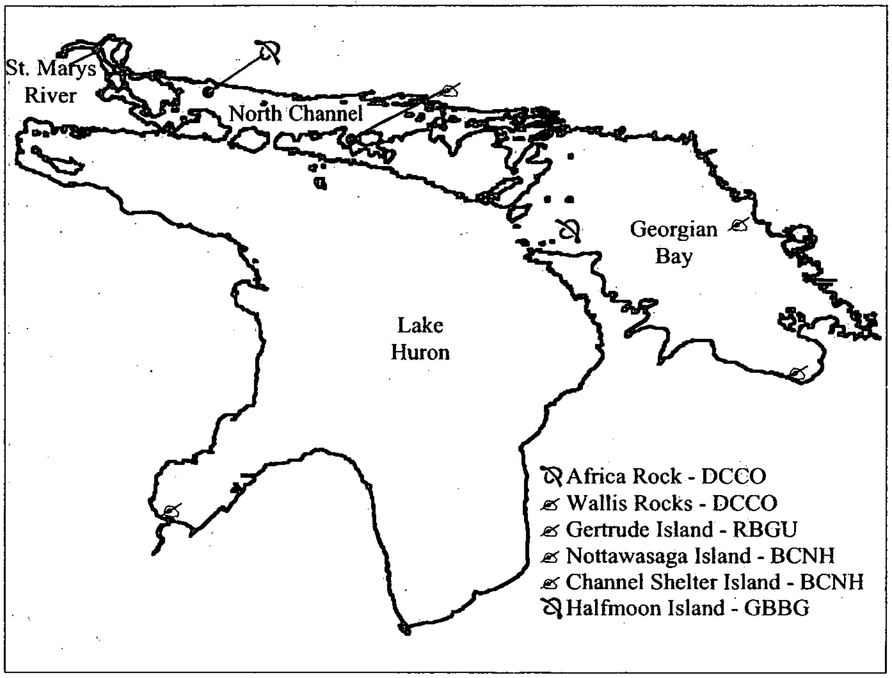
Although Double-crested Cormorants are migratory birds, annual fluctuations in contaminant levels in cormorant eggs are similar to those reported in Great Lakes Herring Gull eggs collected from the same colony (Ryckman *et al.* 1998). This suggests that a much larger portion of their contaminant load is picked up on their Great Lakes breeding grounds relative to their wintering grounds, providing evidence of the usefulness of this species as an indicator of local contaminant conditions.

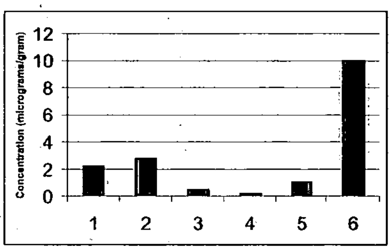
Ring-billed Gull eggs were collected from Gertrude Island on the northern shore of Manitoulin Island in the North Channel in 1994 and analyzed as a pooled sample (usually 11-13 eggs per pool) for contaminants (Figure 19; Pekarik *et al.* 1998). Comparatively, Herring Gull eggs collected from approximately 30 kilometres away across the North Channel at Double Island in 1994 yielded DDE, total PCB, total chlordane and heptachlor epoxide levels which were 3-6 times higher than those found in Ring-billed Gull eggs. Mirex levels in Herring Gull eggs were 21 times those observed in Ring-billed Gull eggs. Levels of 2,3,7,8-TCDD measured in ring-billed eggs were low (4.7 pg/g) compared to levels found in Herring Gull eggs collected from Double Island in 1993 (17.6 pg/g). Generally, low levels of contaminants found in Ring-billed Gull eggs are in part due their diet consisting of a greater proportion of terrestrial-based food items (Jarvis and Southern 1976) relative to Herring Gulls which feed more predominately on fish (Fox *et al.* 1990).

Black-crowned Night-Heron eggs were collected from Nottawasaga Island in Georgian Bay and Channel Shelter Island on the U.S. side of Lake Huron in 2000 and analyzed as pooled samples for contaminant analysis (Figure 19; Jermyn-Gee *et al.* 2005). Levels of DDE, total PCBs and heptachlor epoxide in eggs from Nottawasaga Island ranged from approximately one-quarter to three-quarters of those in eggs from Channel Shelter Island; levels of mirex were 4.5 times higher in eggs from Nottawasaga Island compared to those from Channel Shelter Island. Interestingly, mercury concentrations were higher in eggs from Nottawasaga Island (0.29 μg/g) compared to levels in eggs from Channel Shelter Island (0.17 μg/g).

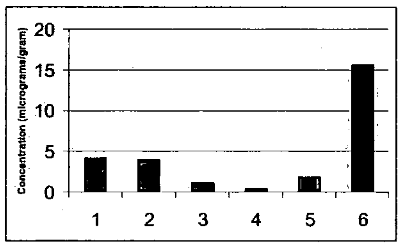
Great Black-backed Gull eggs (usually two to three) were collected from Halfmoon Island in Georgian Bay in 1994 and analyzed as a pooled sample for contaminants (Figure 19; Pekarik *et al.* 1998). Levels of DDE, sum PCBs, mirex, total chlordane and heptachlor in Great Black-backed Gull eggs collected from Halfmoon Island in 1994 were two to five times higher than those found in Herring Gull eggs collected from this site in the same year. Levels of sum PCBs and DDE in Great Black-backed Gull eggs collected from Halfmoon Island were approximately one-half and two-thirds, respectively, of levels found in Great Black-backed Gull eggs collected from Little Galloo Island in Lake Ontario in 1994. It is unclear to what extent Great Black-backed Gulls nesting on Lake Ontario might be affected by contaminants; they have been breeding regularly at several locations in eastern Lake Ontario since the 1970s (Angehrn *et al.* 1979; Weseloh 1984).

Figure 19. Contaminant levels in Double-crested Cormorant (DCCO, 1995), Ring-billed Gull (RBGU, 1994), Black-crowned Night-Heron (BCNH, 2000) and Great Black-backed Gull (GBBG, 1994) eggs at selected Lake Huron sites (Pekarik *et al.* 1998; Jermyn-Gee *et al.* 2005).

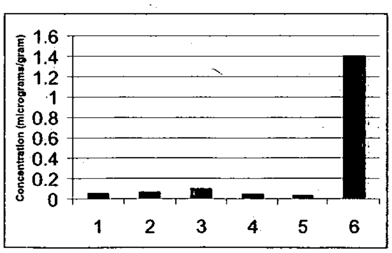




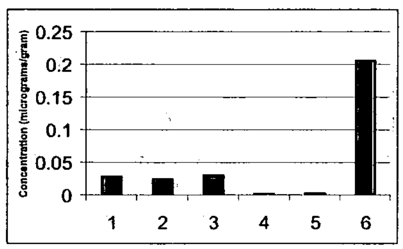
a) DDE



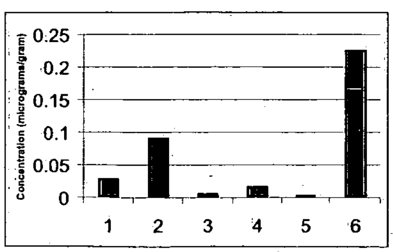
b) Sum PCBs



c) Total chlordane



d) Heptachlor epoxide



e) Mirex

iii) Terns: Caspian Tern, Common Tern and Black Tern

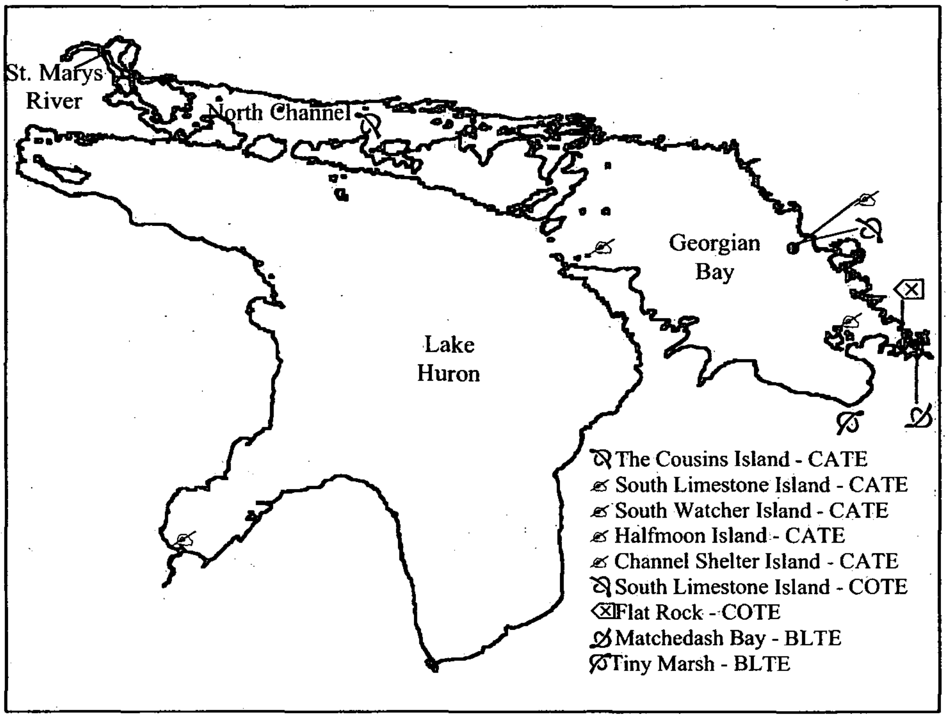
Ten Caspian Tern eggs were collected from each of five sites on Lake Huron in 1991 and analyzed for contaminants separately as pooled samples: The Cousins Island (North Channel), South Limestone Island (Georgian Bay), South Watcher Island (Severn Sound), Halfmoon Island (main basin of Lake Huron) and Channel Shelter Island (Saginaw Bay) (Figure 20). Levels of DDE, total chlordane and heptachlor epoxide were consistently highest in eggs from The Cousins Island, followed second by South Watcher Island. Levels of sum PCBs were highest in eggs from Channel Shelter Island relative to the other four sites. South Limestone Island in Georgian Bay consistently had the lowest level of these contaminants. In contrast, levels of 2,3,7,8-TCDD were highest in eggs from South Limestone Island (26 pg/g) relative to the other sites. The highest levels of mirex were reported in Caspian Tern eggs from South Watcher Island and South Limestone Island, which suggest that these birds may spend some time feeding on prey from Lake Ontario. Levels of sum PCBs, total chlordane, heptachlor epoxide and mirex were slightly higher (1.2-1.6 times) in Caspian Tern eggs from South Limestone Island compared to levels detected in Common Tern eggs collected from this island in the same year; levels of DDE were very similar for the two species; 2,3,7,8-TCDD levels in Caspian Tern eggs were also higher than that found in Common Tern eggs (17 pg/g). Caspian Terns have a lower metabolic rate than Common Terns and are less likely to be affected by contaminants than Common Tern. Levels of contaminants in Caspian Terns from Lake Huron in 1991 did not appear to cause adverse effects on reproduction at the population level since clutch size, hatching success, and reproductive output were considered high (Ewins *et al.* 1994); this is following a period of slow population growth for Caspian Terns on Canadian Lake Huron from 1980 to 1989 (Blokpoel and Tessier 1997).

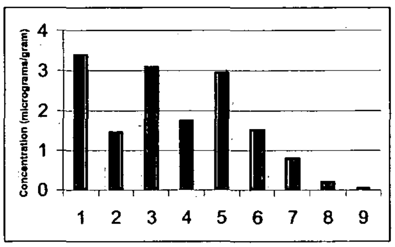
Ten Common Tern eggs were collected from South Limestone Island (Georgian Bay) and Flat Rock (Severn Sound) in 1991 and analyzed as pooled samples for contaminants (Figure 20). In contrast to the pattern observed for Caspian Terns, levels of DDE, sum PCBs, total chlordane and mirex were at least 1.3 times higher in eggs from South Limestone Island compared to eggs from Flat Rock. Levels of 2,3,7,8-TCDD were 2.4 times higher in Common Tern eggs from South Limestone Island (17 pg/g) relative to eggs collected from Flat Rock (7 pg/g). It is not clear how much of an impact toxic chemicals have had on reproductive success of Common Terns; the relative sensitivity of Common Terns to the effects of chemical contamination has been examined through biochemical induction studies (Lorenzen *et al.* 1997).

Ten fresh Black Tern eggs were collected from Matchedash Bay in 1996 and Tiny Marsh in 1999 and analyzed as a pooled sample for contaminants (Weseloh *et al.* 1997; Jermyn-Gee *et al.* 2005; Figure 20). Contaminant concentrations in eggs from Matchedash Bay were 2.3 to 10.2 times higher than concentrations found in eggs from Tiny Marsh. While Matchedash Bay is situated on the Lake Huron shoreline in Severn Sound, Tiny Marsh is located approximately three kilometres inland from Nottawasaga Bay, the southernmost lobe of Georgian Bay; this likely accounts for differences in contaminant concentrations at the two sites. Noteworthy is that the Black Tern eggshells from Matchedash Bay were the thinnest reported for all Ontario and Quebec collection sites and were 12.9% thinner than pre-DDT 1947 values (Weseloh *et al.* 1997); a range of 15%-20% eggshell thinning is generally associated with eggshell-induced reproductive problems (Weseloh *et al.* 1983). Nonetheless, reproductive success at these sites does not appear to be impaired (CWS, unpublished).

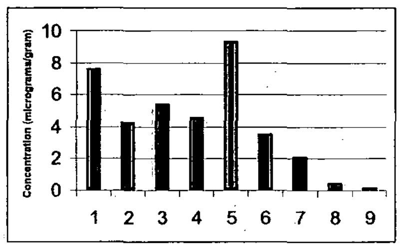
Total mercury analyzed in the pooled sample of 10 eggs from Tiny Marsh in 1999 was equal to 0.15 μg/g wet weight (Jermyn-Gee *et al.* 2005); this concentration is below levels reported in other tern species in which no effects on reproduction were noted (Koster *et al.* 1996). This concentration is similar to concentrations found in Herring Gull eggs collected from Double Island (0.16 μg/g) and Chantry Island (0.13 μg/g) in 1999. This may be noteworthy since contaminant levels in Black Tern eggs have been reported to be an order of magnitude less than those found in Herring Gull eggs collected from the same island (Weseloh *et al.* 1997), due to their largely insectivorous diet supplemented with fish, if available (Dunn and Agro 1995).

Figure 20. Contaminant levels in Caspian Tern (CATE, 1991), Common Tern (COTE, 1991) and Black Tern (BLTE, 1996 and 1999) eggs at selected Lake Huron sites (Ewins *et al.* 1994; Pettit *et al.* 1994; Martin *et al.* 1995; Weseloh *et al.* 1997; Jermyn-Gee *et al.* 2005).

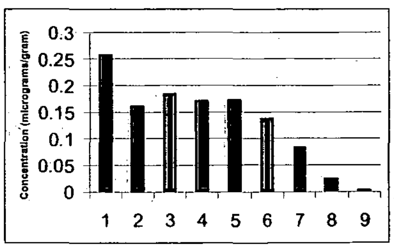




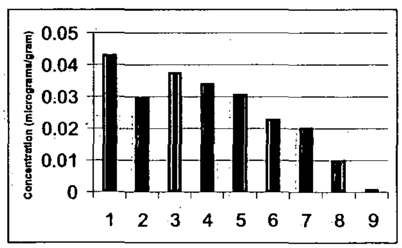
a) DDE



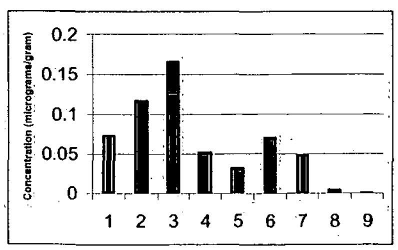
b) Sum PCBs



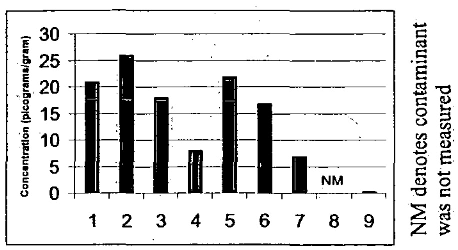
c) Total chlordane



d) Heptachlor epoxide



e) Mirex

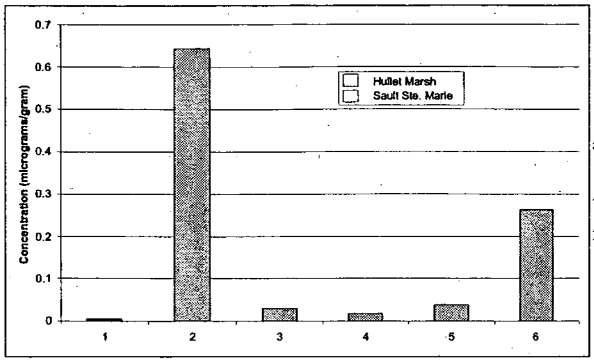


f) 2,3,7,8-TCDD

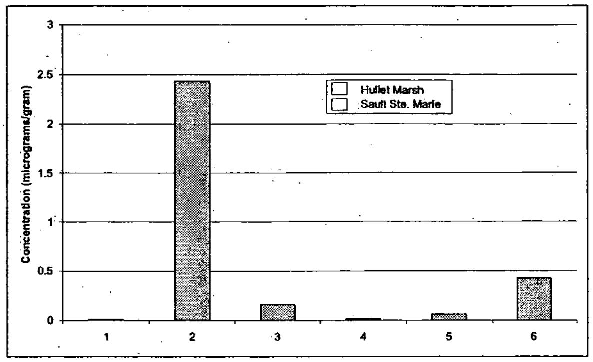
b) Waterfowl

Environmental contaminants were measured in pectoral muscle of waterfowl shot by hunters at three sites: Hullet Marsh (approximately 15 kilometres inland from Georgian Bay), Lake Simcoe/Georgian Bay and Sault Ste. Marie in the autumn of 1989 and 1990 (Braune *et al.* 1999). In total, 33 birds were collected, representing six different species, and analyzed as 11 pooled samples; one to eight birds of the same species made up a pooled sample. Contaminant levels reported in waterfowl are separated into two different groups based on their aquatic feeding habits. Mergansers, which include Common Merganser, Hooded Merganser and Red-breasted Merganser (*M. serrator*), feed predominately on fish and aquatic invertebrates; other sea ducks and bay ducks, which include Bufflehead, Common Goldeneye and Lesser Scaup (*A. affinis*), feed predominately on aquatic invertebrates and aquatic vegetation. With one exception, concentrations of all organochlorines, sum PCBs and mercury in pectoral muscle of all birds were low (less than 1.0 μg/g), were not associated with adverse effects in birds and did not pose a health hazard to consumers. The one exception was a Common Merganser shot in Sault Ste. Marie in 1989 which had the highest sum PCB concentration (2.44 μg/g) of all Canadian waterfowl and gamebirds collected across Canada from 1987 to 1995 (Braune *et al.* 1999). Mergansers from Sault Ste. Marie had higher or similar levels of DDE, sum PCBs, total chlordane and heptachlor epoxide relative to the one pooled sample of mergansers from Hullet Marsh (Figure 21). Contaminant levels were similar in sea and bay ducks from Georgian Bay and Sault Ste. Marie (Figure 22). Interestingly, levels of mercury were higher in mergansers from Hullet Marsh and sea ducks from Georgian Bay relative to comparable birds from Sault Ste. Marie. It should be noted that metal residues tend to accumulate in liver and kidney, rather than pectoral muscle, which is not considered to be a major target for bioaccumulation of heavy metals (Braune *et al.* 1999).

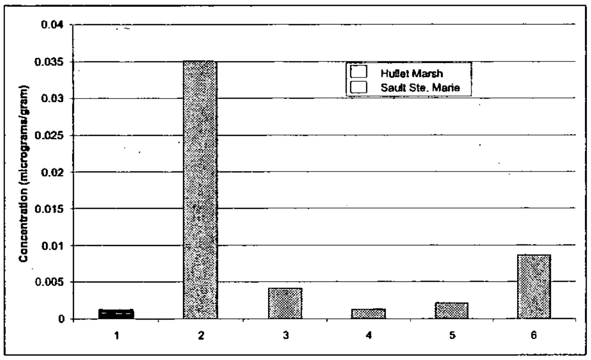
Figure 21. Levels of contaminants in pectoral muscle of mergansers shot at Hullet Marsh and Sault Ste. Marie in 1989 and 1990 (Braune *et al.* 1999). Species collected and number analyzed (n) are as follows: 1 – Hooded Merganser n=2; 2 – Common Merganser n=1; 3 – Common Merganser n=3; 4 – Hooded Merganser n=4; 5 – Hooded Merganser n=1; 6 – Red-breasted Merganser n=1.



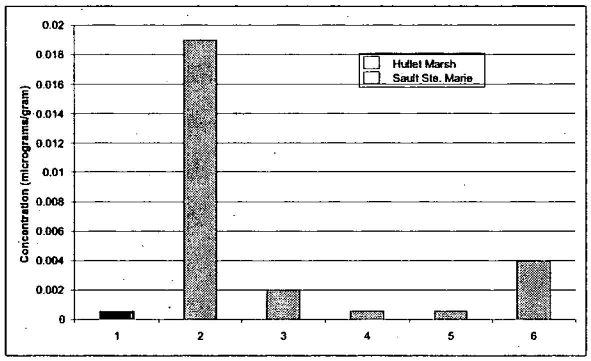
a) DDE



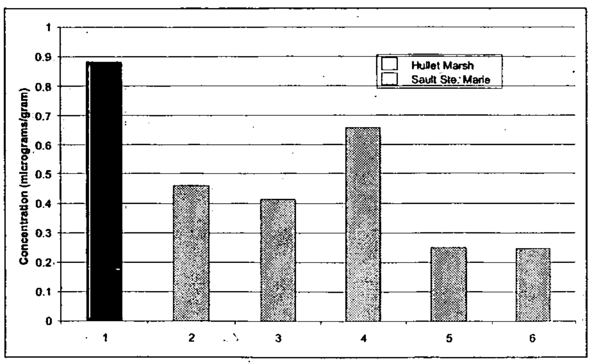
b) Sum PCBs



c) Total chlordane

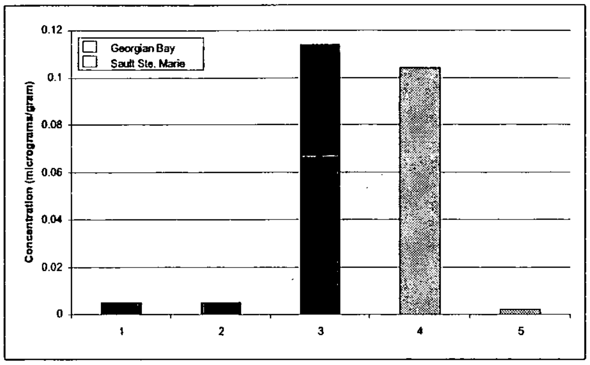


d) Heptachlor epoxide

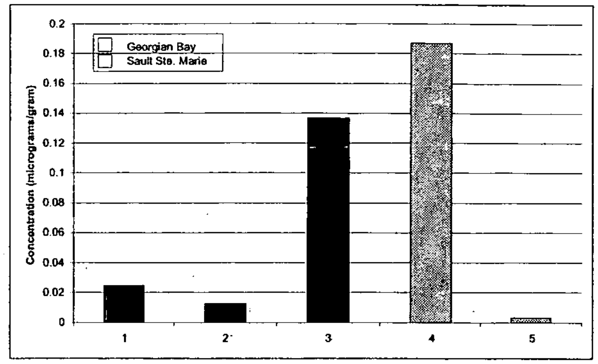


e) Mercury

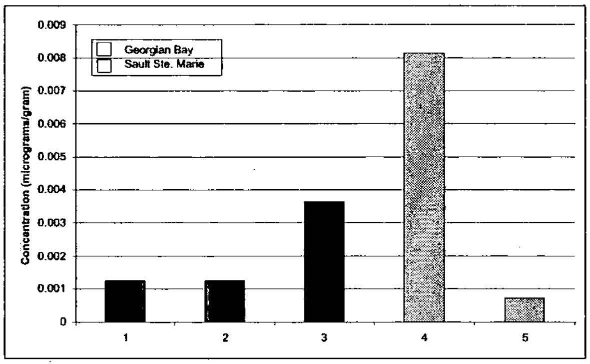
Figure 22. Levels of contaminants in pectoral muscle of sea and bay ducks shot at Georgian Bay and Sault Ste. Marie in 1989 and 1990 (Braune *et al.* 1999). Species collected and number analyzed (n) are as follows: 1 – Lesser Scaup n=7; 2 – Bufflehead n=3; 3 – Common Goldeneye n=8; 4 – Common Goldeneye n=2; 5 – Common Goldeneye n=1.



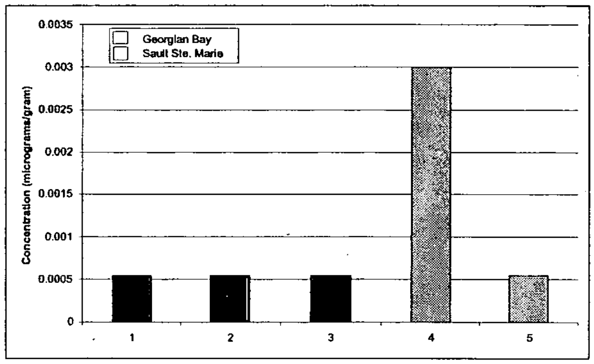
a) DDE



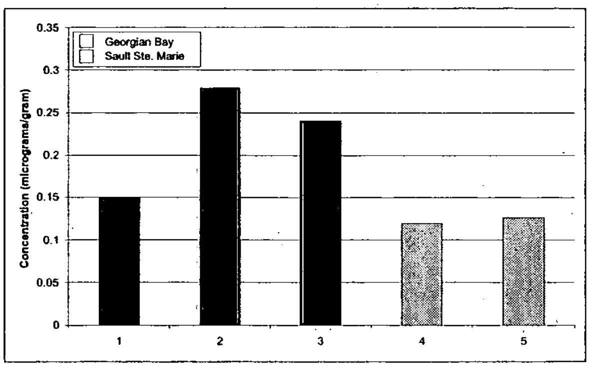
b) Sum PCBs



c) Total chlordane



d) Heptachlor epoxide



e) Mercury

c) Birds of Prey

i) Bald Eagle

As top predators, Bald Eagles are highly suspectible to the effects of toxic contaminants. At present, very little contaminant data exists for Bald Eagles on the shores of Lake Huron. As part of the Southern Ontario Bald Eagle Monitoring Project, a blood sample was collected from one eaglet (between five to eight weeks old) at a nest on Georgian Bay in 1994 (Donaldson *et al.* 1999). Contaminant levels in Bald Eagle chick plasma for this eaglet were as follows: DDE: 0.063 µg/g; sum PCBs: 0.092 µg/g; sum chlordane (including heptachlor epoxide): 0.044 µg/g; dieldrin: 0.007 µg/g; and sum mirex: 0.002 µg/g. While contaminant levels reported for this one eaglet were in the range of levels reported in chicks sampled from Lake Erie and Lake Superior sites, levels of all contaminants except sum PCBs in this eaglet were also higher than mean contaminant levels reported for the two other Great Lakes sites. Extensive work has been done on monitoring contaminants and productivity of Bald Eagles nesting along the U.S. side of the Lake Huron shoreline (Best *et al.* 1994; Bowerman *et al.* 1994).

The overall health of adult Bald Eagles must be considered when examining the success and long-term sustainability of a nesting population. Decreased adult survival, namely due to exposure to heavy metals, has been identified as of concern for Bald Eagles nesting along the Great Lakes shoreline in Ontario; in the last few years, several Bald Eagles found dead in Ontario have had elevated levels of both mercury and lead in their bodies (Badzinski and Richards 2002). Bald Eagles may be exposed to these metals during migration at locations away from the Great Lakes. Adult longevity and nest occupancy turn-over rates including age of replacement birds, are important factors which will ultimately determine how successful nesting Bald Eagles are on the shores of Lake Huron.

ii) Osprey

Concentrations of DDE in eggs and plasma sampled from 1991 to 1993 were significantly higher in Osprey from Georgian Bay than those from the St. Marys River (Tables 4 and 5), Kawartha Lakes region and Ogoki Reservoir in northern Ontario (Martin *et al.* 2003). DDE concentrations of 4.2 µg/g in Osprey eggs have been associated with an average of 15% eggshell thinning (Wiemeyer *et al.* 1988). While mean concentrations of DDE in eggs from Lake Huron sites in 1991 and 1992 were lower than this critical value, four out of the 20 eggs collected from Georgian Bay exceeded this value. Furthermore, Ewins *et al.* (1995) found that the mean eggshell thickness of Osprey eggs collected in 1992 from Georgian Bay was below the pre-DDT value for the Osprey population (0.505 mm; Anderson and Hickey 1972). Due to fluctuating environmental conditions, Martin *et al.* (2003) suggest that a small proportion of Osprey in Georgian Bay may be at an increased risk of eggshell thinning as a result of elevated levels of DDE. Levels of sum PCBs, total mirex (sum of mirex and photomirex), total chlordane, heptachlor epoxide and 2,3,7,8-TCDD in Osprey eggs and plasma are also shown in Tables 4 and 5.

Table 4. Mean levels (± SD) of contaminants (µg/g) in Osprey eggs collected from St. Marys River and Georgian Bay from 1991-1992 (Martin *et al.* 2003). Mean 2,3,7,8-TCDD levels (pg/g) represent the mean level of two pooled samples of eggs collected in 1992.

Site	N	DDE	Sum PCBs	Total Mirex	Total Chlordane	Heptachlor Epoxide	2,3,7,8-TCDD
St. Marys River	10	1.71 ± 0.47	3.51 ± 1.07	0.04 ± 0.04	0.10 ± 0.04	0.02 ± 0.004	5.85 ± 0.35
Georgian Bay	20	2.90 ± 2.33	3.70 ± 3.06	0.05 ± 0.04	0.11 ± 0.10	0.01 ± 0.009	5.55 ± 1.91

Table 5. Mean levels (± SD) of contaminants (µg/g) in plasma of Ospreys collected from St. Marys River and Georgian Bay from 1991-1993 (Martin *et al.* 2003).

Site	N	DDE	Sum PCBs	Total Mirex	Total Chlordane	Heptachlor Expoxide
St. Marys River	17	0.010 ±0.006	0.060 ± 0.026	0.0005 ± 0.0003	0.0035 ± 0	0.0004 ± 0.0004
Georgian Bay	15	0.065 ± 0.052	0.100 ±0.060	0.0019 ± 0.001	0.010 ± 0.01	0.0005 ± 0.0005

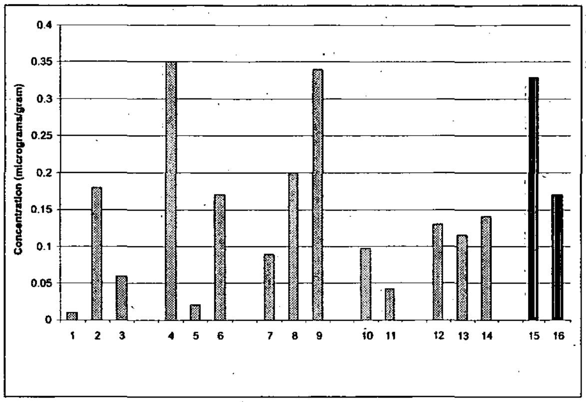
Mercury levels in Osprey eggs, chick feathers and adult feathers did not approach levels associated with toxic reproductive effects. Mean mercury levels (+SD, dry weight) in eggs collected from Georgian Bay and St. Marys River in 1991 and 1992 were not significantly different from each other and were equal to 0.8 + 0.6 µg/g (n=17) and 0.6 + 0.2 µg/g (n=8), respectively. Mean mercury levels (+SD, dry weight) in chick feathers from St. Marys River and Georgian Bay were equal to 7.4 + 1.4 µg/g (n=12) and 4.6 + 1.6 µg/g (n=13), respectively; mean mercury levels (+SD, dry weight) in adult feathers from St. Marys River and Georgian Bay were equal to 28.8 +16.2 µg/g (n=2) and 21.1 + 15.8 µg/g (n=5), respectively (Hughes *et al.* 1997). Mean productivity for Osprey on Georgian Bay and St. Marys River in 1994 was 1.05 and 0.91 young per occupied nest, respectively (Martin *et al.* 2003); mean productivity is higher than 0.8 young per occupied nest, a value considered necessary to maintain a stable population (Spitzer 1980). While Osprey appear to be good indicators of local contaminant conditions, generally, the Canadian Lake Huron Osprey population does not appear to be affected by the current level of contaminants (Martin *et al.* 2003).

d) Amphibians and Reptiles

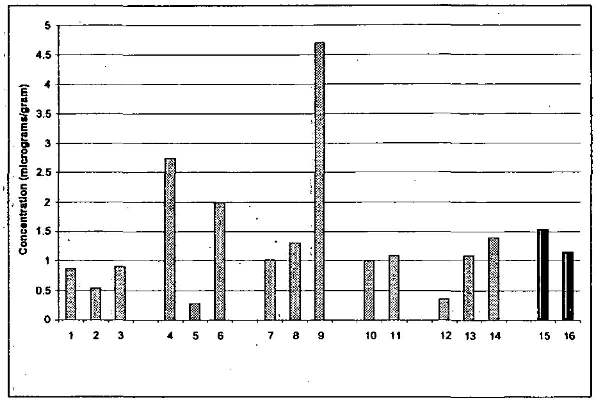
Snapping turtles (*Chelydra serpentina*) are ideal monitors of wetland health because of their sedentary nature, their position as a top predator in the food chain and their ability to accumulate high levels of contaminants over the course of their long lives. In 1984, 10 snapping turtle eggs from each of four clutches were collected at two sites near Port Franks (Pinery Provincial Park and Thedford Conservation Area) on the southeastern shore of the main basin of Lake Huron; these eggs were analyzed for contaminants (Struger *et al.* 1993; Figure 23). With the exception of sites on the Bay of Quinte (sites 4-6) and Hamilton Harbour (sites 8 and 9), levels of DDE, dieldrin, heptachlor epoxide and sum PCBs were generally higher at the two Lake Huron sites relative to the other Great Lakes sites; mirex levels were lower compared to the other sites. In the Great Lakes, the pattern of geographic variation observed for some contaminants in snapping turtle eggs is similar to variation reported in spottail shiners (*Notropis hudsonius*) and Herring Gull eggs (Struger *et al.* 1985; Suns *et al.* 1991) suggesting that this species is valuable for monitoring contaminants in wetland environments.

The mudpuppy (*Necturus maculosus*) is a long-lived, benthic-feeding amphibian with the ability to accumulate high levels of contaminants. High rates of skeletal deformities have been associated with exposure to elevated levels of chlorinated hydrocarbons (Bishop and Gendron 1998). While studied at other Great Lakes sites, contaminant levels and associated rates of developmental deformities in mudpuppies along the Lake Huron shoreline have not been assessed, to date.

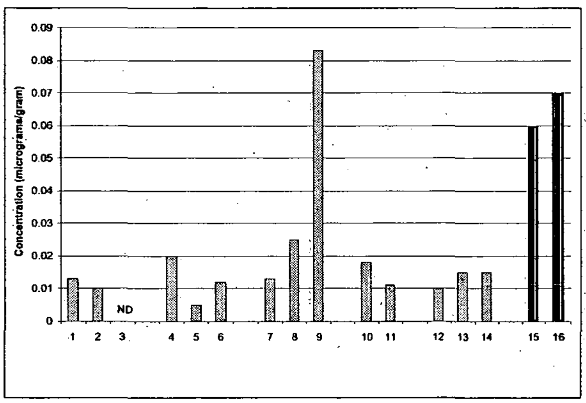
Figure 23. Levels of contaminants in snapping turtle eggs collected from 15 Great Lakes sites in 1984 and one site in 1981 (site 10) (Struger *et al.* 1993). Numbered sites are as follows: 1-3: St. Lawrence River (Loon I. and Hwy#2, Ingleside, Morrisburg); 4-6: Bay of Quinte, eastern Lake Ontario (South of Moira River, Sawguin Cr., Big I.); 7-9: western Lake Ontario (Lynde Shores Conservation Area and Hamilton Harbour (Cootes Paradise, Grindstone Cr.)); 10-11: Lake Erie (Big Creek National Wildlife Area, Rondeau Prov. Park); 12-14: Lake St. Clair (Thames River, St. Clair Nat. Wildlife Area, Mitchell Bay); 15-16: Lake Huron (Pinery Provincial Park, Thedford Conservation Area). "ND" = not detected.



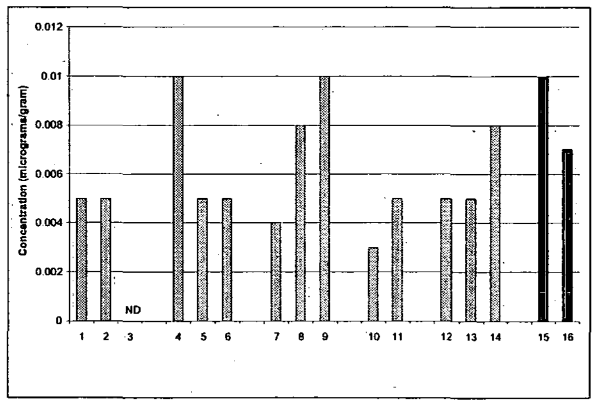
a) DDE



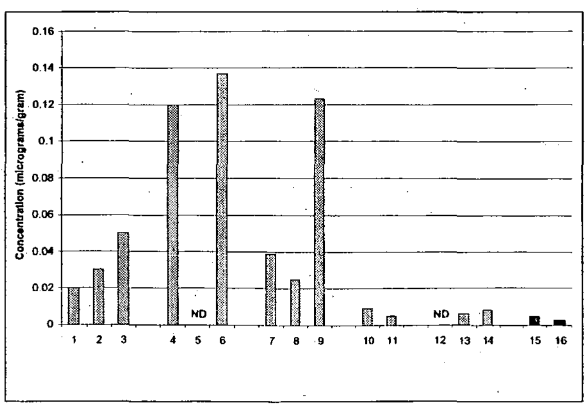
b) Sum PCBs



c) Dieldrin



d) Heptachlor epoxide



e) Mirex

e) Mammals – River Otter and Mink

Mink and otter are sensitive bioindicators of mercury in the aquatic environment (Wren *et al.* 1986). Mink, in particular, are excellent indicators of local contamination due to their relatively small home ranges. Concentrations of total mercury were determined in hair, liver and brain tissues of mink and otter collected in four townships in the Parry Sound region in 2001-2003 (Klenavic 2004; Table 6). Traplines from which animals were collected transected the township of Wallbridge, situated along the Georgian Bay shoreline, and adjacent townships of Harrison, Brown and Burton townships, which are further inland. Total mean mercury concentrations in tissues of otter were higher than those in corresponding tissues of mink.

Mean total mercury levels (+SD) in otter hair from the Wallbridge township in 1993 and 1994 were equal to 12.6 + 3.8 µg/g (n=4) and 9.72 + 0.41 µg/g (n=13), respectively (Evans *et al.* 1998; Mierle *et al.* 2000). Thus, mercury levels in otter hair appear to be within the range of levels found in earlier studies, as well as those found in other townships in southern Ontario (Mierle *et al.* 2000). Mierle *et al.* (2000) suggest that a lethal concentration for mercury in the brain of otter is in the order of 56.5 µg/g (dry weight); levels reported for Lake Huron otter are well below this threshold level.

Table 6. Mean total mercury concentrations ± SD, in µg/g (dry weight), in hair, liver and brain tissue collected from mink and otter in four townships in the Parry Sound region in 2001-2003 (Klenavic 2004). N indicates the number of individuals collected.

	N	Hair (µg/g)	Liver (µg/g)	Brain (µg/g)
Mink	6	3.93 ± 3.16	1.30 ± 1.33	0.51 ± 0.40
Otter	29	7.47 ± 3.28	4.71 ± 2.69	1.51 ± 1.19

IV. HABITAT – CURRENT STATUS

a) Wetlands

Wetlands along the Canadian shoreline of Lake Huron are generally found in the protected embayments of islands and the mainland where there is shelter from wave and wind action (Environment Canada and Ontario Ministry of Natural Resources 2003). Large numbers of wetlands are found on Manitoulin Island, Parry Sound area, Severn Sound area, and the western shore of the Bruce Peninsula. Relatively fewer wetlands are found along the eastern shoreline of the Bruce Peninsula in Georgian Bay where the shoreline is rugged with steep nearshore slopes that prevent the development of wetlands. Similarly, fewer coastal wetlands are found along the shoreline from Sarnia, Ontario at the bottom of Lake Huron to Point Clark (halfway up to the base of the Bruce Peninsula) due in part to the high-energy shoreline environment. On the St. Marys River, numerous wetlands are also found in protected areas of the river; extensive emergent wetlands are also found along the shores of St. Joseph Island and Drummond Island.

From 1983 to 1996, 55 wetlands were evaluated on the Canadian shores of Lake Huron and the St. Marys River (Environment Canada and Ontario Ministry of Natural Resources 2003). Table 7 provides a summary of evaluated Ontario coastal wetlands on Lake Huron and St. Marys River as well as, for comparison purposes, total figures for all of the Ontario Great Lakes and connecting channels. Of the 48 evaluated wetlands on Lake Huron, a number of these include natural areas (identified in the Natural Heritage Information Centre Natural Areas Database) that overlap or are adjacent to the evaluated wetland. The number of evaluated wetlands with a corresponding natural area include:

1) 22 wetlands in/adjacent to an Area of Natural and Scientific Interest (ANSI), including Wasaga Beach, MacGregor Point Wetland Complex and Spanish River Delta Marsh;
2) four wetlands in/adjacent to a Provincial Wildlife Area (PWA), including Wye Marsh and Matchedash Bay Marsh;
3) one wetland in/adjacent to a National Wildlife Area (NWA), namely Wye Marsh;
4) 11 wetlands in/adjacent to an International Biological Program (IBP) site, including Balm Beach Swamp, Sadler Creek Wetland Complex and Oliphant Wetland; and
5) one wetland, Matchedash Bay Marsh, which has been designated as a Ramsar site and recognized as a Wetland of International Importance under the Ramsar Convention (www.ramsar.org).

A complete listing of Lake Huron evaluated wetlands with corresponding natural areas that overlap or are adjacent to the evaluated wetland is provided in Appendix I. Of the seven evaluated wetlands on the St. Marys River, none have special designation status.

Table 7. Summary of evaluated Ontario Great Lakes coastal wetlands (from Environment Canada and Ontario Ministry of Natural Resources 2003).

Lake/Connecting Channel	Evaluated Wetland[1]			Wetland Area				Wetland Type			
	Number of Evaluated Wetlands	Number of PSW[2]	Number of NPSW[3]	Total Area (ha)	Mean Size (ha)	Smallest Wetland > 2 ha (ha)	Largest Wetland (ha)	Swamp (ha)	Marsh (ha)	Bog (ha)	Fen (ha)
Lake Huron[4]	48	41	7	7,459.0	155.4	5.0	807.4	3,768.8	3,227.7	16.1	447.8
St. Marys River	7	3	4	3,567.0	509.6	42.0	2,275.0	1,387.6	1,724.4	0	455.0
Total all Great Lakes/Connecting Channels[4]	236	175	61	53,619.5	227.2	2.0	13,465.0	11,358.2	41,200.1	95.7	964.3

[1] Number of evaluated wetlands counts a wetland complex as one wetland
[2] PSW=Provincially Significant Wetland
[3] NPSW=Non-Provincially Significant Wetland
[4] The total areas of swamp, marsh, bog and fen do not add up to the total size of wetland area due to percentage of wetland type being recorded as either under or over 100% in several original evaluations

In terms of unevaluated wetlands, Lake Huron and the St. Marys River regions have the greatest number of unevaluated wetlands on all of the Great Lakes and connecting channels equal to 151. As of the end of 1996, 97 unevaluated wetlands on Lake Huron were identified using data from the Natural Heritage Information Centre Natural Areas Database, the Environmental Sensitivity Atlas and the 1996 Ontario Ministry of Natural Resources (OMNR) District/Area Survey. Of these, 29 have been designated as ANSIs and six as IBPs. Of the 54 unevaluated wetlands on the St. Marys River, one has been designated as an ANSI (Marks Bay in the District of Sault Ste. Marie). In addition, the 1996 OMNR District/Area Survey identified that there are likely significantly more coastal wetlands that remain to be evaluated in Lake Huron, especially in the Parry Sound area, Manitoulin Island and Sudbury area, and the St. Marys River, including St. Joseph Island. Many of these wetlands are thought to be provincially significant and therefore contain species or habitat which are at risk.

Of the Great Lakes in Ontario, Lake Huron is one of the most diverse and important sites in terms of significant species: approximately half of the provincially significant plants, birds, herptiles, fish and lepidoptera of coastal wetlands are found in this lake (Environment Canada and Ontario Ministry of Natural Resources 2003). Wetlands in Lake Huron have more complex vegetation communities than those in the southern Great Lakes (Environment Canada and Ontario Ministry of Natural Resources 2003). The fens, which are commonly found in Lake Huron and Georgian Bay marshes, are known as coastal meadow marshes and have been identified as globally imperilled communities (Natural Heritage Information Centre 1995). The coastal wetlands of Lake Huron provide important habitat for fish, amphibian and reptile species. Prince *et al.* (1992) identified the marshes of Georgian Bay and St. Marys River as critical areas for waterfowl staging during migration and breeding in the Great Lakes. Wetlands also provide important habitat for fur-bearing animals including mink and otter. The numbers of provincially significant species by group on the Canadian side of Lake Huron and St. Marys River are as follows:

1) 48 plant species including bluehearts (*Buchnera americana*) and Gattinger's agalinis (*Agalinis gattingeri*);
2) 14 bird species including the Bald Eagle, Little Gull (*Larus minutus*), Least Bittern (*Ixobrychus exilis*) and King Rail (*Rallus elegans*);
3) six reptile and amphibian species including Eastern fox snake (*Elaphe vulpina gloydi*), Eastern Massasauga rattlesnake (*Sistrurus catenatus catenatus*), Eastern spiny softshell turtle (*Apalone spinifera*) and Jefferson salamander (*Ambystoma jeffersonianum*);
4) five fish species including lake chubsucker (*Erimyzon sucetta*) and pugnose shiner (*Notropis anogenus*); and
5) two lepidopteran species, namely mulberry wing *(Poanes massasoit)* and two-spotted skipper (*Euphyes bimacula*).

A complete listing of provincially significant species found in the coastal wetlands of Lake Huron and the St. Marys River is provided in Appendix II.

Sixteen Important Bird Areas (IBA) are found along the Canadian shoreline of Lake Huron, encompassing a total of 1,583 square kilometres of essential habitat for one or more species of breeding and non-breeding birds. A complete listing of IBAs located along the Lake Huron shoreline is provided in Appendix III (information obtained from the Canadian BirdLife International co-partners [Bird Studies Canada and the Canadian Nature Federation] on-line IBA Site Directory at www.bsc-eoc.org/iba/canmap.jsp). Chantry Island is also recognized as a Migratory Bird Sanctuary (MBS), representing nationally significant habitat for migratory birds.

Comprehensive estimates of coastal wetland loss are not available for the Canadian shore of Lake Huron. On Lake Huron, within the last 15 years, loss of wetland habitat appears to have been incremental and site-specific; wetland loss on a large scale has not occurred because most of the shoreline is remote and sparsely populated (Environment Canada and Ontario Ministry of Natural Resources 2003). In Severn Sound in Georgian Bay, the main causes of wetland loss were identified as shoreline modification, road construction, low water levels, filling for urban and cottage development and dredging and channelization associated with marina development (Severn Sound Remedial Action Plan 1993). Additional stressors which threaten remnant wetlands around the shore of the North Channel and northern and southern Georgian Bay include cottaging, subdivision development and road crossings. Wetlands in the bays of southern Georgian Bay have also been affected by excessive phosphate inputs and sediment loadings originating from point and non-point sources (Severn Sound Remedial Action Plan 1993). Through a number of initiatives directed in the Severn Sound Remedial Action Plan, phosphorus loadings have been significantly reduced in this area; Severn Sound was delisted as an Area of Concern (AOC) in January 2003.

Most of the evaluated wetlands on the Canadian side of the St. Marys River have suffered some loss primarily from shoreline modification, dredging, filling, channelization and cottage development (Environment Canada and Ontario Ministry of Natural Resources 2003). Additional stressors to wetlands in this area include high levels of contaminants in localized sediment (Nichols *et al.* 1991) and increased wave action, erosion, turbidity and dredging associated with commercial shipping (Environment Canada and Ontario Ministry of Natural Resources 2003).

The Great Lakes Coastal Wetlands Consortium was formed with the purpose of designing a long term monitoring strategy in order to assess the health of coastal wetlands in the Great Lakes basin. The consortium consists of scientific and policy experts from Canadian and U.S. governments at the federal, provincial or state level non-profit agencies and other interest groups. This strategy is being accomplished using flora and fauna indicators (plant community, invertebrate, bird and amphibian), in association with physical characteristics and landscape measures of the coastal wetland. The initial phase of the project was to develop and assess the metrics and methodologies for these indicators which could then be refined and adopted as a standard, long-term monitoring protocol for Great Lakes coastal wetlands into the future. In 2002, six pilot projects were initiated by different agencies at a variety of coastal wetland sites to evaluate these bioindicators and assess the standard methodologies. Following data collection at these sites, the consortium is continuing to refine and develop these methodologies for implementation throughout the Great Lakes basin.

On the Great Lakes, changes in water levels due to climate change will result in changes to wetland communities along the shoreline. Environment Canada and a number of other collaborators have initiated a study examining the vulnerability of Great Lakes coastal wetland ecosystems to water level change as a surrogate for climate change. Use of historical aerial photos taken during periods of low and high water levels over the past century on Great Lakes coastal wetland sites and air photo interpretation will examine changes in wetland plant community distribution and abundance in response to changes in water levels. Subsequent computer modelling will provide temporal and spatial trend analysis of areas of wetland vegetation change and the relationship between vegetation to elevation and water level fluctuations. Among other Great Lakes sites, three Lake Huron wetland sites (fens) have been selected for analysis: Baie du Dore, Oliphant and Howendale; these sites are of particular interest since their historical vegetation in response to changing water levels have never been examined rigorously. The development and application of a wetland vegetation response model and habitat suitability models due to water level changes will provide an indication of projected changes to plant, fish and bird community structure at coastal wetland sites in response to climate change.

b) Bald Eagle and Osprey Habitat

Aerial surveys of the Canadian and U.S. shoreline of Lake Huron in 1992 indicate that 76% of the shoreline can be classified as potentially suitable (i.e., good or marginal) nesting habitat (Bowerman *et al.* in review). Habitat was scored based on variables which included: tree cover, proximity and type/amount of human disturbance, potential foraging habitat/shoreline irregularity and suitable trees for perching and nesting. Based on these variables, there appears to be adequate habitat available for breeding Bald Eagles on the shores of Lake Huron. Since 1992, however, the extent of loss of Bald Eagle nesting habitat due to forest harvest and lakeshore development is unknown.

In locations where natural nesting sites (large live or dead trees) are not available, Osprey will use artificial structures, such as hydro poles, transmission line towers and buildings, to reproduce. The rapid occupation of artificial structures by Osprey at sites in the Great Lake basin since 1945 suggest that suitable nesting habitat may have been in short supply (Ewins 1996). On the shores of Lake Huron, the successful introduction of nesting platforms has provided additional nesting structures for Osprey: 82% of nesting platforms on Lake Huron were occupied within the first year of installation (Ewins 1996). Furthermore, nests on artificial platforms are less likely to be blown down by wind, and if outfitted with anti-predator guards, provide protection from predators such as racoons. The proportion of occupied nests that occurred on artificial structures versus natural sites was high on Georgian Bay and St. Marys River in the early 1990s (71% and 44% respectively). Reproductive output from nests on artificial structures was similar or higher than at natural sites on Georgian Bay and St. Marys River, respectively (Ewins 1996). Efforts to install artificial Osprey platforms have slowed down in recent years and requests to refurbish platforms in use are directed to the Georgian Bay Osprey Society (R. Black, OMNR, pers. comm.). While Osprey are generally tolerant of human activities, increased boat traffic may influence nesting activity of birds.

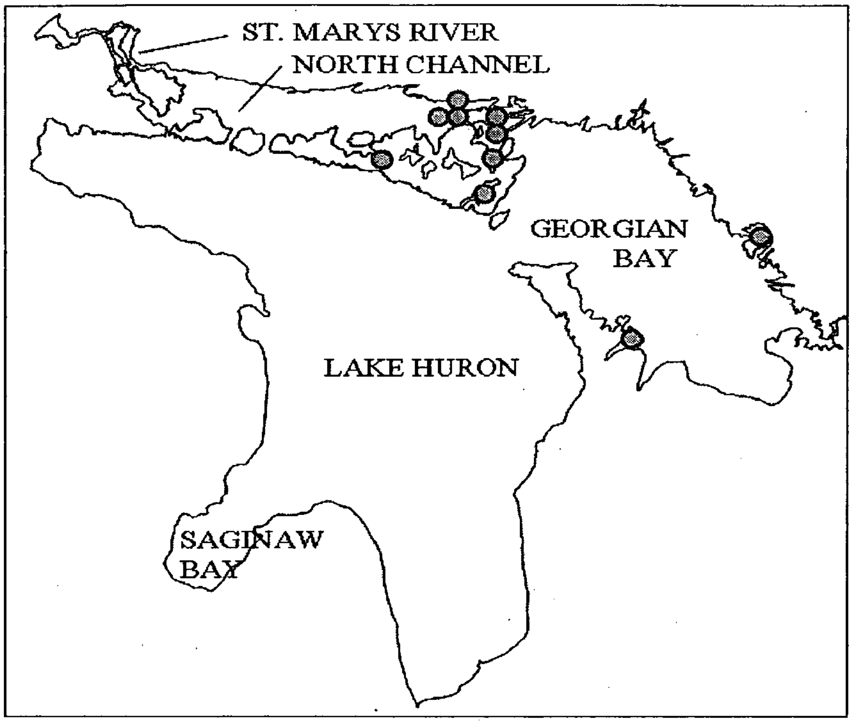
c) Other Habitat Concerns

1. Destruction of vegetation due to nesting by Double-crested Cormorants
Loss of vegetation due to nesting cormorants has been identified as a concern in some Great Lakes areas. On Lake Huron, Double-crested Cormorants nest primarily on the ground, mostly on small treeless islands or on dead or dying deciduous trees. In locations where Double-crested Cormorants nest in shrubs and trees such as Nottawasaga Island, vegetation destruction may not be of great concern since the vegetation is abundant on many nearby islands on which cormorants do not nest (Weseloh *et al.* 2002).

2. Impacts of nesting Double-crested Cormorant on other colonial waterbird species
As the number of nesting Double-crested Cormorants continues to increase on the Canadian side of Lake Huron, the potential for impact on other colonial waterbird species nesting at the same sites (through increased interactions and/or competition for nesting sites) must be considered. Of particular interest is a declining number of Caspian Tern nests (or in some cases, a complete loss of a colony) at Lake Huron colonies where an increase in the number of Double-crested Cormorant nests has also been observed. Cuthbert *et al.* (2002) have found that population trends of Lake Michigan Great Blue Herons and Black-crowned Night-Herons do not indicate cormorants have negatively influenced breeding distribution or productivity of either species at a regional scale. At Lake Huron sites, the number of Black-crowned Night-Heron nests has increased over the past decade and there is no evidence of displacement of Black-crowned Night-Herons from their colony site by Double-crested Cormorants but research is ongoing (D.V. Weseloh, CWS, pers. comm.). Monitoring of cormorant autumn roosting sites is important since they may become potential nesting sites in the spring (Weseloh *et al.* 2002); this may be especially important at new Caspian Tern sites where nesting cormorants are not present.

3. Aquaculture Operations
Aquaculture facilities can cause eutrophication, phosphorus increase, algal blooms, oxygen depletion and localized sediment impairment. Significance of the impact can vary depending on loadings, site morphometry and flushing rates during different times of the year. There are currently 10 rainbow trout aquaculture cage operations on the Canadian shores of Lake Huron, namely in the North Channel and Georgian Bay (Figure 24). In terms of environmental concerns, water quality data suggest that generally nutrient levels at farm limits are not different compared to background levels (Lake Huron Initiative Action Plan 2002). Aquaculture cages are covered with nets and, therefore, predation by Double-crested Cormorants on cultured fish stocks at these sites does not appear to be a concern for the aquaculture facility operators (D. Reid, OMNR, pers. comm.)

Figure 24. Existing aquaculture cage operations on Lake Huron in 2003 (D. Reid, OMNR, pers. comm.).

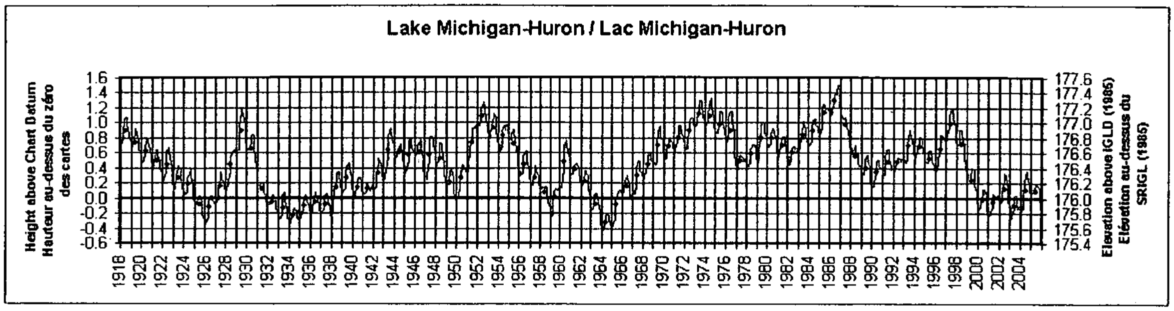


4. Lake Levels

Great Lakes water levels fluctuate as the result of several natural factors and are also influenced by human activities. Three types of water level fluctuations occur on the Great Lakes; short-term (lasting from less than an hour to several days), seasonal (one-year), and long-term (multi-year). Wind generated waves are superimposed on all three categories of water level fluctuations (Department of Fisheries and Oceans 2006a). Figure 25 provides a graphical representation of the 1918-2005 monthly and yearly mean water levels from the coordinated water level gauging network for Lake Michigan and Lake Huron. As indicated in the figure, lake levels were above Chart Datum (176.0 metres International Great Lakes Datum [IGLD] 1985) from 1967 to 2000, with record high lake levels reported in 1986. In 2000, lake levels dropped to this reference point, and have since fluctuated around this height. Indeed, current lake levels are well below long-term averages for Lake Huron (Department of Fisheries and Oceans 2006c). Although opinions vary on the effect a change in climate may have on the Great Lakes, computer models suggest that supplies of water to the lakes may drop dramatically. The mean levels of water in Lake Michigan and Lake Huron may drop by 100 centimetres, the most of all Great Lakes, over the next 35 to 55 years (Mortsch *et al.* 2000).

Natural water level fluctuations are beneficial to coastal wetland habitat and increase the diversity of flora and fauna communities. Extreme or extended periods of high or low water levels, however, can compound the effects of natural lake processes and cause undesirable results. High water levels are of concern for those that live along the shoreline, since they can combine with other factors, such as storms, to cause serious flood and erosion problems. On the other hand, lower lake levels pose safety concerns for boaters, increased costs for commercial ships carrying lighter loads, wetland loss, and generate water quality concerns where, in areas of warm and shallow water, there may be increased bacterial and algal growth along the shoreline. Many tern species are sensitive to changes in water levels. On Lake Huron, Common Terns were found to frequently nest on pebble shoals which makes them vulnerable to changes in lake water levels, especially since these shoals were often situated less than one metre above the water level at their highest point (Pekarik et al. 2003). During periods of increased wave and wind action, the nests may be washed out and, over the longer term, periods of high lake levels may reduce the availability of suitable nesting habitat. During periods of low lake levels, these nests may also be vulnerable since these pebble shoals may become connected to the mainland, thereby exposing the eggs or chicks in the nests to land predators.

Figure 25. A graphical representation of the Historical Monthly and Yearly Mean Water Levels from the coordinated water level gauging network for Lake Michigan and Lake Huron (Department of Fisheries and Oceans 2006b).



V. CONCLUSIONS

The waters of Lake Huron support an abundant and diverse community of aquatic wildlife which rely on its resources and surrounding habitat for survival. Changes in population size are related to changes in food availability, competition between and among species, mortality due to predation and changes in abiotic environmental conditions such as contaminants and weather. Often it is the magnitude of these changes, either on a lake-wide or regional level, and the related impacts on the survival of other species, which trigger further studies. Since the 1970s, the breeding population of Double-crested Cormorants has increased dramatically on the shores of Lake Huron (Weseloh *et al.* 1995). Its large population growth coupled with its large population size (32,000 nests) in 2000 is of increasing interest, both from management and scientific perspectives. On a smaller scale, Great Black-backed Gulls and Great Egrets have also been successful and have slowly colonized the shores of Lake Huron (10 and 60 nests, respectively) since 1980 when no nests of these species were recorded on the lake. Ring-billed Gulls and Herring Gulls, two species which have historically been very successful nesters on Lake Huron, showed lake-wide annual rates of decline between survey periods (-4.6% and -1.6%, respectively). A high annual rate of decline observed in the numbers of Caspian Tern nests on Lake Huron (-5.1%) is noteworthy given that overall the Great Lakes Caspian Tern population is increasing. On a lake-wide basis, numbers of Common Tern nests on Lake Huron are also decreasing, albeit at a slower rate (-0.4%) though a wide range in annual rates of change was detected among the three regions of Lake Huron between survey periods (-8.6% on the main body of Lake Huron to +3.2% on the North Channel). The number of nesting Black Terns on Lake Huron decreased between 1991 and 2001, similar to the pattern observed at other Great Lakes basin sites; Forster's Terns were absent from Lake Huron sites surveyed in 2001. Little information is available with regard to waterfowl usage during periods of migration and breeding along the Lake Huron shoreline. Routine monitoring of Bald Eagle and Osprey nests and productivity are not performed along most of the Canadian Lake Huron shoreline; temporal trends in nest numbers of both species on Lake Huron over the past decade are unclear at this time. Significant changes in abundance and occurrence were reported in some marsh-nesting birds and amphibians, respectively, in the Lake Huron basin as identified in the Marsh Monitoring Program from 1995-2001; additional years of monitoring data are necessary to more precisely estimate these trends. Amphibian populations occurring inland in the Lake Huron basin are also being monitored through the Amphibian Road Call Count and Backyard Frog Survey programs; population trends are not yet available but will be in the near future. Generally, the abundance of mink and otter was rated as common in districts along the Lake Huron shoreline, with the exception of Owen Sound where otter abundance was considered scarce.

Currently, contaminant levels in eggs are low compared to levels reported in the 1970s where near reproductive failure was noted in a number of colonial waterbird species nesting on the Great Lakes (Gilman *et al.* 1977; Weseloh *et al.* 1983). Furthermore, current contaminant levels in colonial waterbird eggs are likely not affecting the reproductive success of these species. Contaminant levels in waterfowl collected in 1989 and 1990 were below those considered harmful to wildlife and human consumption. While contaminant levels in Lake Huron Bald Eagles and Osprey are likely not high enough to elicit population-level effects, factors such as limited food availability influencing adult foraging behaviour and/or productivity and elevated levels of metals in adults may be of increasing concern for this top predator. Contaminant levels in snapping turtle eggs collected in 1984 from two Lake Huron sites were higher than levels reported in eggs collected from sites on the St. Lawrence River, Lake Erie and Lake St. Clair. Mercury levels in mink and otter tissues were below those associated with toxic effects. Ideally, Lake Huron sites showing low contaminant levels for some aquatic species may serve as reference sites for those found at more contaminated Great Lakes sites.

Wetlands provide important habitat for fish, amphibians, reptiles, avian and mammal species. From 1983 to 1997, over two hundred coastal wetlands were identified on Lake Huron and the St. Marys River (Environment Canada and Ontario Ministry of Natural Resources 2003). Evaluated wetlands of Lake Huron support approximately 50% of all provincially significant coastal wetland species. No comprehensive estimates of wetland loss are available for the Canadian shoreline of

Lake Huron: generally, losses appear to be site-specific and localized, attributable to a number of factors including shoreline modification and cottage and marina development. There appears to be adequate habitat available for breeding Bald Eagles and Osprey, particularly since Osprey are amenable to the use of artificial structures for nesting purposes. Competition among species for suitable nesting habitat (particularly Double-crested Cormorants with other species) and changes in lake levels may also influence the nesting success of some colonial waterbird species. Currently, the health of populations of aquatic wildlife found on Lake Huron, to a large extent, does not appear to be impaired.

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APPENDIX I.

Listing of evaluated wetlands (as of 1996) on Lake Huron with natural areas that overlap or are adjacent to the evaluated wetland (Environment Canada and Ontario Ministry of Natural Resources 2003). Natural areas, as identified in the Natural Heritage Information Centre Natural Areas Database, include: Area of Natural and Scientific Interest, Provincial Wildlife Area, National Wildlife Area and International Biological Program site. One Ramsar site, Matchedash Bay Marsh, is recognized as a Wetland of International Importance under the Ramsar Convention.

Wetland Name	Area of Natural and Scientific Interest (ANSI)	Provincial Wildlife Area (PWA)	National Wildlife Area (NWA)	International Biological Program (IBP) site	Ramsar site
Kettle Point Marsh	X				
Port Franks	X				
Baie Du Dore	X				
Scott Point Wetland Complex	X				
MacGregor Point Wetland Complex	X			X	
Chantry Island.					
Oliphant Wetland				X	
Fishing Islands	X				
Howdenvale Bay	X			X	
Sucker Creek (Owen Sound)	X	X			
Gauley Bay Wetland Complex	X			X	
Greenough Harbour				X	
Sadler Creek Wetland Complex	X			X	
Corisande Bay	X			X	
Dorcas Bay	X			X	
Barney Lake Wetland Complex	X			X	
Wingfield Basin	X	X			
Wasaga Beach	X				
Balm Beach Swamp	X			X	
Thunder Bay Swamp	X				
Awenda Shoreline Fen	X				

Wetland Name	Area of Natural and Scientific Interest (ANSI)	Provincial Wildlife Area (PWA)	National Wildlife Area (NWA)	International Biological Program (IBP) site	Ramsar site
Penetang Marsh	X				
Wye Marsh	X	X	X	X	
Matchedash Bay Marsh	X	X			X
Spanish River Delta Marsh	X				

APPENDIX II.

Confirmed records of significant vascular plant species, fish species, reptile species, amphibian species, bird species and lepidopteran species reported in coastal wetlands on the Canadian side of Lake Huron and the St. Marys River (from Environment Canada and Ontario Ministry of Natural Resources 2003). Numbers denote species groups and are as follows: 1-48: plant species; 49-62: bird species; 63-67: reptile species; 68: amphibian species; 69-73: fish species; lepidopteran species: 74-75. Status assigned by the Natural Heritage Information Centre for these species are as follows: S1: extremely rare in Ontario; S2: very rare in Ontario; S3: rare to uncommon in Ontario; S4: common in Ontario; "B" following a bird rank indicates breeding; "?" following a rank indicates some degree of uncertainty. Status assigned by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (as of November 2002) are as follows: END: Endangered; THR: Threatened; SC: Special Concern; NAR: Not At Risk; DD: Data Deficient. Status assigned by Committee on the Status of Species at Risk in Ontario (COSSARO) (as of September 2002) are as follows: END: Endangered; END-R: Endangered species regulated under the provincial Endangered Species Act; THR: Threatened; VUL: Vulnerable; NIAC: Not in any category; IND: Indeterminate. See Environment Canada and Ontario Ministry of Natural Resources (2003) for further descriptions of status categories and data sources.

No.	Common Name	Scientific Name	NHIC S-RANK	COSEWIC	COSSARO
1.	Algae-like Pondweed	Potamogeton confervoides	S2	-	-
2.	American Lotus	Nelumbo lutea	S2	-	-
3.	Arrow-arum	Peltandra virginica	S2	-	-
4.	Awnless Graceful Sedge	Carex formosa	S3S4	-	-
5.	Big Shellbark Hickory	Carya laciniosa	S3	-	-
6.	Bluehearts	Buchnera americana*	S1	END	-
7.	Branched Bartonia (Twining Bartonia)	Bartonia paniculata spp. paniculata	S1	SC	-
8.	Bushy Aster	Aster dumosus	S2	-	-
9.	Carey's Smartweed	Polygonum careyi	S3S4	-	-
10	Common Stiff Sedge	Carex tetanica	S3	-	-
11.	Crested Arrow-head	Sagittaria graminea var. cristata	S3	-	-
12.	Cylindrical Blazing Star	Liatris cylindracea	S3	-	-
13.	Dwarf Lake Iris	Iris lacustris	S3	-	-
14.	Eastern Prairie Orchid	Platanthera leucophaea	S2	SC	-
15.	Eastern Yellow Star Grass	Hypoxis hirsuta	S3	-	-
16	Follicle Sedge	Carex folliculata	S3	-	-
17.	Gattinger's Agalinis (previously Round-stemmed Purple False Foxglove)	Agalinis gattingeri	S1	END	-
18.	Giant Ironweed	Vernonia gigantea	S3	-	-
19.	Hidden-fruited Bladderwort	Utricularia geminiscapa	S3	-	-

No.	Common Name	Scientific Name	NHIC S-RANK	COSEWIC	COSSARO
20.	Houghton's Goldenrod	Solidago houghtonii	S2	-	-
21.	Large Water Starwort	Callitriche heterophylla	S2?	-	-
22.	Low Nut-rush	Scleria verticillata	S3	-	-
23.	Many-fruited False Loosestrife	Ludwigia polycarpa	S2	-	-
24.	Marsh St. John's-wort	Triadenum virginicum	S3	-	-
25.	Narrow-leaved Water-plantain	Alisma gramineum	S3S4	-	-
26.	Prairie Dropseed	Sporobolus heterolepis	S2	-	-
27.	Pumpkin Ash	Fraxinus profunda	S2	-	-
28.	Purple-jointed Joe Pye Weed	Eupatorium purpureum	S3	-	-
29.	Ram's-head Lady's Slipper	Cypripedium arietinum	S3	-	-
30.	Red-rooted Nut Sedge	Cyperus erythrorhizos	S3	-	-
31.	Redtop Panic Grass	Panicum rigidulum	S2S3	-	-
32.	Riddell's Goldenrod	Solidago riddellii	S2S3	SC	VUL
33.	Rigid Yellow Flax	Linum striatum	S1	-	-
34.	Riverbank Sedge	Carex emoryi	S3	-	-
35.	Rough Water Horehound	Lycopus asper	S2	-	-
36.	Sharp-fruit Rush	Juncus acuminatus	S3	-	-
37.	Slender Bulrush	Scirpus heterochaetus	S2	-	-
38.	Smith's Tufted Bulrush	Scirpus smithii	S2?	-	-
39.	Southern Tickseed	Bidens coronata	S2	-	-
40.	Stiff Yellow Flax	Linum medium var. medium	S3	-	-
41.	Tall Yellow-eyed Grass	Xyris difformis	S3?	-	-
42.	Thread-like Naiad	Najas gracillima	S2	-	-
43.	Tuberous Indian-plantain (previously Prairie Indian Plantain)	Arnoglossum plantagineum (previously Cacalia plantaginea)	S3	SC	-
44.	Virginia Meadow Beauty	Rhexia virginica	S3S4	-	-
45.	Water Awlwort	Subularia aquatica	S3?	-	-
46.	White-fringed Orchid	Platanthera blephariglottis	S3S4	-	-
47.	Wicket Spike-rush	Eleocharis rostellata	S3	-	-
48.	Yellow Pond Lily	Nuphar advena	S3	-	-
49.	Bald Eagle	Haliaeetus leucocephalus	S3B	NAR	END-R
50.	Black Tern	Childonias niger	S3B	NAR	VUL
51.	Black-crowned Night-Heron	Nycticorax nycticorax	S3B	-	-
52.	Forster's Tern	Sterna forsteri	S3B	DD	IND
53.	Great Egret	Casmerodius albus	S2B	-	-

No.	Common Name	Scientific Name	NHIC S-RANK	COSEWIC	COSSARO
54.	King Rail	Rallus elegans	S2B	END	END-R
55.	Least Bittern	Ixobrychus exilis	S3B	THR	VUL
56.	Little Gull	Larus minutus	S1S2B	-	-
57.	Louisiana Waterthrush	Seiurus motacilla	S3B	SC	VUL
58.	Northern Shoveler	Anas clypeata	S3S4B	-	-
59.	Redhead	Aytha americana	S2B	-	-
60.	Red-necked Grebe	Podiceps grisegena	S3B	NAR	NIAC
61.	Ruddy Duck	Oxyura jamaicensis	S2B	-	-
62.	Wilson's Phalarope	Phalaropus tricolor	S3B	-	-
63.	Eastern Fox Snake	Elaphe vulpina gloydi	S3	THR	THR
64.	Eastern Massasauga Ratttlesnake	Sistrurus catenatus catenatus	S3	THR	THR
65.	Eastern Spiny Softshell Turtle	Apalone spinifera	S3	THR	THR
66.	Queen Snake	Regina septemvittata	S2	THR	THR
67.	Spotted Turtle	Clemmys guttata	S3	SC	VUL
68.	Jefferson Salamander	Ambystoma jeffersonianum	S2	THR	-
69.	Black Bullhead	Ameiurus melas	S3	-	-
70.	Grass Pickerel	Esox americanus	S3	-	-
71.	Lake Chubsucker	Erimyzon sucetta	S2	THR	THR
72.	Longear Sunfish	Lepomis megalotis	S3	NAR	NIAC
73.	Pugnose Shiner	Notropis anogenus	S2	END	THR
74.	Mulberry Wing	Poanes massasoit	S3	-	-
75.	Two-spotted Skipper	Euphyes bimacula	S3S4	-	-

* indicates a species found only in coastal wetlands

APPENDIX III.

Listing of Important Bird Areas (IBA) situated on the Canadian shoreline of Lake Huron including the names, locations and sizes (in square kilometres) for each of these sites (information obtained from the Canadian BirdLife International co-partners [Bird Studies Canada and the Canadian Nature Federation] on-line IBA Site Directory).

Site Name	Location (i.e., closest town, city) in Ontario	Size (km^2)
Port Frank Forested Dunes	Port Franks	62.0
Thedford Flats*	Grand Bend	10.0
Chantry Island	Southhampton	0.4
Cabot Head	Upper Bruce Peninsula	144.0
Owen Channel	Wikwemikong	31.0
Spring Bay*	Manitoulin Island	140.0
Manitoulin Island North Shore	Gore Bay	788.0
Lake Huron Quarry Bay	Meldrum Bay	15.0
The Cousins	Blind River	0.05
Nottawasaga Island	Collingwood	0.1
Tiny Marsh*	Elmvale	10.0
Wye Marsh	Midland	11.0
Matchedash Bay	Waubaushene	12.0
The Watchers	Penetanguishene	0.18
Limestone Islands	Snug Harbour	1.0
St. Marys River Complex	Sault Ste. Marie	358.0

*located within five kilometres of Lake Huron shoreline