Current Status, Trends and Distributions of Aquatic Wildlife in the Niagara River (Ontario) Watershed

Hughes, K.D.[1]

Technical Report Series Number 452
2006

[1] This report was prepared under contract by K.D. Hughes for Janette Anderson, Restoration Programs Coordinator (Lake Huron and Connecting Channels), Environment Canada, P.O. Box 5050, 867 Lakeshore Rd., Burlington, Ontario L7R 4A6

Catalogue No. CW69-5/452E
ISBN 0-662-42918-4

This report may be cited as:

Hughes, K.D. 2006. Current Status, Trends and Distributions of Aquatic Wildlife in the Niagara River (Ontario) Watershed. Technical Report Series No. 452. Canadian Wildlife Service, Environment Canada, Toronto.

Copies may be obtained from:
Canadian Wildlife Service
Environment Canada
4905 Dufferin Street
Downsview, Ontario, Canada
M3H 5T4

EXECUTIVE SUMMARY

As a connecting waterway of the Great Lakes, many species of wildlife depend on the abundant resources of the Niagara River and its watershed for survival. 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 side of the Niagara River and its watershed in Ontario. The status of habitat, including coastal wetlands, for some of these species is also reviewed.

Located along a major migratory route, the Niagara River provides both abundant food and important habitat to nesting, migratory and overwintering birds throughout the year. On the Canadian side of the Niagara River, three colonial waterbird species were reported nesting in surveys conducted by the Canadian Wildlife Service (CWS) in 1999 and a total of 651 nests were counted during this census year. Compared to CWS surveys conducted on the Niagara River in 1990/91, an annual rate of increase in nest numbers was observed for Black-crowned Night-Herons. Annual rates of decline in nest numbers were observed for Herring Gulls and Ring-billed Gulls. Nest numbers of colonial waterbirds favoured the United States side of the Niagara River, where over 17 000 nests of seven different species were counted from 1997-1999. Significant numbers of gull species (including Bonaparte's Gull and Little Gull) and waterfowl utilize the Niagara River's resources during spring and fall migratory periods. During the winter, the Niagara River, which largely remains ice-free, is also an attractive site for thousands of overwintering waterfowl. Total numbers of overwintering waterfowl on the Niagara River varied widely among survey years and may be due to a number of environmental factors, including changes in food availability and habitat quality. Over 200 waterbirds per hour were reported during Christmas Bird Counts conducted in two census circles in Niagara Falls and Buffalo in early winter from 1998-2002. Eighteen marsh bird species and eleven amphibian species were detected in Niagara River watershed routes monitored by two programs, the Marsh Monitoring Program (MMP) and Backyard Frog Survey.

Based on marsh bird and amphibian ratings defined by the MMP, wetlands in the Niagara River Area of Concern (AOC), including those on the U.S. side of the Niagara River, were given an "impaired" rating (relative to non-AOCs in the same Great Lakes basin) in their ability to support a high diversity of marsh bird and amphibian species. Very little is known regarding the abundance of reptiles found in the Niagara River AOC. No Bald Eagles are reported to be nesting along the Niagara River, although some winter activity has been reported in the area from 2001 to 2003. Based on trapper evidence, mink are generally considered common in the Niagara District while otter abundance was rated to be very scarce.

In terms of habitat, there are 117 evaluated wetlands in the Niagara River (Ontario) watershed covering a total area of over 7000 ha and representing approximately 5.4% of the total watershed area. Some wetlands in the Niagara River watershed (Ontario) remain to be evaluated. Coastal wetlands provide important habitat for a number of provincially significant plant, fish and bird species. As in many areas of southern Ontario, there have been considerable historic wetland losses in the Niagara River AOC. In Ontario, coastal and inland wetlands and tributaries of the Niagara River watershed are vulnerable to a number of stressors including eutrophication, contamination, altered water flow, shoreline modification, wetland drainage and urban development.

Currently, there are some concerns regarding the health of some populations of aquatic wildlife found in the Niagara River (Ontario) watershed. While results are preliminary, some species, such as snapping turtles and mink, may show elevated levels of contaminants in their tissues, particularly polychlorinated biphenyls (PCBs). Mean levels of dichlorodiphenyldichloroethylene (DDE), PCBs and 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) in Herring Gull eggs collected from 1998-2002 in the Niagara River were found to exceed guidelines associated with the protection of piscivorous wildlife. While these levels of contaminants are below those expected to elicit population-level effects, subtle individual physiological effects may be present in some gulls. Contaminant levels in waterfowl collected in 1988 were below those considered harmful to wildlife and human consumption. In all cases these results demonstrate that contaminants continue to be present in the habitat of aquatic wildlife in the Niagara River (Ontario) watershed. As toxic loadings into the Niagara River and upstream from other sites on the Great Lakes decrease and water quality in the Niagara River continues to improve, it is hoped that numbers of nesting Bald Eagles and otter will increase given suitable habitat conditions.

Rehabilitation projects that create, enhance and preserve wetland habitat in the Niagara River watershed will help to ensure the success of diverse and healthy populations of marsh inhabitants. Recruitment of new volunteers is essential for continuing to monitor marsh bird and amphibian trends in the Niagara River AOC using the MMP, and additional volunteers are required.

Water quality in the Welland River watershed, which encompasses a substantial portion of the Niagara River (Ontario) AOC, is considered poor; however, attempts to mitigate the effects of altered water flow, eutrophication and sedimentation have been implemented, and more favourable land-use practices have been introduced.

RÉSUMÉ ADMINISTRATIF

Les abondantes ressources de la rivière Niagara, voie interlacustre des Grands Lacs, et de son bassin hydrographique assurent la survie de nombreuses espèces sauvages. 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 la rive canadienne de la rivière Niagara et dans son bassin en Ontario. Nous examinons aussi la situation de l'habitat, notamment les marais littoraux, pour certaines des espèces.

Située sur une grande route migratoire, la rivière Niagara constitue une source de nourriture abondante et un habitat important tout au long de l'année pour les oiseaux nicheurs, migrateurs et hivernants. Du côté canadien de la rivière, la nidification de trois espèces coloniales d'oiseaux aquatiques a été signalée dans les relevés effectués par le Service canadien de la faune (SCF) en 1999, et 651 nids ont été dénombrés au cours de cette année de recensement. Par rapport aux relevés réalisés par le SCF le long de la Niagara en 1990-1991, on observe, pour le Bihoreau gris, un taux annuel en hausse du nombre de nids et, pour le Goéland argenté et le Goéland à bec cerclé, un taux annuel qui diminue. Il y a un plus grand nombre de nids d'oiseaux aquatiques coloniaux du côté américain de la rivière, où plus de 17 000 nids de sept espèces ont été dénombrés entre 1997 et 1999. Un nombre important d'espèces de mouettes et de goélands (dont la Mouette de Bonaparte et la Mouette pygmée) et de sauvagine utilisent les ressources de la rivière durant les périodes de migration du printemps et de l'automne. À l'hiver, la Niagara, qui reste pour l'essentiel libre de glace, attire aussi des milliers d'oiseaux aquatiques hivernants. Le nombre total d'oiseaux d'eau qui hivernent le long de la rivière varie grandement d'une année de recensement à une autre, ce qui peut être attribuable à divers facteurs environnementaux, dont la disponibilité de la nourriture et la qualité de l'habitat plus ou moins grandes. Plus de 200 oiseaux aquatiques par heure ont été signalés à l'occasion des Recensements des oiseaux de Noël effectués dans deux cercles de recensement à Niagara Falls et à Buffalo en début d'hiver, entre 1998 et 2002. On a décelé 18 espèces d'oiseaux de marais et 11 espèces d'amphibiens sur les parcours du bassin hydrographique de la rivière retenus par deux programmes, le Programme de surveillance des marais (PSM) et le Relevé des amphibiens dans l'arrière-cour.

D'après les cotes définies par le PSM, les milieux humides dans le secteur préoccupant (SP) de la rivière Niagara, y compris ceux de la rive américaine, ont une capacité diminuée (par rapport aux secteurs non préoccupants du même bassin des Grands Lacs) d'entretenir une grande diversité d'espèces d'oiseaux de marais et d'amphibiens. On connaît très mal l'abondance des reptiles dans le SP de la rivière Niagara. Aucun Pygargue à tête blanche n'a été trouvé nichant le long de la rivière, quoiqu'on ait signalé une certaine activité hivernale dans le secteur entre 2001 et 2003. D'après les indications de trappeurs, le vison est commun dans le district de Niagara, tandis que la loutre s'y fait très rare.

Sur le plan de l'habitat, 117 zones humides sont évaluées dans le bassin de la rivière Niagara (Ontario); elles couvrent plus de 7 000 hectares et constituent environ 5,4 % de la superficie du bassin. Certaines zones humides du bassin (Ontario) restent à évaluer. Les milieux humides riverains offre un habitat crucial à nombre d'espèces de plantes, de poissons et d'oiseaux d'importance provinciale. Comme à bien des endroits dans le Sud de l'Ontario, le SP de la rivière Niagara a perdu beaucoup de ses milieux humides depuis la colonisation européenne. En Ontario, les zones humides riveraines et intérieures et les affluents du bassin hydrographique de la Niagara sont vulnérables à de nombreux agents de stress, dont l'eutrophisation, la contamination, le changement du débit d'eau et la modification de la rive, l'assèchement et l'urbanisation.

À l'heure actuelle, on se préoccupe de la santé de certaines populations d'espèces aquatiques dans le bassin de la rivière Niagara (Ontario). Il s'agit de résultats préliminaires, mais certaines espèces comme la chélydre serpentine et le vison montrent peut-être des concentrations élevées de contaminants dans les tissus, notamment de biphényles polychlorés (BPC). Les concentrations moyennes de 1,1-dichloro-2,2-bis(4-chlorophényl)éthène (DDE), de BPC et de 2,3,7,8-tétrachlorodibenzodioxine (2,3,7,8-TCDD) dans les oeufs du Goéland argenté recueillis entre 1998

et 2002 le long de la Niagara dépassaient les doses recommandées pour la protection de la faune piscivore. Les concentrations étaient inférieures à celles susceptibles d'effets à l'échelle des populations de goélands, mais elles peuvent produire de subtils effets physiologiques chez certains individus. La contamination de la sauvagine recueillie en 1988 était inférieure à celle jugée nuisible pour la consommation par les animaux et les humains. Dans tous les cas, les résultats ont montré que les contaminants continuent d'être présents dans l'habitat des espèces aquatiques du bassin de la Niagara (Ontario). Comme les charges toxiques à la rivière et en amont en provenance d'autres sites des Grands Lacs diminuent et que la qualité de l'eau de la Niagara continue de s'améliorer, le nombre de loutres et de Pygargues à tête blanche nichant dans le secteur augmentera, espère-t-on, si les conditions d'habitat sont propices.

Les projets de rétablissement qui créent, améliorent et préservent l'habitat humide du bassin de la rivière Niagara aideront à faire prospérer des populations diverses et saines dans les marais. Le recrutement de bénévoles est essentiel pour continuer à surveiller les tendances des oiseaux de marais et des amphibiens du secteur préoccupant de la rivière dans le cadre du PSM, et il faut que le nombre de bénévoles augmente.

La qualité de l'eau est piètre dans le bassin de la rivière Welland, qui englobe une bonne partie du SP de la Niagara (Ontario). Cela dit, on a entrepris d'atténuer les effets du débit d'eau modifié, de l'eutrophisation et de la sédimentation, et des pratiques plus favorables d'utilisation du sol ont été introduites.

ACKNOWLEDGEMENTS

Thanks go to Janette Anderson of Environment Canada for providing direction in the development of this report.

Thanks also to D.V. (Chip) Weseloh of the Canadian Wildlife Service (CWS) for providing colonial waterbird survey and contaminants data; C. Pekarik (CWS) for insights on Niagara River colonial waterbird surveys; R. Russell and D. Fillman (CWS) for preparation of Niagara River colonial waterbird maps; N. North (CWS) for providing Niagara River waterfowl data and for comments on the waterfowl section of the report; S. Petrie of Bird Studies Canada for providing annual aerial waterfowl survey data; P. Martin, K. Fernie and S. deSolla (CWS) for contributing unpublished mink and snapping turtle contaminants data and Backyard Frog Survey data; C. Heydon and N. Dawson of the Ontario Ministry of Natural Resources for contributing mink and otter population data; A. Yagi of the Ontario Ministry of Natural Resources for comments on aquatic wildlife on the Niagara River; J. Baker and G. Verkade of the Niagara Peninsula Conservation Authority for information on Niagara River watershed wetlands and preparation of Niagara River maps. Thanks also to Janette Anderson, D.V. (Chip) Weseloh, S. deSolla, K. Fernie, P. Martin and N. North for providing comments on an earlier draft of this report.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

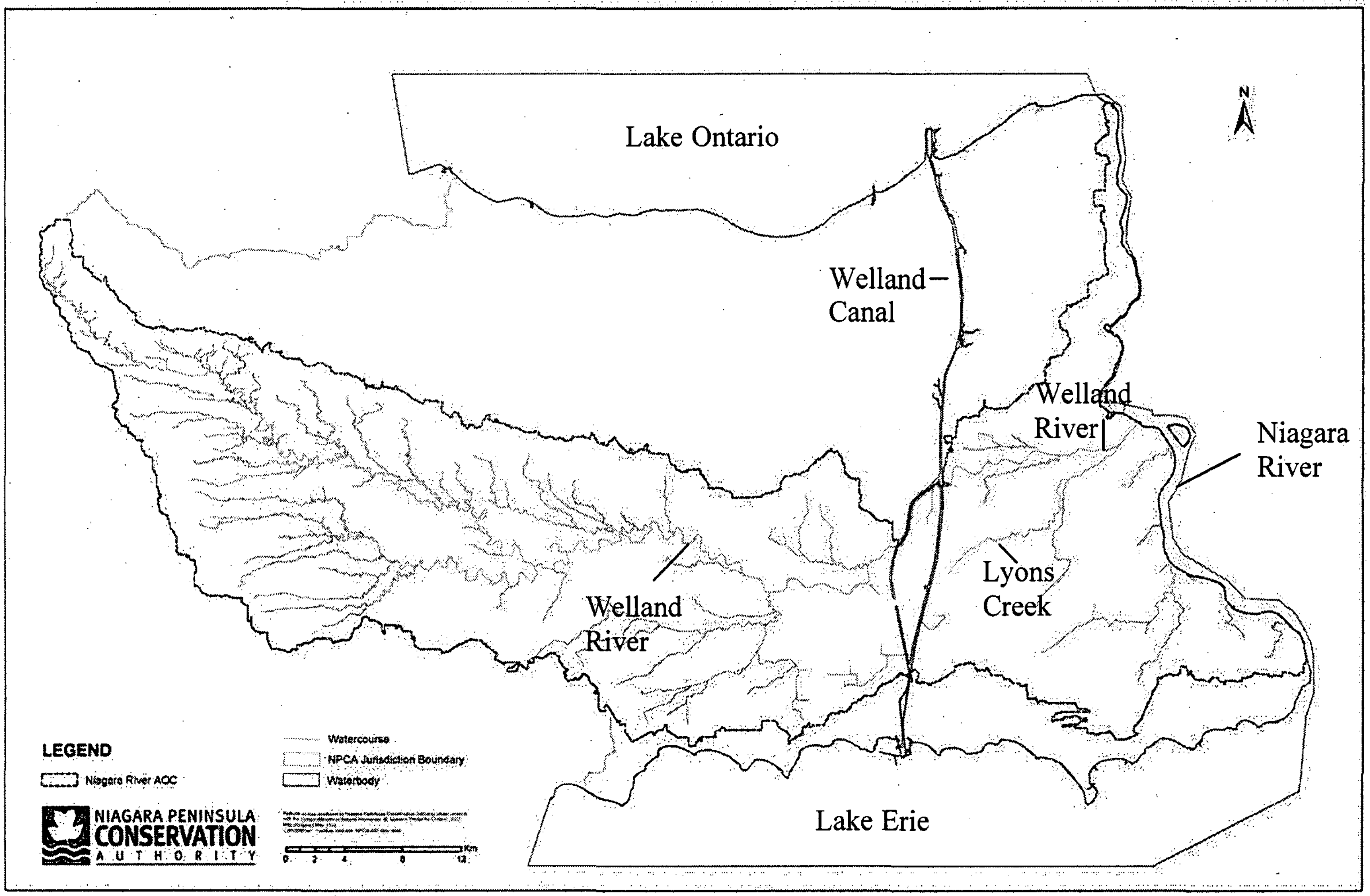
I. INTRODUCTION

The Niagara River which flows from Lake Erie into Lake Ontario is approximately 56 km in length and forms part of an international boundary between Canada and the United States (Environment Canada 1994). The vast majority of its water comes from the basins of the four Great Lakes upstream of the Niagara River. Consequently, the Niagara River, with a drop of 99 m along its course (half of which is at Niagara Falls), is a fast moving river, with an average flow of 5700 m^3 per second from Lake Erie to Lake Ontario (Niagara River Remedial Action Plan 1995). The shoreline extends 58 km on the Canadian side and is much longer on the United States side, extending 113 km as a result of the complex shoreline along the Grand Island (Environment Canada 1994). Hydroelectric power stations use the water for power production and industrial and municipal facilities use river water to run plant operations and wastewater discharge. The Niagara River is a popular location for boating, fishing and bird watching and also provides a source of drinking water to the public. The magnificence of Niagara Falls as a world-renowned attraction is also a boon to the tourism industry on both sides of the border.

The Niagara River area became a centre for industrial and chemical production during the 1940s and 1950s, and, as a result, the Niagara River became severely degraded. Several major industrial and municipal facilities as well as hazardous waste and landfill sites (primarily on the U.S. side of the Niagara River) have, over decades, introduced toxic chemicals into the Niagara River that have been deposited and/or travelled downstream into Lake Ontario. Due to degraded water quality, the Niagara River was designated as a binational Area of Concern (AOC) by the International Joint Commission in 1987. Remedial Action Plans (RAPs) were developed independently by the Canadian and U.S. sides to improve the overall health of the river by implementing strategies for remediation and pollution prevention in the AOC. On the Canadian side of the Niagara River, the Niagara River (Ontario) RAP was initiated in 1989. As of 2003, there were eight beneficial uses identified as impaired (or requiring further assessment) in the Niagara River (Ontario) AOC, four of which pertain to fish and wildlife. These include: restrictions on fish and wildlife consumption, degradation of fish and wildlife populations, bird or animal deformities or reproductive problems, and loss of fish and wildlife habitat (Environment Canada 2004). Remedial activities are currently well underway to restore the desired beneficial uses and achieve the environmental goals outlined in the RAP Stage II report. Another plan, the Niagara River Toxics Management Plan, is a binational initiative that specifically targets the reduction of a number of priority toxic chemicals from sites on both sides of the Niagara River. Significant reductions in concentrations and loads of most of the priority toxics in water have been achieved with decreases exceeding more than 70% since 1986/87 (Williams and O'Shea 2004). The Niagara River (Ontario) AOC encompasses the entire Niagara River watershed on the Canadian side of the Niagara River and covers the central portion of the Niagara Peninsula from Mount Hope to Niagara Falls, a total area of 1304 km^2 (OMNR unpublished). The Niagara River AOC also includes the Welland River drainage basin which extends some 70 km west of the Niagara River (Figure 1).

As water quality continues to improve in the Niagara River and its watershed, the health of aquatic populations of wildlife, which utilize the river's resources and available habitat throughout the entire year, should also improve. This report will focus on the current status of aquatic-feeding wildlife on the Niagara River and its Ontario watershed and AOC. In some cases, data from the U.S. side of the Niagara River 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 Bald Eagle (*Haliaeetus leucocephalus*), waterfowl, amphibians, reptiles, such as the snapping turtle (*Chelydra serpentina*), and mammals such as river otter (*Lutra canadensis*) and mink (*Mustela vison*). Contaminant levels for aquatic wildlife found in the Niagara River (Ontario) watershed, where available, are reported. The status of suitable habitat (notably coastal wetland habitat) for some aquatic species is also summarized.

Figure 1. The Niagara River Area of Concern (AOC) and watershed in Ontario including major tributaries within the AOC. The area delineated by the dashed line denotes the boundary of the Niagara River AOC. The Welland River watershed is located within the Niagara River AOC.



II. CURRENT STATUS, TRENDS AND DISTRIBUTION OF POPULATIONS ON THE NIAGARA RIVER

a) Colonial Waterbirds

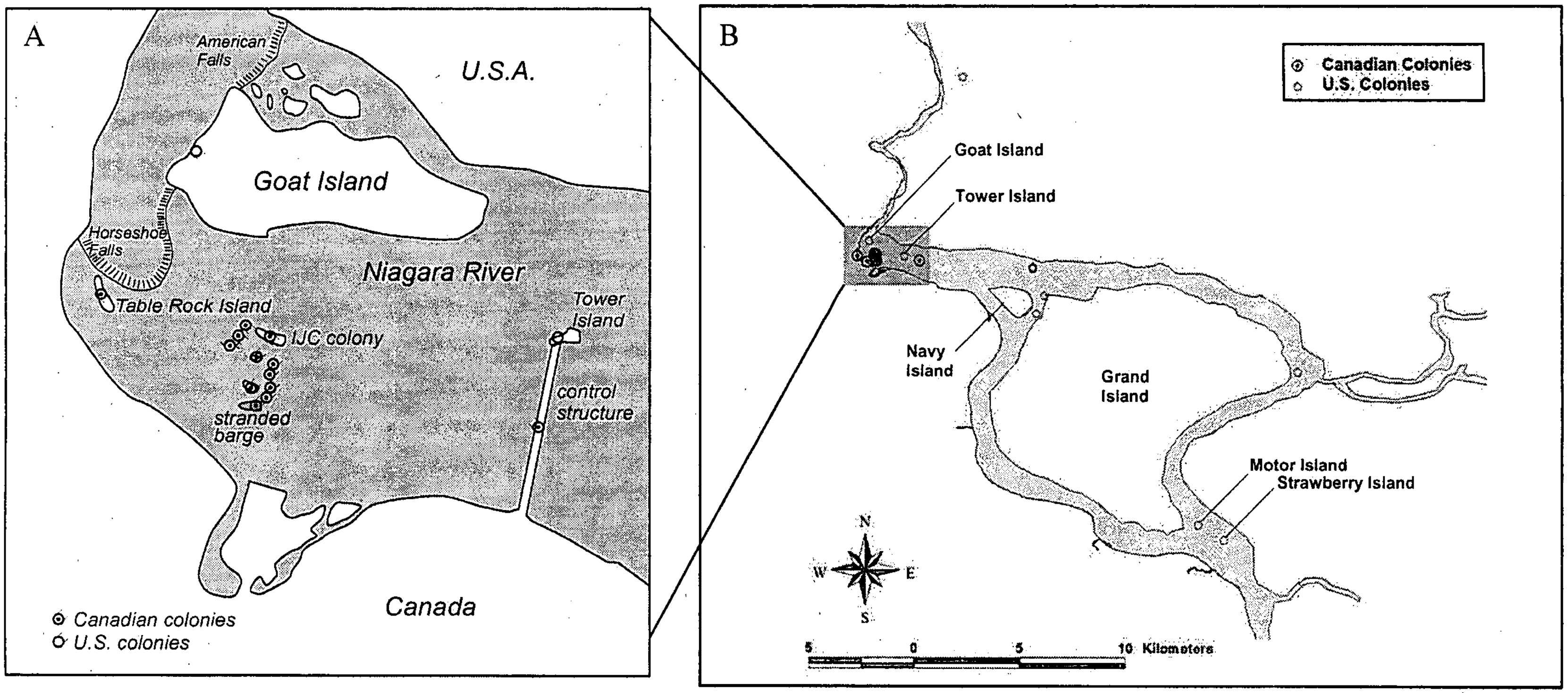
The Niagara River provides good nesting habitat for a large population of colonial waterbirds. During the period 1997-1999, biologists from Canada and the U.S. jointly censused all colonial waterbirds nesting on the Niagara River. A total of 17 745 nests of colonial waterbirds were counted. The numbers and distribution heavily favoured the U.S. side of the river where there were 17 130 nests of seven species at 10 sites. On the Canadian side, there were 651 nests of three species at 13 sites (CWS unpublished). Dramatic differences in the numbers of nests between the Canadian and U.S. sides of the Niagara River are primarily due to differences in the availability of suitable habitat. Larger U.S. islands such as Strawberry Island, Motor Island, Goat Island and Tower Island support large numbers of nesting birds while nesting sites on the Canadian side of the River are relatively much smaller in size, consisting of small islands and rocky outcrops. A summary of nest numbers on the Canadian and U.S. sides of the Niagara River spanning three decades of colonial waterbird censuses by Canadian and U.S. agencies is provided in Table 1. The large increase in nest numbers on the Niagara River over three decades is largely attributable to increases in the numbers of nesting Ring-billed Gulls (*Larus delawarensis*) on the U.S. side of the Niagara River.

The locations of waterbird colonies on the Canadian and U.S. sides of the Niagara River are shown in Figure 2. Waterbird colonies on the Canadian side of the Niagara River are situated relatively close together: 97% of all nests are found within an area of 0.375 km^2 in size. U.S. waterbird colonies, on the other hand, are more dispersed along the length of the Niagara River. Significant sources of contaminants from hazardous waste sites (predominately from U.S. sources) are found upstream of Canadian waterbird colonies. A more detailed discussion of trends in nest numbers of colonial waterbirds along both sides of the Niagara River will follow.

Table 1. Census data of colonial waterbird pairs nests (= pairs) at sites on the Canadian and U.S. sides of the Niagara River (Blokpoel and McKeating 1978; Blokpoel and Tessier 1996, 1998; CWS unpublished; Cuthbert *et al.* 2001).

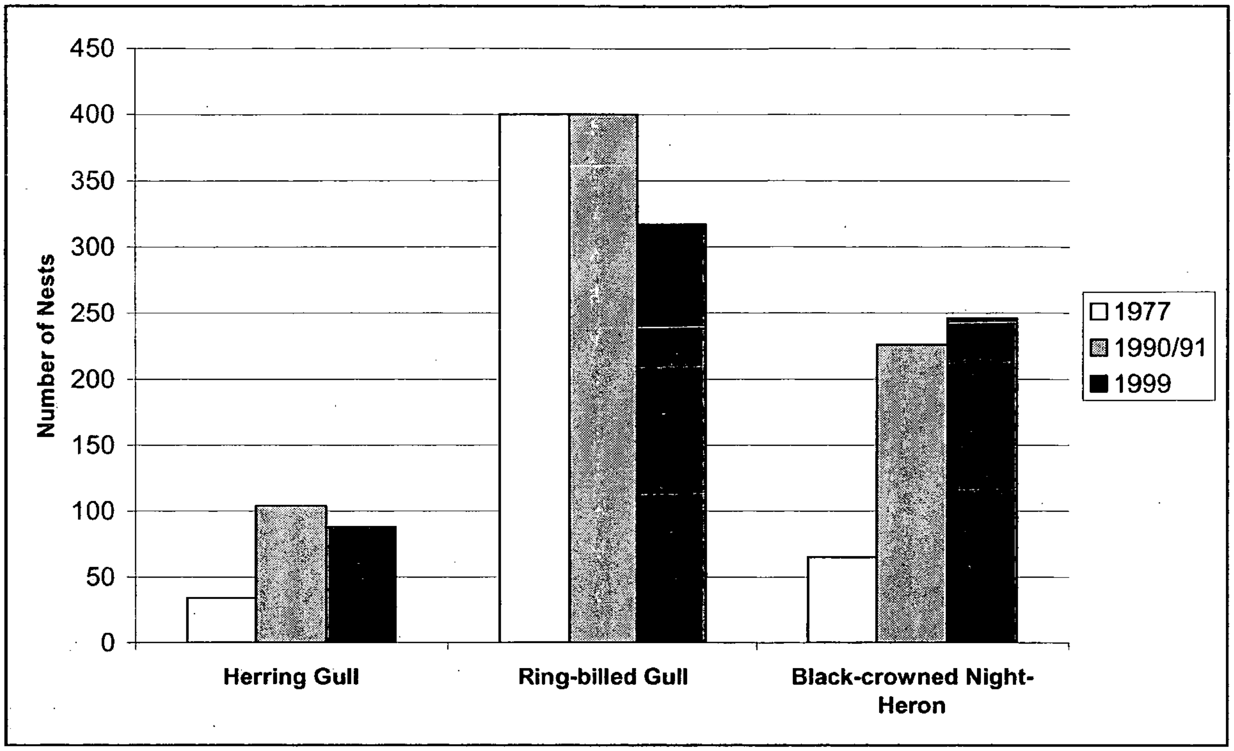
Country	Census Year	Ring-billed Gull	Herring Gull	Black-crowned Night-Heron	Common Tern	Double-crested Cormorant	Great Blue Heron	Great Egret	Total	Niagara River Total
Canada	1977	400	38	65	0	0	0	0	503	**5940**
U.S.	1977	4809	110	0	518	0	0	0	5437	
Canada	1990/91	400	104	426	0	0	0	0	930	**12 673**
U.S.	1989-91	11 427	156	0	160	0	0	0	11 743	
Canada	1999	317	88	246	0	0	0	0	651	**17 781**
U.S.	1997-99	16 859	24	38	113	49	40	7	17 130	

Figure 2. Distribution of colonial waterbird nests on the Canadian and U.S. sides of the Niagara River in 1997-1999 (CWS unpublished; Cuthbert *et al.* 2001): "A" is a detailed section of the Niagara River denoting the location of all Canadian nesting sites of Herring Gulls, Black-crowned Night-Herons and Ring-billed Gulls; "B" is a broader section of the Niagara River denoting the larger distribution of U.S. nesting sites of Herring Gulls, Double-crested Cormorants, Ring-billed Gulls, Common Terns, Black-crowned Night-Herons, Great Blue Herons and Great Egrets.



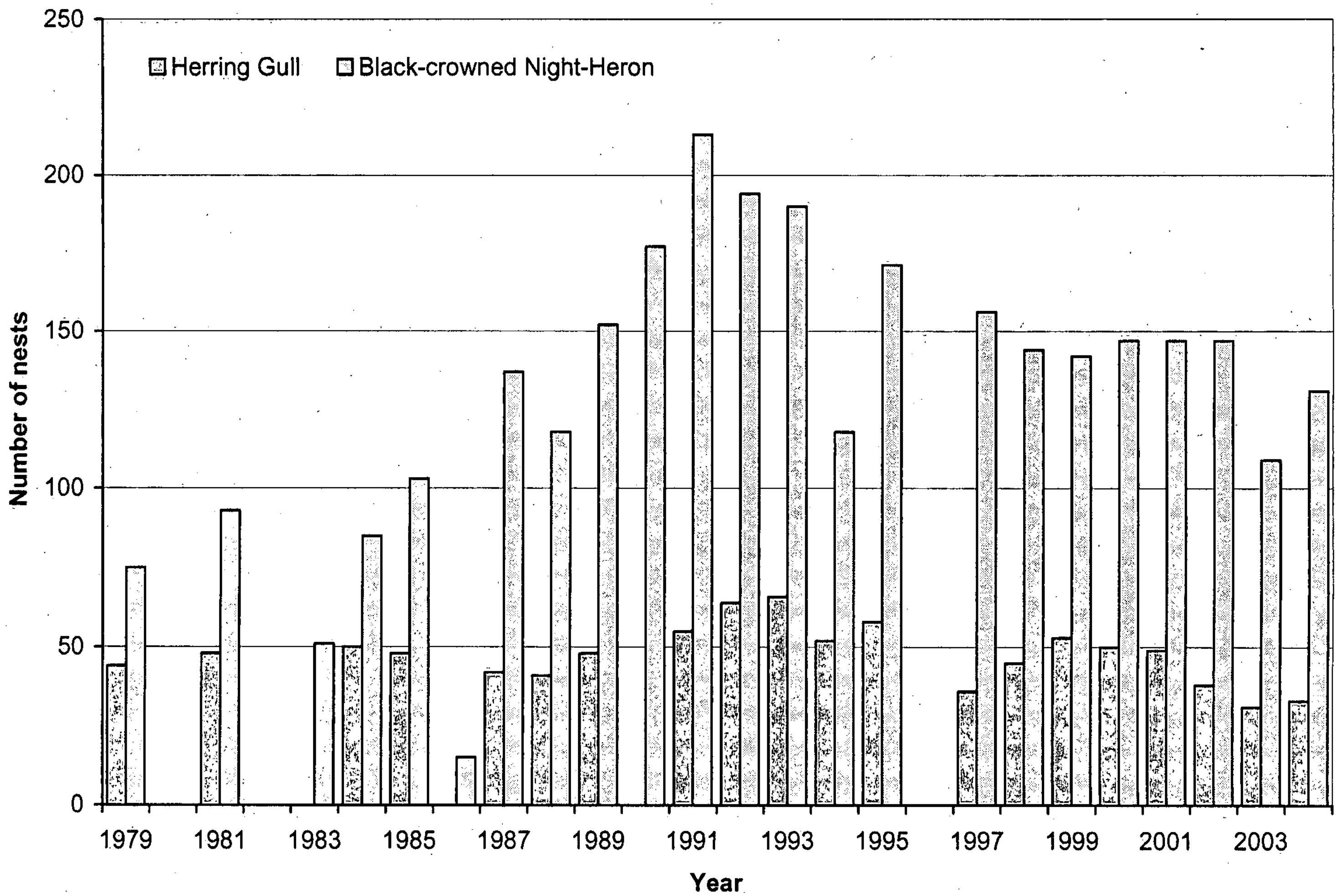
In 1999, three colonial waterbird species were found nesting on the Canadian side of the Niagara River: Herring Gull (*Larus argentatus*), Ring-billed Gull and Black-crowned Night-Heron (*Nycticorax nycticorax*) (CWS unpublished; Table 1). In total, 651 nests were counted at 13 sites situated on natural habitat (small islands and rocks) and artificial habitat (a gated control structure, which partially spans the Niagara River from the Canadian shoreline and is located above Niagara Falls, as well as a stranded barge). During the 1999 Canadian Wildlife Service (CWS) survey, 88 Herring Gull nests were counted at 13 sites on the Canadian side of the Niagara River. Colony sizes ranged from one to 61 nests. Since the 1990 CWS survey, numbers of Herring Gull nests decreased slightly, when 104 nests at three sites were counted on the Niagara River (Blokpoel and Tessier 1996); comparing only those colonies surveyed during both time periods, the annual rate of decline for Herring Gull nests on the Niagara River was equal to -1.8%. A decrease in the number of Ring-billed Gull nests was also observed on the Niagara River between 1990 and 1999 survey periods. In 1991, 400 nests were counted at one site (Table Rock Island; Blokpoel and Tessier 1996) and in 1999, 317 Ring-billed Gull nests were counted at two sites (Table Rock Island and the control structure), representing an annual rate of decline equal to -2.6%. In 1999, 246 Black-crowned Night-Heron nests were counted at two Niagara River sites (unnamed islands); in 1991, 426 nests were counted at three sites (Blokpoel and Tessier 1998). While this suggests an apparent decline in nest numbers, no data were collected in 1999 for one large colony counted in 1991 (consisting of 200 nests). Therefore, comparing only the two colonies surveyed in both time periods, an annual rate of increase was apparent (+1.1%) for Black-crowned Night-Herons nesting on the Niagara River. Numbers of Herring Gull and Black-crowned Night-Heron nests have increased by approximately 160% and 280%, respectively, since the first CWS survey was performed on the Niagara River in 1977. Numbers of Ring-billed Gull nests on the Niagara River have dropped by 20% since 1977; a similar decline in Ring-billed Gull nest numbers was also reported in CWS surveys conducted on Lake Huron in 1980 and 1999/2000 (CWS unpublished). Figure 3 summarizes the number of Herring Gull, Ring-billed Gull and Black-crowned Night-Heron nests and colonies found on the Niagara River during three CWS surveys performed in 1977, 1990/91 and 1999 (Blokpoel and McKeating 1978; Blokpoel and Tessier 1996, 1998; CWS unpublished). Herring Gull productivity has not been measured at colonies on the Niagara River due to access difficulty.

Figure 3. The number of Herring Gull, Ring-billed Gull and Black-crowned Night-Heron nests found on the Canadian side of the Niagara River during three CWS surveys performed in 1977, 1990/91 and 1999. Note that total nest numbers shown here are specific to colonies that were censused in all three surveys.



Annual counts of numbers of Herring Gull and Black-crowned Night-Heron nests have been performed on the central-most island (named the "IJC colony" [International Joint Commission]) in the Niagara River from 1979 to 2004 (Figure 4). Numbers of Black-crowned Night-Heron nests were at least two times higher than Herring Gull nests on this island during this period. Nest numbers for both species on this island increased from 1979, peaked between 1991 to 1993 and subsequently decreased since that time.

Figure 4. Number of Herring Gull and Black-crowned Night-Heron nests on the central-most island (in late April) in the Niagara River, approximately 300 m above Niagara Falls, 1979-2004 (CWS unpublished). Note that data are not available for some years.



Historically, Common Tern (*Sterna hirundo*) nests were last reported on Table Rock Island on the Canadian side of the Niagara River in 1956 (Sheppard 1970) but in 1960, Ring-billed Gulls had taken over most suitable nesting areas. Recent evidence, however, of possible nesting behaviour (i.e., adults sitting) was observed on the control structure early in the Common Tern nesting season during the aerial survey in 1999 (C. Pekarik, CWS, pers. comm.). Since 1999 was not an official census year for terns on the Great Lakes, this observation was not confirmed (through examination of nests and/or eggs) later in the nesting season. No Common Tern nests were reported on this structure during the 1998 Niagara River tern survey. Colonies of Double-crested Cormorant (*Phalacrocorax auritus*), Caspian Tern (*Sterna caspia*) and Great Egret (*Ardea alba*) were not found on the Canadian side of Niagara River in 1977 (Blokpoel and McKeating 1978). Navy Island, a large island located upstream from Niagara Falls, had a small Great Blue Heron (*Ardea herodias*) colony in the late 1960s (Sheppard 1970), but at the time of the 1977 census, no colony was present (Blokpoel and McKeating 1978). While numerous Great Black-backed Gulls (*Larus marinus*) utilize the Niagara River during the winter, there are no reports of this species breeding at sites on the Niagara River (Beardslee and Mitchell 1965; Blokpoel and Tessier 1996; CWS unpublished; Cuthbert *et al.* 2001).

During the 1997-1999 colonial waterbird survey by the U.S. Fish and Wildlife Service (USFWS) on the U.S. side of the Niagara River, seven colonial waterbird species were reported nesting on the Niagara River, including Herring Gull, Double-crested Cormorant, Ring-billed Gull, Common Tern, Black-crowned Night-Heron, Great Blue Heron and Great Egret (Cuthbert *et al.* 2001; Table 1). In total, over 17 000 colonial waterbird nests were found on the U.S. side of the Niagara River during this survey, 98% of which were Ring-billed Gull nests. Ring-billed Gulls have been successful nesters throughout the lower Great Lakes due to their opportunistic and more terrestrial-based feeding habits and the fact that, as migratory birds, they may be less stressed due to extreme weather and feeding conditions during the winter period compared to Herring Gulls (Blokpoel and Tessier 1996). Double-crested Cormorants, Great Egrets, Great Blue Heron and Black-crowned Night-Herons were new colonizers to the U.S. side of the Niagara River, with 18, 7, 40 and 38 nests reported, respectively on Motor Island in the 1997-1999 survey. An additional 31 Double-crested Cormorant nests were reported on Strawberry Island in 1997. Since an earlier USFWS survey in 1989-91, numbers of Ring-billed Gull nests increased by 48% to 16 859 nests; Herring Gull nests decreased by 85% to 24 nests; and Common Tern nests decreased by 29% to 113 nests on the U.S. side of the Niagara River. The recent expansion of Double-crested Cormorants to the U.S. side of the Niagara River may be cause for concern for nesting Black-crowned Night-Herons on the Canadian side of the river given the limited amount of available nesting habitat for Black-crowned Night-Herons, which also nest in trees.

Historical records of the status of colonial waterbirds in the Niagara Region during the 1930s to 1960s indicated that the Common Tern and Ring-billed Gull were "very common" summer residents in the Region. The Great Blue Heron was considered a "common" summer resident; and the Green Heron (*Butorides virescens*), Black-crowned Night-Heron and Herring Gull were considered to be "fairly common" summer residents (Beardslee and Mitchell 1965). All species were reported to breed as summer residents in the Niagara Region. Relative to the current status of nesting colonial waterbirds on the Niagara River, the Common Tern, Great Blue Heron and Green Heron do not appear to be as abundant as they once were.

Since it remains ice-free in the winter relative to other locations in the Great Lakes, the Niagara River is also a favourite wintering ground for large numbers of Great Lakes Herring Gulls; up to 20 000 Herring Gulls have been recorded daily along the Niagara River in fall and early winter (Knapton and Weseloh 1999). Large numbers of Great Lakes Ring-billed Gulls also pass through the area during migration.

b) Other Gulls

Thousands of migrating gulls utilize the Niagara River as a staging area on their way to wintering areas. In total, 19 species of gulls have been recorded in the Niagara River, representing almost half of the world's 45 species of gulls (Knapton and Weseloh 1999). Bonaparte's Gull (*Larus philadelphia*), Ring-billed Gull and Herring Gull are the most numerous gull species observed in the tens of thousands annually on the Niagara River while less abundant but regular migrant gull species include Great Black-backed Gull, Little Gull (*Larus minutus*), Thayer's Gull (*Larus thayeri*), Iceland Gull (*Larus glaucoides*), Lesser Black-backed Gull (*Larus fuscus*) and Glaucous Gull (*Larus hyperboreus*).

The Niagara River is an especially important staging area for Bonaparte's Gulls and Little Gulls. The Niagara River attracts as many as 40 000 Bonaparte's Gulls daily in the late fall and winter and it has been estimated that 20% of the world's population of Bonaparte's Gull passes through the Niagara River during migration (Knapton and Weseloh 1999). Since 1986, G. Bellerby, an avid birder, has performed annual systematic counts of Bonaparte's Gulls and Little Gulls during staging periods flying north from the lower Niagara River to roost overnight on Lake Ontario. An average of nearly 3000 Bonaparte's Gulls was counted daily during the autumn and spring staging periods on the Niagara River from 1987 to 1996 (Kirk *et al.* 2001). Autumn counts during this time period indicated no significant changes in numbers of Bonaparte's Gulls utilizing the Niagara River. Spring counts of staging Little Gulls on the Niagara River from 1987 to 1996 indicated an increase in numbers of Little Gulls over this period whereas a decrease was noted during autumn counts (Bellerby *et al.* 2000). Reported increases in spring counts of Little Gulls in the Niagara River during the last two years of study were coincident with decreases in numbers of Little Gulls counted at Long Point, which suggested that the preferred feeding ground of these birds may have changed.

c) Marsh-nesting Birds

The Marsh Monitoring Program (MMP), a binational 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 four Canadian routes and six U.S. routes were monitored for marsh birds within the Niagara River AOC from 1995 to 2002 (Timmermans *et al.* 2003). Twelve marsh bird species/categories were selected as indicators of high quality marsh habitat. These marsh bird indicator species included: American Bittern (*Botaurus lentiginosus*), American Coot (*Fulica americana*), Black Tern (*Chilidonias niger*), Blue-winged Teal (*Anas discors*), Common Moorhen (*Gallinula chloropus*), Common Snipe (*Capella gallinago*), Least Bittern (*Ixobrychus exilis*), Marsh Wren (*Cistothorus palustris*), Common Moorhen/American Coot (category selected if call indiscernible between two species), Pied-billed Grebe (*Podilymbus podiceps*), Sora (*Porzana carolina*) and Virginia Rail (*Rallus limicola*). Measures of total marsh bird species diversity and indicator species diversity as well as species abundance at MMP routes were calculated. In total, 18 marsh bird species were identified at MMP routes in the Niagara River AOC, which represented a moderate level of diversity. Seven (Blue-winged Teal, Common Moorhen, Marsh Wren, Least Bittern, Pied-billed Grebe, Sora, and Virginia Rail) out of the twelve marsh bird indicator species were recorded. Abundance of six out of seven indicator species scored within the average of those at Great Lakes basin non-AOC routes (i.e., on Lake Erie) while Common Moorhen abundance scored below the Great Lakes basin non-AOC average. Red-winged Blackbird (*Agelaius phoeniceus*), Swamp Sparrow (*Melospiza geogiana*), Yellow Warbler (*Dendroica petechia*) and Marsh Wren were the most abundant species reported at the Niagara AOC from 1995 to 2002. Least Bittern and Pied-billed Grebe were the least abundant of the selected species. In summary, total marsh bird species diversity and marsh bird indicator species diversity scored below the average of those at Great Lakes basin non-AOC routes. Accordingly, based on these ratings (relative to those for non-AOCs in the same lake basin [i.e., Lake Erie]) and those found for amphibians (see below), the Niagara River AOC was given an "impaired" rating in its ability to support a high diversity of marsh-nesting bird and amphibian species. From 1997 to 2002, the number of marsh bird MMP routes in the Niagara River AOC has decreased from three to zero and attempts at volunteer recruitment to fill these needs are ongoing (Timmermans *et al.* 2003).

d) Waterfowl

The Niagara River is an important stop-over site for waterfowl during fall and spring migration. In a CWS study of migrant waterfowl use at the Niagara River AOC, a number of trends were observed in three sets of aerial surveys conducted in the fall and spring of 1971/72, 1980/81 and 1993/94 (Mullie *et al.* 1996). These included:

- Total waterfowl use was greatest during the fall and spring migrations of 1980/81, primarily due to large numbers of Common Merganser (*Mergus merganser*) and Red-breasted Merganser (*M. serrator*); waterfowl use was similar between the 1971 and 1993 spring survey periods and the 1972 and 1994 fall survey periods.
- *Bucephala* spp. (i.e., Common Goldeneye and Bufflehead) numbers declined during spring migrations from 1972 to 1994. During the fall migration, numbers rose from 1971 to 1980 but declined to their lowest point in 1993. Common Goldeneye was the most common of the two species.
- Numbers of Canada Geese (*Branta canadensis*) were highest in the fall and spring of 1993/94, representing 25% of the total number of waterfowl days, relative to the two earlier survey periods when Canada Geese represented less than 0.5% of the total number of waterfowl days.
- Numbers of dabbling ducks remained constant during the three survey periods with greater use during the fall versus the spring migration periods. The most common species were American Black Ducks (*Anas rubripes*) and Mallards (*A. platyrhynchos*), together comprising over 95% of dabbler waterfowl use days. The relative proportion of these two species changed over the three survey periods: namely, use of the Niagara River by American Black Ducks decreased while use by Mallards increased during both the spring and fall periods. For example, in the spring of 1972 and 1981, American Black Ducks represented 62% and 71% of dabbler use, respectively, but only 2% of dabbler use in the spring of 1994. In contrast, the proportion of Mallards using this area during the spring increased from 29% in 1981 to 97% in 1994; a similar pattern was observed in the fall. This pattern has been observed at a number of other Great Lakes AOCs. Possible explanations given for these observations include hybridization, competitive exclusion, hunting and/or habitat changes.
- *Scaup* spp. and Canvasback (*Aythya valisineria*) were the most abundant species of bay ducks. Numbers of other bay ducks such as Redheads and Ruddy Ducks were more variable in the spring, but virtually absent in the fall. It is unclear why there were differences in waterfowl use of the area for some species between the spring and fall.
- Sea ducks, consisting predominately of Long-tailed Ducks (*Clangula hyemalis*), were more common in the spring compared to the fall, when no sea ducks were reported in fall surveys in 1980 and 1993. (Large numbers of Long-tailed Duck, however, were reported in aerial surveys performed in December 2000 and January 2001 [see below].) Overall, sea ducks made up a small proportion of waterfowl on the Niagara River (less than 9.3% of the waterfowl use in the area).
- During the fall surveys, total numbers of waterfowl peaked in late December, while in spring surveys, waterfowl numbers decreased from the beginning of March until the end of May suggesting that the area is used more as a winter site than as a migration staging area.
- During all surveys, waterfowl use was greater in the upper portion of the Niagara River (i.e., above the Niagara Falls) compared to the lower portion of the river, with high concentrations of mergansers, *Bucephala* spp. and some bay ducks found in the areas from Navy Island to Goat Island.

The Niagara River is also an important overwintering location for waterfowl, particularly when Lake Erie and portions of Lake Ontario freeze over. Waterfowl ground surveys by the CWS along the length of the Niagara River (Canadian side) reported between approximately 11 000 to 19 000 birds per survey from December 1986 to March 1987, representing a mean of 15 different waterfowl species (Table 2; Barrett 1995). Fewer mean numbers of waterfowl were observed in similar CWS waterfowl surveys conducted weekly from December 1994 to March 1995 along the Niagara River: an average of between 3500 to 7800 individuals were counted per survey, representing a mean of 18 different waterfowl species (Table 2; Barrett 1995). *Scaup* spp. (Greater and Lesser Scaup), Common Merganser, Common Goldeneye and Canada Goose were among the most numerous species counted during the 1994/95 winter survey periods. In total, 22 different waterfowl species were counted in weekly surveys conducted along the length of the Niagara River from February 1994 to April 1995 with the largest concentrations of waterfowl found during the winter months. Since 1995, ground surveys of waterfowl and gulls on the Canadian side of the Niagara River have been performed on only a casual basis (N. North, CWS, pers. comm.).

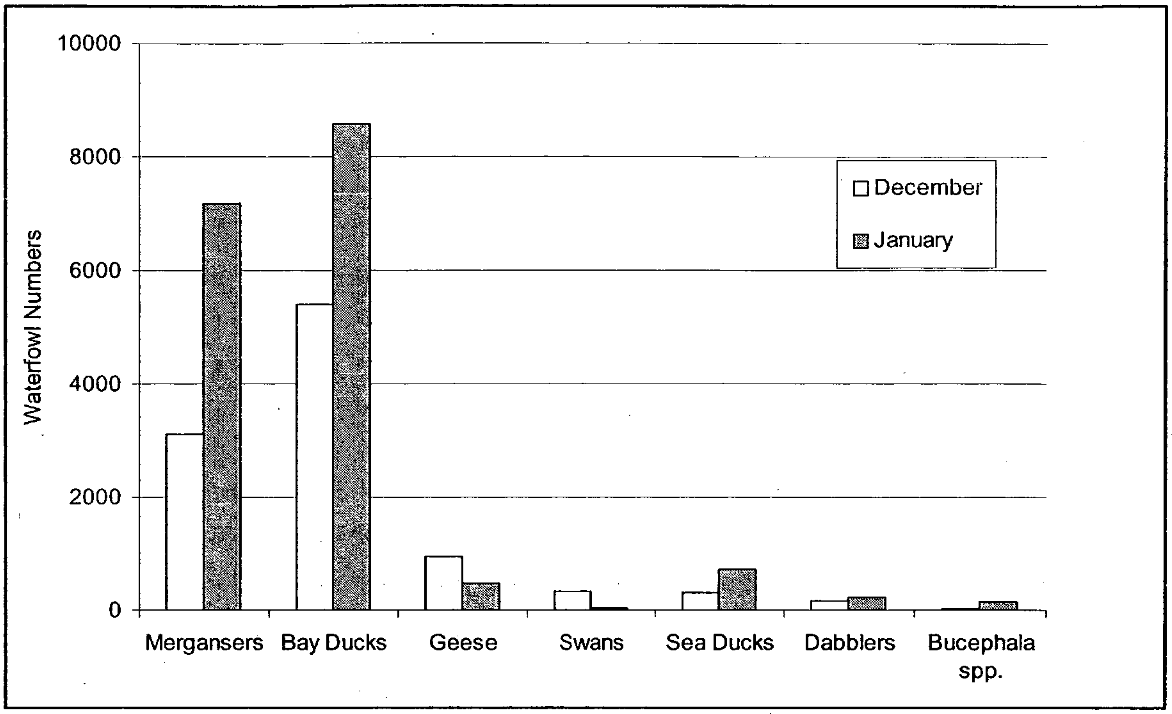
Table 2. Mean number of waterfowl counted along the Canadian side of the Niagara River from December to March in two sets of surveys conducted by the Canadian Wildlife Service in 1986/87 and 1994/95 (Barrett 1995). The number in brackets denotes the number of surveys conducted during the month.

Survey	December	January	February	March	Mean Number of Species
1986/87	16 626 (1)	11 628 (1)	18 895 (2)	17 390 (1)	15
1994/95	3477 (5)	4070 (4)	7195 (4)	7821 (5)	18

Estimates of waterfowl use may fluctuate with seasons and years due to a number of variables including changes in food availability and habitat quality on wintering and breeding sites, extent of human disturbance (due to small aircraft and boat disturbance and hunting practices), weather, and degree of ice cover on Lake Erie and Lake Ontario. Since the late 1980s, the rapid colonization of zebra mussels throughout the lower Great Lakes has likely influenced the distribution of migrant and overwintering waterfowl by directly providing an additional food resource for some waterfowl (i.e., diving ducks) and also indirectly by improving water clarity and improving foraging ability (Barret 1995). It is possible that an apparent decline in the number of birds found on the Niagara River may be due to movement of these birds to other more attractive sites such as Lake St. Clair (where water levels are low and water clarity is good) and where, for instance, a record number of waterfowl were reported in the winter of 2004 (N. North, CWS, pers. comm.). Conversely, apparent increases in the number of birds found on the Niagara River during other years may be due to less than favourable conditions at other locations. Knowledge of environmental conditions, biology, dietary requirements and population dynamics of waterfowl are necessary in order to evaluate temporal changes in waterfowl use in the Niagara River, a very dynamic and important location for both overwintering and migratory waterfowl.

During two aerial surveys of waterfowl performed on the Niagara River in the winter of 2000/01 (December and January), total numbers of waterfowl were high and equal to approximately 10 000 and 17 000 birds, respectively (N. North, CWS unpublished; Figure 5). Bay ducks (Canvasbacks and unidentified *Scaup* spp.) and mergansers (predominately Common Merganser and Red-breasted Merganser) were the most common groups of waterfowl reported. Canvasbacks were the most abundant of all duck species found, comprising approximately 44% of all waterfowl counted during both surveys. Canada Geese were the only goose species reported and were found in higher numbers in December 2000 compared to January 2001. One hundred Tundra Swans (*Cygnus columbianus*), two hundred and thirty Mute Swans (*C. olor*) and two Trumpeter Swans (*C. buccinator*) were recorded in the December 2000 survey; the only swans reported in the earlier Niagara River aerial surveys by Mullie *et al.* (1996) were two mute swans in the 1994 spring survey.

Figure 5. Total numbers, by taxonomic group, of waterfowl counted during two aerial surveys of the Canadian side of the Niagara River conducted in December 2000 and January 2001 (CWS, unpublished).



The sea duck group was almost entirely made up of Long-tailed Ducks, with seven White-winged Scoters (*Melanitta fusca*) reported in the January 2001 survey. Dabblers, namely Mallard, American Black Duck and Gadwall (*A. strepera*), comprised less than 2% of waterfowl counted during the two surveys; Mallards were the most common dabbler species. *Bucephala* spp. (Common Goldeneye and Bufflehead) comprised less than 1% of waterfowl counted on the Niagara River in both surveys. The Long Point Waterfowl and Wetlands Research Fund (part of Bird Studies Canada [BSC]) have been performing annual aerial waterfowl surveys of the lower Great Lakes shoreline, in the first week of January, since 2002. Total waterfowl numbers for three surveys from January 2002 to January 2004 varied widely and ranged from 4000 to 14 000 birds per survey (S. Petrie, BSC, pers. comm).

Christmas Bird Counts of bird species during one day in the early winter is another method for assessing the abundance of birds utilizing the Niagara River. From 1998 to 2002, 56 waterbird species (and/or categories) were counted at an average rate of over 200 birds per hour within a 24 km circle which includes Niagara Falls (Ontario) and encompasses the lower portion of the Niagara River (National Audubon Society 2002). Within another circle, in Buffalo, New York, covering the upper portion of the Niagara River, 45 species were counted at a similar average rate to that observed for Niagara Falls (over 200 birds per hour). Field party hours for counts from 1998-2002 ranged from 121 to 158 hours for each of the five census years for the two circles and numbers of participants ranged from 31 to 48 during this period. Herring Gulls and Ring-billed Gulls were the most numerous species recorded per hour in both Niagara Falls and Buffalo CBC counts followed by Bonaparte's Gull, Canada Goose and Long-tailed Duck for Niagara Falls and Canada Goose, Mallard and Canvasback for Buffalo. A greater number of species/categories were observed within the Niagara Falls circle and Bonaparte's Gulls and Long-tailed Ducks were observed at higher rates relative to Buffalo while Greater Scaup, Mallard and Common Goldeneye were observed at higher rates within the Buffalo circle. A complete listing of the waterbird species reported within the two Niagara Falls and Buffalo CBC circles and for the entire Niagara River (both circles together), as well as the average numbers of birds reported per hour in surveys from 1998 to 2002, is provided in Appendix I.

e) Bald Eagle

While once frequently observed in the Niagara Region, a marked decline in reports of Bald Eagles in the Niagara Region in the 1950s was noted by Beardslee and Mitchell (1965). Historically, Bald Eagles have nested along the Niagara River with the last known breeding pair reported on Navy Island in 1946 (Knapton and Weseloh 1999). Currently, no Bald Eagles are nesting on the Niagara River, although some nesting activity has been observed at Queenston (A. Yagi, OMNR, pers. comm.). Additionally, some Bald Eagle activity was reported during the winters of 2001 to 2003 on a nesting platform on Navy Island (Laing and Badzinski 2005). The Southern Ontario Bald Eagle Monitoring Project (a joint operation among the Ontario Ministry of Natural Resources, Environment Canada and Bird Studies Canada) will continue to monitor Bald Eagle nesting activity along the Niagara River.

f) Amphibians and Reptiles

In addition to monitoring marsh bird populations, the Marsh Monitoring Program monitors amphibian populations in the Great Lakes basin. Using a standardized protocol, a total of 12 Canadian routes and six U.S. routes were monitored for amphibians within the Niagara River AOC from 1995 to 2002 (Timmermans *et al.* 2003). In addition to marsh-nesting bird species, five amphibian indicator species were selected to assess wetland status. These amphibian indicator species included: bullfrog (*Rana catesbeiana*), chorus frog (*Acris crepitans*), mink frog (*Rana septentrionalis*), northern leopard frog (*Rana pipiens*) and spring peeper (*Hyla crucifer*). Measures of total amphibian species diversity, indicator species diversity and occurrence at MMP routes were also calculated. In general, 10 amphibian species were identified at MMP routes in the Niagara River AOC including four out of five amphibian indicator species; the fifth indicator species, mink frog, was not detected at any of the routes (Table 3). Of the four amphibian indicator species present, all species occurrences scored within the average of those at Great Lakes basin non-AOC routes (i.e., in Lake Erie). However, total amphibian species diversity and amphibian indicator species diversity scored below the average of those at Great Lakes basin non-AOC routes. Accordingly, based on these ratings and those found for marsh-nesting birds (see above), the Niagara River AOC was given an "impaired" rating in its ability to support a high diversity of marsh-dependent species. In addition to the four amphibian indicator species, six additional amphibian species were found including American toad (*Bufo americanus*), Cope's gray treefrog (*Hyla chrysoscelis*), gray treefrog (*Hyla versicolor*), green frog (*Rana clamitans*), pickerel frog (*Rana palustris*) and wood frog (*Rana sylvatica*) (Table 3). Spring peeper, chorus frog and bullfrog were the most common species reported occurring at 72-94% of Niagara River AOC routes surveyed from 1995 to 2002. Pickerel frog and Cope's gray treefrog (unverified) were the least common species reported at only 6% of routes surveyed. These patterns of occurrence were similar when U.S. Niagara River routes were removed from the analysis.

Amphibians in the Niagara River watershed are also being monitored through the Backyard Frog Survey (Canadian side only), a program initiated by the Canadian Wildlife Service in 1992 which focuses on more rare amphibians found in both marsh and non-marsh habitat (e.g., ditches, small ponds, etc.). Calling was monitored at a maximum of 20 sites from 1995 to 2001. Ten species were identified in the Backyard Frog Survey, including one additional species, mink frog, which was not identified on MMP routes. Cope's gray treefrog was not found using this protocol (Table 3). American toad, spring peeper and chorus frog were the three most common amphibian species found at between 75-96% of sites surveyed from 1995 to 2001. Mink frog and pickerel frog were the least abundant species found at 29% and 17% of sites surveyed, respectively. Generally, these patterns of occurrence were similar between the two sampling protocols and differences (e.g., occurrence of American toad) may be due to differences in the types of habitats monitored.

Table 3. Comparison of amphibian species found in the Niagara River watershed/AOC as identified in the Marsh Monitoring Program (MMP) and the Backyard Frog Survey. "√" indicates presence of species from 1995 to 2001/02. MMP results include data collected from six sites on the U.S. side of the river. Ontario Backyard Frog survey results are for the Niagara area which include the Niagara River (Ontario) AOC. "*" denotes the indicator species selected in the Marsh Monitoring Program.

Species	Scientific Name	**Marsh Monitoring Program**	**Ontario Backyard Survey**
Bullfrog*	*Rana catesbeiana*	√	√
Chorus Frog*	*Acris crepitans*	√	√
Northern Leopard Frog*	*Rana pipiens*	√	√
Spring Peeper*	*Hyla crucifer*	√	√
Mink Frog*	*Rana septentrionalis*		√
Cope's Gray Treefrog[a]	*Hyla chrysoscelis*	√	
Tetraploid Gray Treefrog	*Hyla versicolor*	√	√
Green Frog	*Rana clamitans*	√	√
Pickerel Frog	*Rana palustris*	√	√
Wood Frog	*Rana sylvatica*	√	√

[a] = not verified

Very little is known regarding the abundance of reptiles found in the Niagara River (Ontario) watershed.

In terms of distributions of reptiles and amphibians along the Niagara River, a listing of additional species native to Niagara River Areas of Concern (AOC) in Canada is shown in Table 4 (Oldham and Weller 2000). Species which were reported to the Ontario Herpetofaunal Atlas in the Niagara

River AOC between 1983 and 2000 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 AOC. This listing is designed to indicate species which were historically found in the Niagara River AOC and, therefore, those that may require more intensive monitoring and remediation efforts.

Table 4. Listing of additional amphibians and reptiles native to the Niagara River Area of Concern (AOC) in Canada (Oldham and Weller 2000). "1" in the table denotes that the species was sighted between 1983 to 2000 and reported to the Ontario Herpetofaunal Atlas; "2" denotes that the sighting was reported prior to, but not after, 1984.

Species	Scientific Name	Niagara River AOC
Red-spotted Newt	*Notophthalmus v. viridenscens*	1
Blue-spotted Salamander	*Ambystoma laterale*	1
Northern Dusky Salamander	*Desmognathus fuscus*	1
Spotted Salamander	*Ambystoma maculatum*	1
Northern Redback Salamander	*Plethodon cinereus*	1
Four-toed Salamander	*Hemidactylium scutatum*	1
Northern Spring Salamander	*Gyrinophilus p. porphyriticus*	2
Mudpuppy	*Necturus maculosus*	1
Common Snapping Turtle	*Chelydra s. serpentina*	1
Map Turtle	*Graptemys geographica*	2
Blanding's Turtle	*Emydoidea blandingi*	1
Wood Turtle	*Clemmys insculpta*	1*
Spotted Turtle	*Clemmys guttata*	1
Midland Painted Turtle	*Chrysemys picta marginata*	1
Eastern Box Turtle	*Terrapene c. carolina*	1
Five-lined Skink	*Eumeces fasciatus*	2
Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*	1
Eastern Garter Snake	*Thamnophis s. sirtalis*	1
Northern Water Snake	*Nerodia s. sipedon*	1
Eastern Hognose Snake	*Heterodon platirhinos*	1
Smooth Green Snake	*Liochlorophilis vernalis*	1
Northern Redbelly Snake	*Storeria o. occipitomaculata*	1
Eastern Massassauga Rattlesnake	*Sistrurus c. cantenatus*	1
Brown Snake	*Storeria dekayi*	1
Eastern Milk Snake	*Lampropeltis t. triangulum*	1
Timber Rattlesnake	*Crotalus horridus*	2
Black Rat Snake	*Elaphe o. obsoleta*	2

* = specimen was identified by a photo

g) Mammals

River Otter and Mink

River otter (*Lutra canadensis*) feed mainly on fish, amphibians, crayfish and other invertebrates. They live close to water and prefer lakes, marshes and streams. Mink (*Mustela vison*) 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.

Information from trappers and trapping records are two methods which have been used to examine population status and relative changes in harvested mink and otter populations. Since 1997, annual estimates of mink and otter abundance have been determined throughout Ontario using survey information from trappers through the Ontario Trapper Questionnaire developed for the Ontario Ministry of Natural Resources (OMNR) Wildlife Assessment Program (N. Dawson, OMNR, unpublished). A Population Level Index (PLI) was determined for both mink and otter in the Niagara District from 1997-2002, with the exception of 1999/2000 for which years no data were available (Figure 6). It should be noted that Niagara District is not specific only to the Niagara River basin but also encompasses portions of the Lake Ontario and Lake Erie shorelines. A Population Level Index is calculated using a formula, and is 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). The average number of trapper responses for the five survey years was equal to 17 and 20 for mink and otter, respectively. In general, the abundance of mink was rated as common. Otter abundance was rated as absent to very scarce, with PLI scores equal to zero for four out of the five survey years.

Figure 6. Population Level Index (PLI) calculated for mink and otter in the Niagara District from 1997 to 2002 (N. Dawson, OMNR, unpublished). Note that no data was available for 1999/2000.

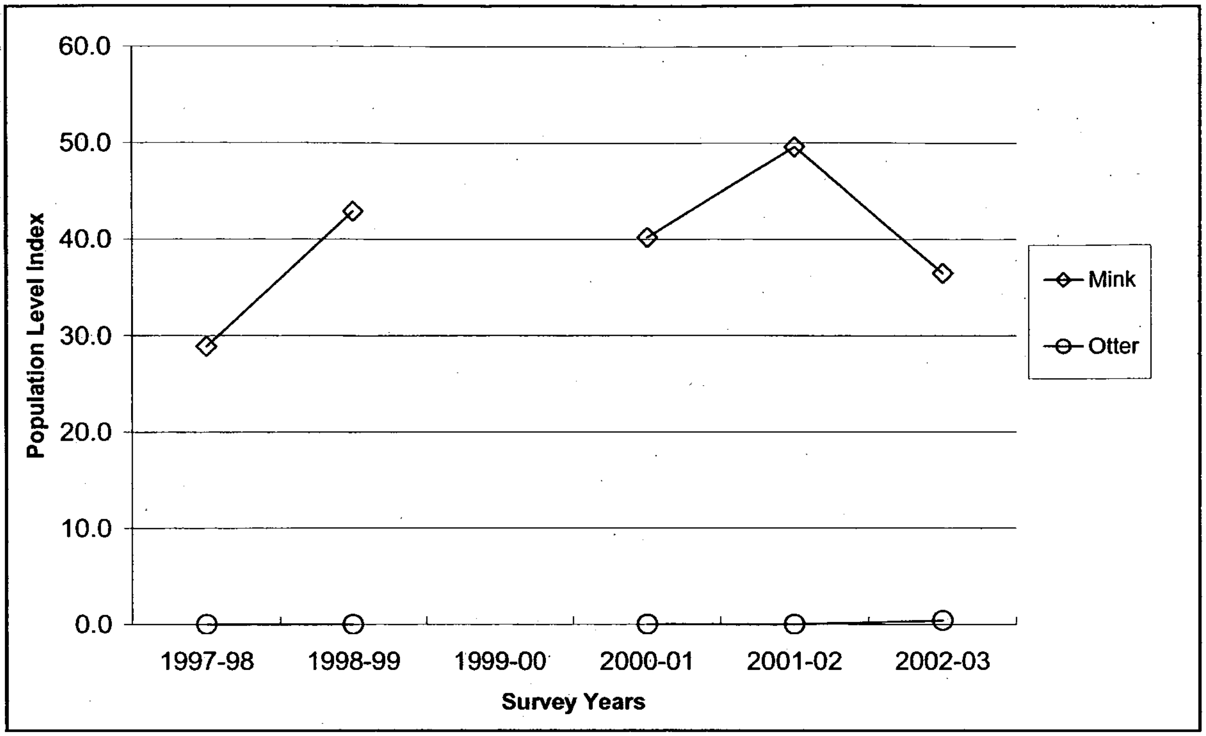


Table 5 shows the harvest numbers for mink and otter collected from 16 townships found in the Niagara River basin over three decades (C. Heydon, OMNR, unpublished). These townships include: Niagara, Stamford, Thorold, Pelham, Gainsborough, Caistor, Binbrook, Glanford, Seneca, Canborough, Moulton, Wainfleet, Crowland, Humberstone, Bertie and Willoughby. It is important to note that four of these townships are found along the shoreline of Lake Erie and therefore may be associated with the Lake Erie drainage basin; none are situated along the Lake Ontario shoreline. Trapper records indicate that more mink have been trapped in the Niagara River basin relative to otter. Furthermore, the low harvest numbers of otters trapped is in agreement with the trapper survey data reported above: otter are very scarce in the Niagara basin and surrounding area. While harvest numbers of otter have generally been stable, throughout Ontario 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.). Generally, it should be noted that 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.

Table 5. Harvest numbers of mink and otter trapped in 16 townships in the Niagara River basin over three decades. Note that no data are available for the 1980s.

Harvest Year	Number of Trappers	Number of Mink	Number of Otter
1972-1973	140	47	0
1993-1994	78	83	1
2002-2003	53	25	0

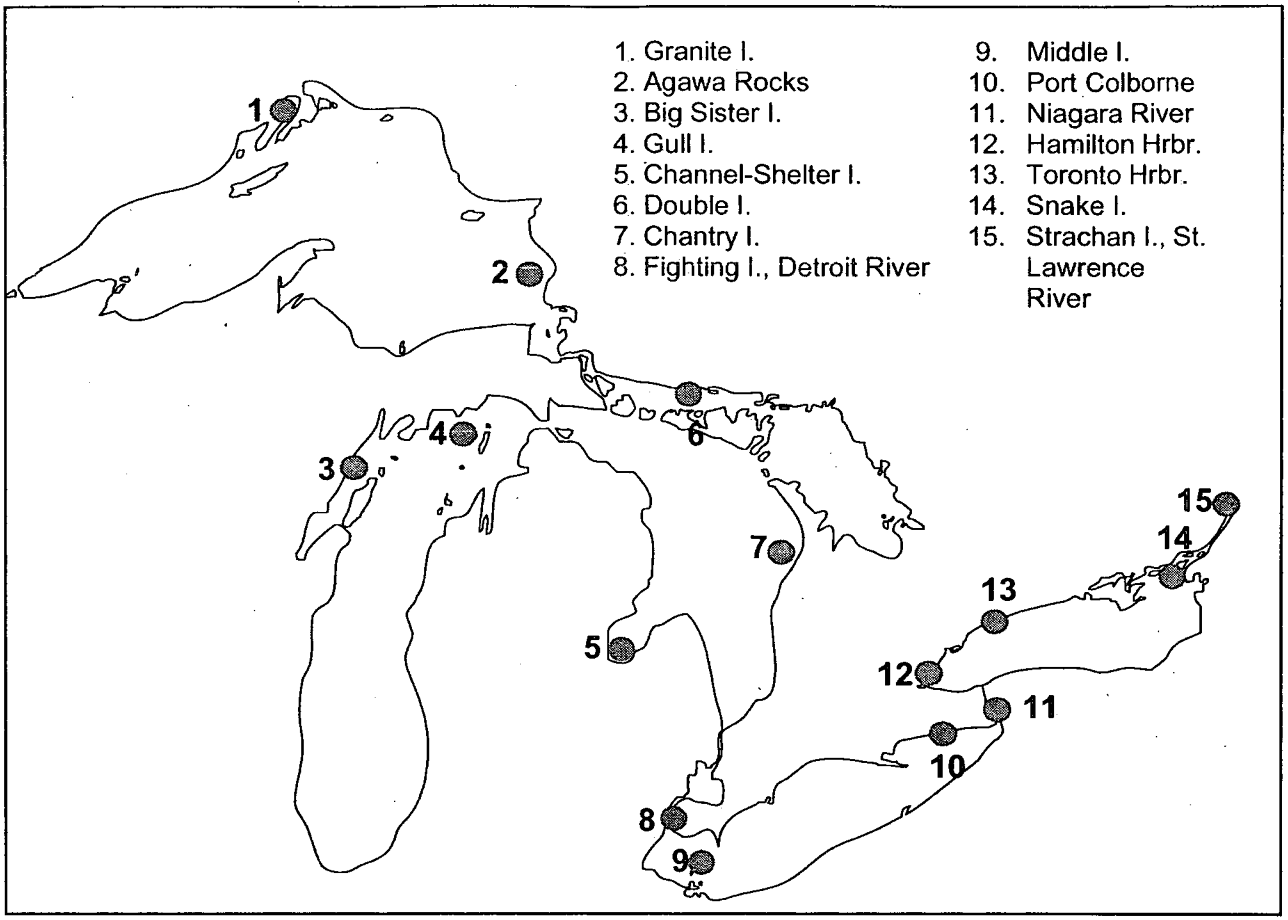
III. CONTAMINANTS – CURRENT STATUS

a) Colonial Waterbirds

Following an agreement between Canadian and U.S. environmental agencies in 1987, the Niagara River Toxics Management Plan was developed to reduce the concentration of contaminants found in the Niagara River. Eighteen contaminants were identified as "priority toxics," some of which include: DDT (dichlorodiphenyltrichloroethane), PCBs (polychlorinated biphenyls), dieldrin, mirex, chlordane, hexachlorobenzene, dioxins and mercury. Five of these chemicals (PCBs, mirex, hexachlorobenzene, dioxins and mercury) were designated for 50% reduction by 1996 since it was thought they had specific sources on both the Canadian and U.S. sides of the Niagara River. Sources of these chemicals include major municipal and industrial outfalls along the Niagara River and leachates from hazardous waste disposal and landfill sites (notably on the U.S. side of the river).

Herring Gulls, as non-migratory species, are excellent biomonitors of regional contaminant conditions in the Great Lakes because of their elevated trophic status and their ability to accumulate high levels of contaminants (Weseloh *et al.* 1990). 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, dieldrin, mirex, total chlordane (sum of concentrations of oxychlordane, cis-chlordane, trans-chlordane, cis-nonachlor and trans-nonachlor), heptachlor epoxide, hexachlorobenzene and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The CWS 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 7). On the Niagara River, Herring Gull eggs have been collected annually since 1979 from an unnamed island located approximately 300 m above Niagara Falls. Generally, mean contaminant levels detected in Herring Gull eggs collected from the Niagara River from 1998-2002 were within the range of levels detected in eggs from other AMC sites (Figure 8; Weseloh *et al.* 2006). An in-depth analysis of spatial trends during this five-year period revealed that eggs from the Niagara River had significantly lower concentrations of DDE than eggs from AMCs on Lake Superior, Lake Michigan and Lake Ontario, as well as from Channel-Shelter Island (Lake Huron) and Strachan Island (St. Lawrence River). Niagara River eggs also had significantly higher concentrations of DDE than that found in eggs from Port Colborne in Lake Erie. Concentrations of sum PCBs were significantly lower in eggs from the Niagara River compared to eggs from Lake Michigan, two Lake Ontario AMCs (Snake Island and Hamilton Harbour), Channel-Shelter Island, Fighting Island and Middle Island in Lake Erie. Sum PCB concentrations were significantly higher in Niagara River eggs compared to two AMCs on Lake Huron (Chantry Island and Double Island). Eggs from the Niagara River also had significantly lower concentrations of mirex than eggs from all three Lake Ontario AMCs and Strachan Island, yet had significantly higher concentrations than all other Great Lakes AMCs. Heptachlor epoxide concentrations were significantly lower in eggs from Niagara River compared to AMCs on Lake Superior and Lake Michigan and were statistically similar to all other Great Lakes AMCs. Concentrations of 2,3,7,8-TCDD in Niagara River eggs were significantly lower than in eggs from Channel-Shelter Island and Snake Island in Lake Ontario, and significantly higher than eggs from Port Colborne. No significant differences in concentrations of dieldrin, hexachlorobenzene and mercury were found in eggs from the Niagara River compared to other Great Lakes AMCs. In terms of an overall Great Lakes perspective, contaminant levels in Herring Gull eggs from the Niagara River AMC ranked 11 out of the 15 Great Lakes AMCs studied on the Great Lakes (Weseloh *et al.* 2006). Colonies were given an overall weighted ranking using mean values of seven contaminants reported in eggs from 1998 to 2002 and based on fish flesh criteria for the protection of piscivorous wildlife.

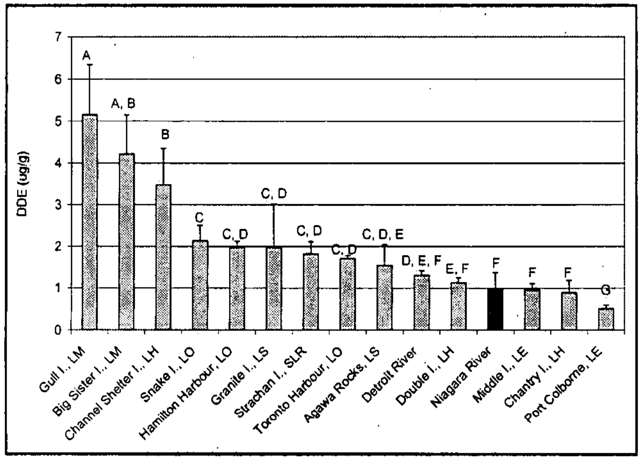
Figure 7. Location of the 15 Herring Gull Annual Monitor Colonies on the Great Lakes.



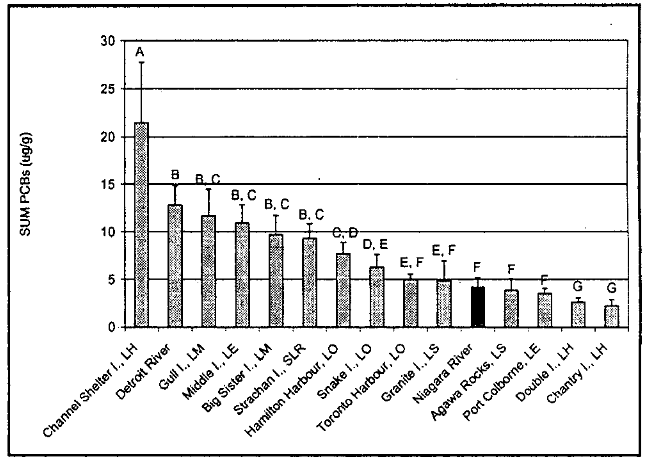
While it may be difficult to link specific contaminants to sites on the Niagara River and other Great Lakes sites further upstream, two chemicals for which the Niagara River has been identified as a significant source are mirex and hexachlorobenzene (Williams *et al.* 2000). The largest source of mirex in the Great Lakes basin was Hooker Chemicals and Plastics Corporation on the Niagara River at Niagara Falls, New York, where mirex was manufactured (Sergeant *et al.* 1993). Indeed, significantly higher concentrations of mirex were detected in eggs from the Niagara River relative to upstream sites. Eggs from downstream sites on Lake Ontario and the St. Lawrence River had significantly higher concentrations of mirex (Weseloh *et al.* 2006). Interestingly, though mean concentrations of hexachlorobenzene in Niagara River eggs from 1998-2002 were the second highest of all AMCs, no significant differences in hexachlorobenzene concentrations were found in eggs from the Niagara River compared to other Great Lakes AMCs (Weseloh *et al.* 2006). Effluents from the historical manufacturing of 2,4,5-trichlorophenol and disposal of chemical wastes at landfill sites (e.g., Love Canal) have also been significant sources of 2,3,7,8-TCDD to the Niagara River and Lake Ontario (Hebert *et al.* 1994). The majority of the hazardous wastes sites are located on the U.S. side of the Niagara River and are located upstream of the Niagara River Herring Gull AMC. With the exception of three AMC sites, the mean concentration of 2,3,7,8-TCDD in eggs from the Niagara River AMC was not significantly different from the mean concentrations found in eggs at all other AMCs on the Great Lakes from 1998-2002.

In terms of relating levels of contaminants in Herring Gull eggs to possible adverse effects, mean levels of DDE, total PCBs and TCDD in Herring Gull eggs from the Niagara River from 1998-2002 exceeded fish flesh guidelines established to protect piscivorous wildlife (Weseloh *et al.* 2006). Mean levels for dieldrin, heptachlor epoxide, hexachlorobenzene and mirex in eggs during this period, however, did not exceed these guidelines. These general guidelines were established to protect wildlife which feed on (contaminated) fish from adverse effects such as mortality, reproductive impairment and organ damage (Newell *et al.* 1987). Overall, while these levels of contaminants are below those expected to elicit population-level effects, subtle individual physiological effects may be present in some gulls.

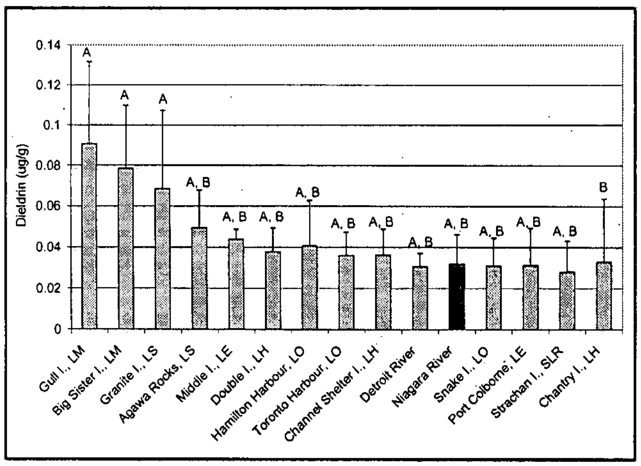
Figure 8. Mean contaminant levels (±SD) in Herring Gull eggs collected from 1998-2002 at 15 Annual Monitor Colonies on the Great Lakes (Weseloh *et al.* 2006). The bold bar indicates the Niagara River Annual Monitor Colony (unnamed). Means with the same letter are not significantly different.



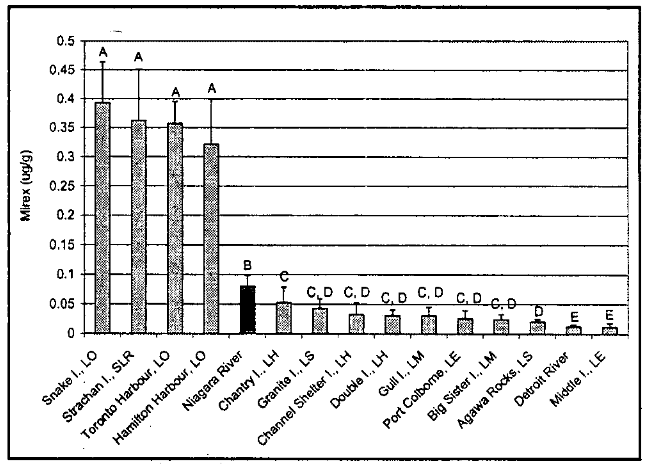
a) DDE



b) Sum PCBs

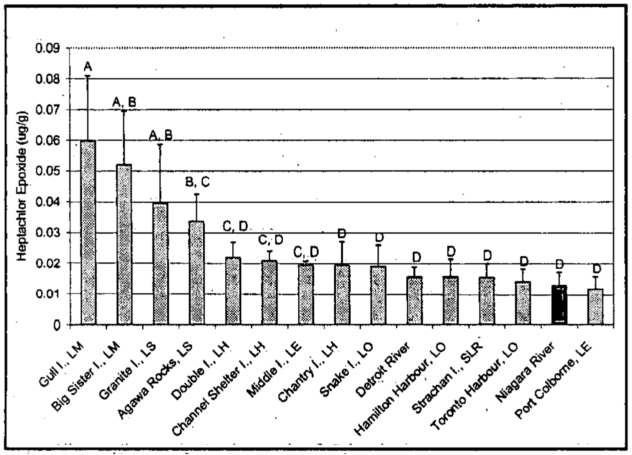


c) Dieldrin

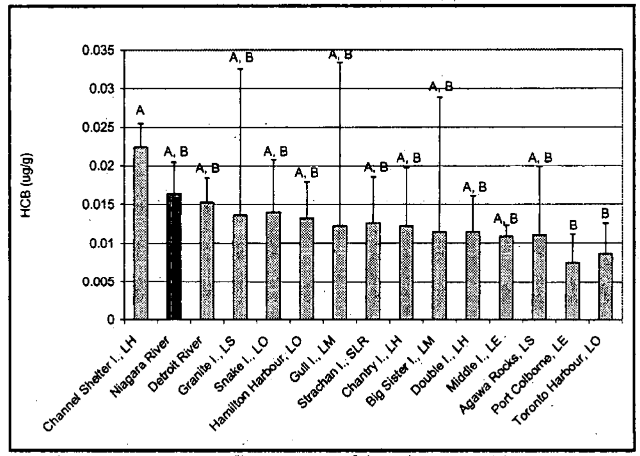


d) Mirex

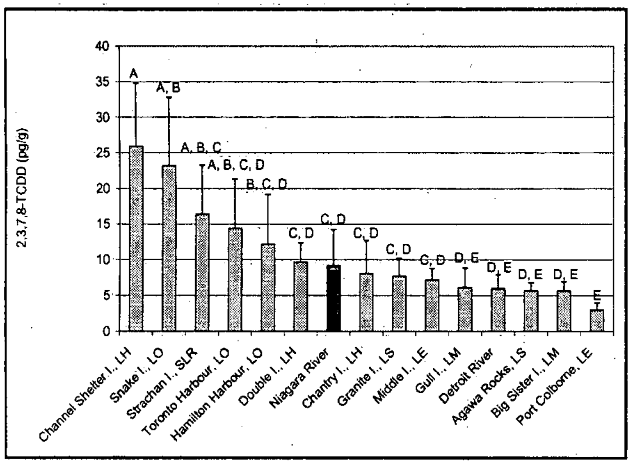
Figure 8 (continued). Mean contaminant levels (±SD) in Herring Gull eggs collected from 1998-2002 at 15 Annual Monitor Colonies on the Great Lakes (Weseloh *et al.* 2006). The bold bar indicates the Niagara River Annual Monitor Colony (unnamed). Means with the same letter are not significantly different.



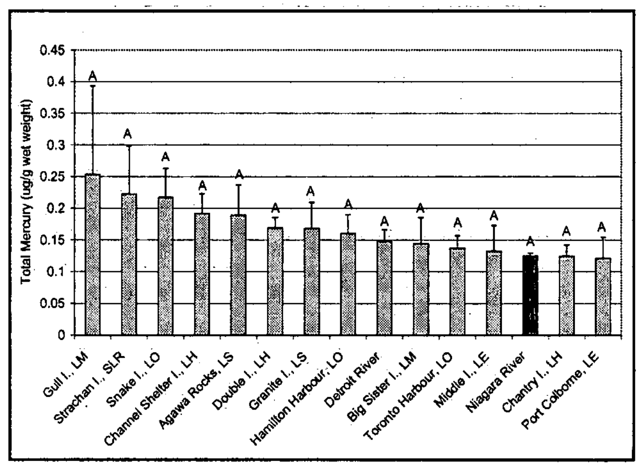
e) Heptachlor epoxide



f) Hexachlorobenzene



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

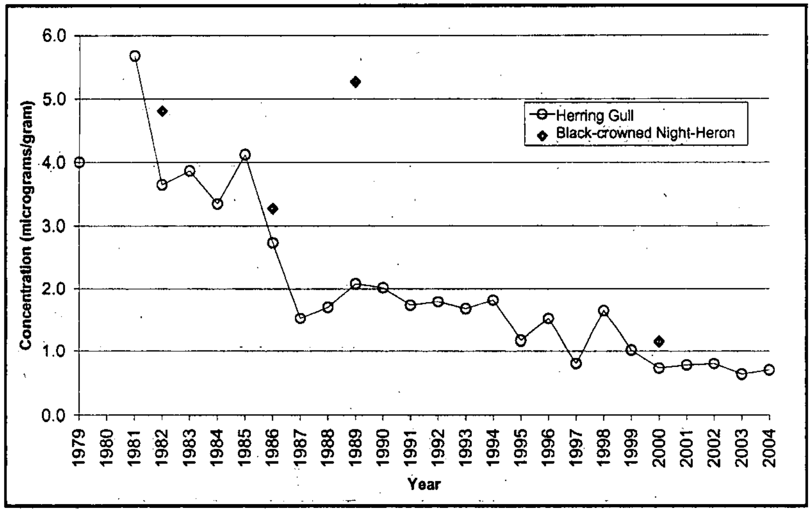


h) Mercury

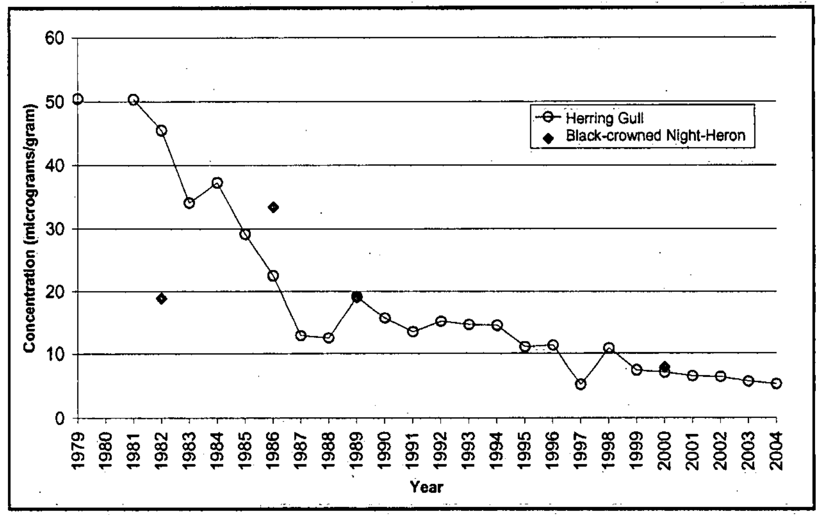
Large declines in levels of all eight contaminants have been observed in Herring Gull eggs collected from the Niagara River AMC since monitoring began in 1979 (Bishop *et al.* 1992; Pettit *et al.*1994; Pekarik *et al.* 1998; Jermyn-Gee *et al.* 2005; Figure 9). Statistical analyses of the long-term trends using change point regression analyses of seven of these contaminants (rates of decline of total chlordane were not statistically analyzed) indicate that for five of these contaminants, there has been a constant rate of decline in levels at the Niagara River AMC from 1979 to 2003 (CWS unpublished). For two of these contaminants (i.e., PCBs and heptachlor epoxide), rates of decline have slowed compared to earlier years. Declines in contaminant levels have also been reported in other monitoring programs along the Niagara River. Significant reductions in concentrations and loads of most of the "priority toxics" in the Niagara River have also been achieved in 2000/2001, with decreases often exceeding more than 70% since 1986/87 (Williams and O'Shea 2004). Similar declines in PCB levels since the 1970s have been reported in young of the spottail shiners (*Notropis hudsonius*) collected from sites in the Niagara River watershed in Ontario (Scheider *et al.* 1998). These temporal trends provide evidence of improved industrial practices, more stringent regulations, restrictions on the use of these chemicals and the effectiveness of remedial activities in reducing chemical inputs into the Niagara River by both Canadian and U.S. agencies. However in 2000/2001, levels (i.e., using the upper 90th percentile) of many of the "priority toxics" in water exceeded the most stringent agency criterion and sportfish consumption advisories continue to be issued for some fish species due to elevated levels of PCBs and/or mercury (Williams and O'Shea 2004). Continued monitoring of contaminants is essential to assessing the success of remediation activities in the Niagara River AOC.

Black-crowned Night-Heron eggs were also collected by CWS for contaminant analyses from an unnamed island on the Niagara River in 1982, 1986, 1989 and 2000 (Figure 9). Similar declines in levels of DDE, PCBs (expressed as Aroclor 1254: 1260, 1:1), dieldrin, mirex, total chlordane, heptachlor epoxide and hexachlorobenzene in Black-crowned Night-Heron eggs from 1982 to 2000 are evident. Concentrations of these contaminants were higher in eggs of Black-crowned Night-Heron versus Herring Gulls in half of the comparisons (13 of 26 cases).

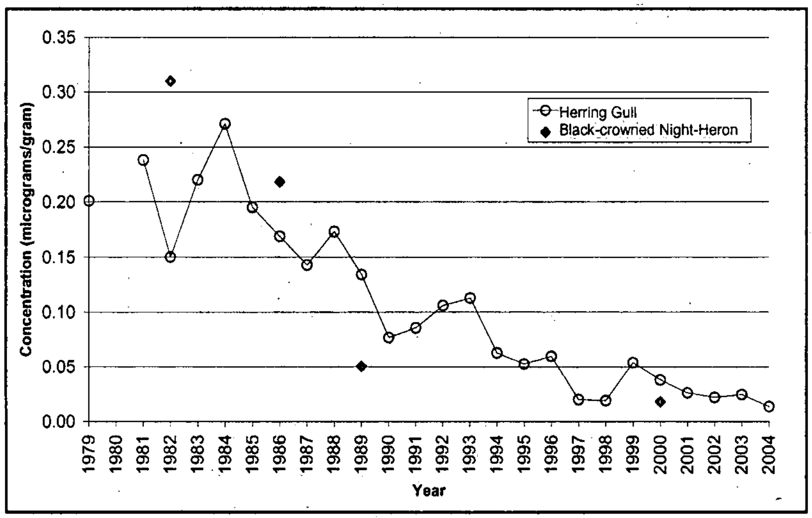
Figure 9. Temporal trends in levels of contaminants in Herring Gull eggs and Black-crowned Night-Heron eggs collected from the Niagara River Annual Monitor Colony (AMC).



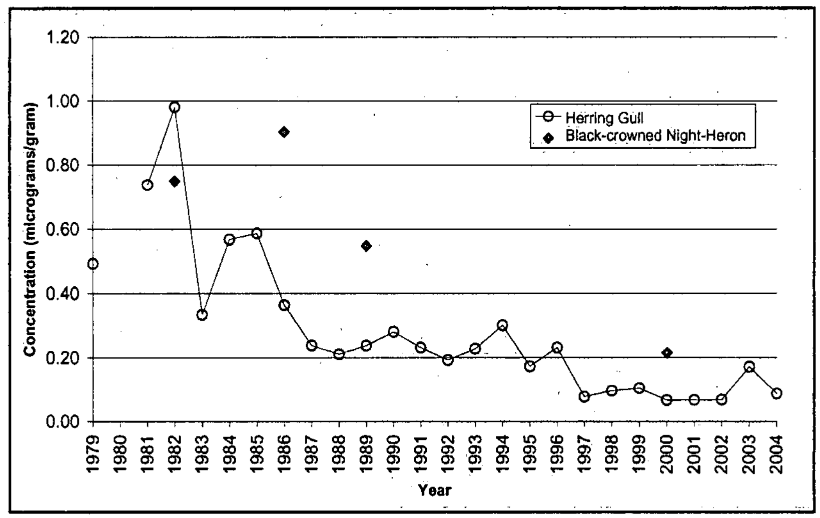
a) DDE



b) PCB 1254:1260

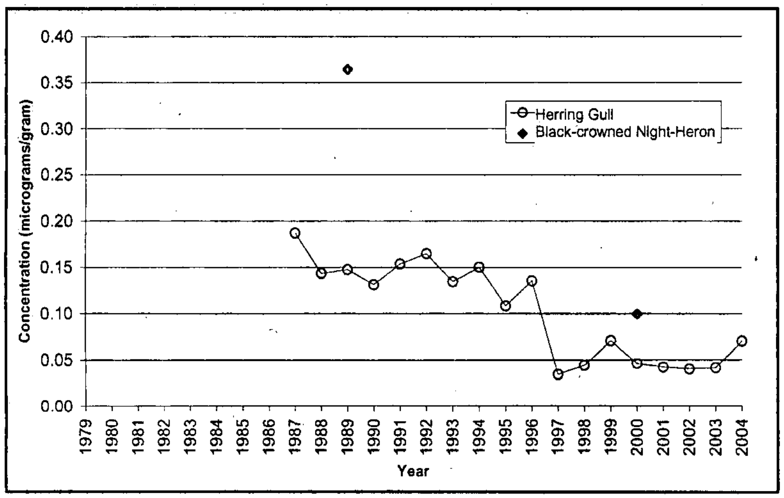


c) Dieldrin

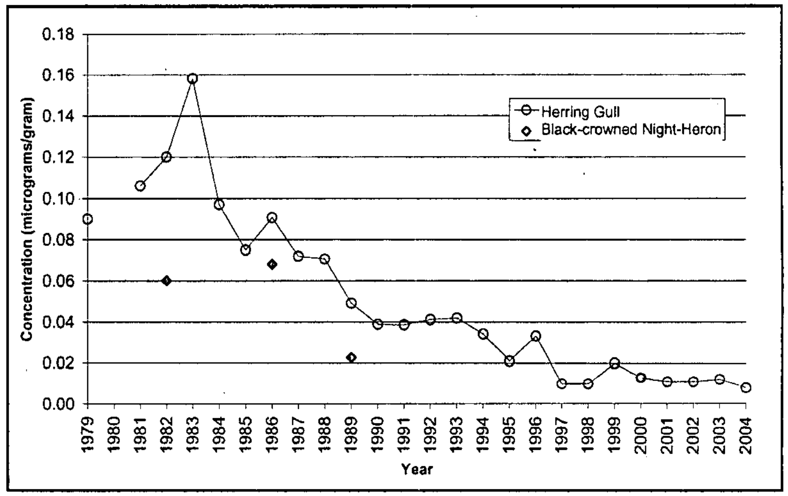


d) Mirex

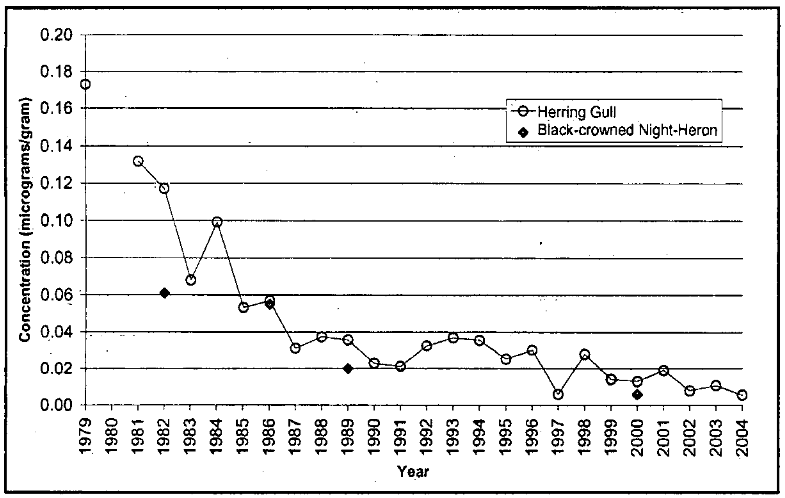
Figure 9 (continued). Temporal trends in levels of contaminants in Herring Gull eggs and Black-crowned Night-Heron eggs collected from the Niagara River Annual Monitor Colony (AMC).



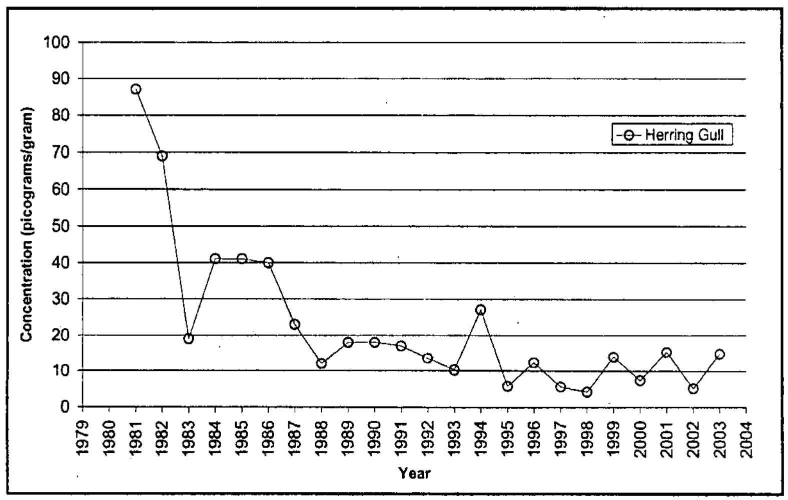
e) Total chlordane



f) Heptachlor epoxide



g) Hexachlorobenzene



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

The Niagara River, which is also a favourite wintering and staging ground for many gull species, remains largely ice-free in the winter and thereby provides necessary food reserves. Unfortunately, the effects on these species with increased exposure to contaminants in the winter months are largely unknown. However, Hebert (1998) has shown that Herring Gulls which breed at northern Great Lakes colonies have elevated egg contaminant levels following severe winters. This suggests that the gulls spend greater time at southerly Great Lakes locations (feeding on a more contaminated diet) during severe winters than they do during mild winters. Elevated levels of mirex in Herring Gull eggs collected from Chantry Island and colonies on Georgian Bay relative to levels found in eggs from elsewhere on Lake Huron suggest that these birds spend some time feeding on the Niagara River and/or Lake Ontario in the winter or pre-breeding period (Ewins *et al.* 1992).

Levels of mercury in Herring Gull eggs from the Niagara River have declined from 1982 to 2003, when levels were equal to 0.35 µg/g and 0.17 µg/g, respectively (CWS unpublished). The concentration of mercury in a pooled sample of Black-crowned Night-Heron eggs collected from the Niagara River in 2000 was 0.26 µg/g. Since current mercury concentrations are below the critical value of 0.5 µg/g typically associated with adverse reproduction in birds (Thompson 1996), no adverse effects would be expected in these two species.

High concentrations of brominated diphenyl ether (BDE) flame retardants in Great Lakes Herring Gull eggs have recently been identified as a concern (Norstrom *et al.* 2002). Total BDE in Herring Gull eggs sampled from Annual Monitor Colonies in 2000 were found at concentrations ranging from 192-1400 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 congeners associated with the penta-BDE formulation indicate dramatic increases over the past 20 years with continuing increases projected. The total concentration of BDEs at the Niagara River AMC was equal to 432 µg/kg and was low in comparison to other Great Lakes sites, largely due to its remoteness from relatively larger urban/heavy industrial centres. Little is known with regard to the toxic effects of brominated diphenyl ethers in humans and wildlife, although their structural similarity and initial toxicity tests suggest their toxicity may be somewhat similar to PCBs (Darnerud *et al.* 2001).

b) Waterfowl

Waterfowl utilizing known areas of contamination are at increased risk of accumulating elevated levels of contaminants in their tissues (Gebauer and Weseloh 1993). Environmental contaminants were measured in pectoral muscle of waterfowl shot by hunters in the Niagara area (Canada) in the autumn of 1988 (Braune *et al.* 1999). Pectoral muscle from one Common Goldeneye and four Long-tailed Ducks were analyzed as two pooled samples for contaminant analysis (Table 6). These waterfowl are species of diving ducks that feed predominately on aquatic invertebrates and aquatic vegetation. In both species, DDE and sum PCBs were found in the highest concentrations relative to levels of other organochlorines. Furthermore, levels of all organochlorines and sum PCBs were higher in Long-tailed Duck compared to Common Goldeneye, likely related to the fact that large numbers of Long-tailed Duck are known to overwinter in the Great Lakes and St. Lawrence River regions which are areas known to be contaminated. For metals, the concentration of mercury (Hg) in muscle was higher in Common Goldeneye compared to Long-tailed Duck while in the case of cadmium (Cd) the opposite was true.

Table 6. Levels of contaminants (µg/g, wet weight) in pectoral muscle of Common Goldeneye and Long-tailed Duck shot in the Niagara area in 1988 (Braune *et al.* 1999). N represents the number of birds analyzed in the pooled sample.

Species	N	DDE	Sum PCBs	Dieldrin	Mirex	Total Chlordane	H.E.[1]	HCB[2]	Hg	Cd
Common Goldeneye	1	0.079	0.181	0.006	0.021	0.001	0.001	0.006	0.460	0.023
Long-tailed Duck	4	0.208	0.421	0.033	0.026	0.031	0.008	0.012	0.233	0.110

[1] = Heptachlor epoxide
[2] = Hexachlorobenzene

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). Concentrations of all organochlorines, sum PCBs and metals in pectoral muscle of all birds were low, were not associated with adverse effects in birds, and did not pose a health hazard to consumers.

c) 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 1988 and 1989, 12 snapping turtles were collected from the Welland River for contaminant analysis (Hebert *et al.* 1993). Mean concentrations (±SD) of total DDT, total PCBs (expressed as Aroclor 1254:1260) and mirex in snapping turtle muscle were low and equal to 0.0019 (±0.0006) µg/g, 0.132 (±0.035) µg/g and 0.0004 (±0.0001) µg/g, respectively. Residues would be expected to be higher in eggs or other tissues compared to muscle tissue. For eggs, it would be approximately 8.4 times higher than in muscle, on a wet weight basis (Russell *et al.*, 1999). These levels in muscle tissue were well below the fish consumption guidelines and were within the range of levels found in snapping turtles collected from other southern Ontario locations. It should be noted that the contaminant burden in snapping turtle plasma (de Solla *et al.* 1998) and muscle (Hebert *et al.* 1993) are highly dependent on size, with larger turtles showing higher levels of contaminants, but Bishop *et al.* (1994) found no relationship between female size and contaminant burdens in eggs.

In contrast, preliminary results suggest that snapping turtle eggs collected in 2002 from Lyons Creek, a tributary of the Niagara River, had significantly higher levels of total PCBs relative to levels in eggs collected at Wheatley Harbour (another Area of Concern) and two reference sites (Tiny Marsh and Algonquin Park) (K. Fernie, CWS, unpublished). Furthermore, eight out of the nine clutches exceeded the minimum PCB advisory level provincial guideline (0.5 µg/g) for sport fish consumption in Ontario. This is cause for concern, particularly for human consumption of snapping turtle eggs. Further details relating to the clinical chemistry, reproductive biology and *in ovo* chemical concentrations of snapping turtles in Lyons Creek will be available in the near future (K. Fernie, CWS, pers. comm.). 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. A sediment management strategy for Lyons Creek East is currently being developed by Environment Canada and the Ontario Ministry of the Environment.

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 Areas of Concern on the Great Lakes, contaminant levels and associated rates of developmental deformities in mudpuppies in the Niagara River AOC, to date, have not been assessed. During fisheries assessments by the Ontario Ministry of Natural Resources, mudpuppies have been found in the Welland River (J. Baker, NPCA, pers. comm.).

d) Mammals

Mink

Mink are valuable indicators of local contamination in the aquatic environment due to their piscivorous diet and their restricted home ranges. Mink are especially sensitive to effects of PCBs and 2,3,7,8-TCDD in the environment. Eight mink were collected from Wainfleet township by trappers in 1988 and 1989 and their livers removed for contaminant analysis (Haffner *et al.* 1998). While the township of Wainfleet is adjacent to Lake Erie, the majority of the township is found in the Niagara River basin. In addition, two mink were trapped in Stevensville along Black Creek, a tributary of the Niagara River, in 2001 and their livers were analyzed for contaminants (CWS, unpublished). In general, mean contaminant concentrations in mink liver varied between sampling years with the highest mean levels reported for total PCBs (expressed as Aroclor 1254:1260; Table 7). Haffner *et al.* (1998) suggested that PCB concentrations in mink liver in 1988/1989 may be sufficiently elevated to possibly affect the overall fitness of the mink population in the township. With the exception of DDE and heptachlor epoxide, mean contaminant levels were higher in 2001 compared to 1988/1989. Differences in contaminant levels reported in mink between years may be related to differences in sampling locations, apparent changes in exposure over time and/or differences in ages of individuals sampled. For mink collected during the earlier period a high proportion of PCB congener 118 relative to total PCBs (41%) was evident, which is unusual since levels of this congener do not typically exceed those of PCB congeners 153, 138 and 180 in the Great Lakes. A high proportion of PCB congener 118 in tissue may indicate exposure to an Aroclor 1254 source (Norstrom 1988), though in this case, the precise location of mink collection is unknown. This pattern was not evident for the two mink collected along Black Creek in 2001. Furthermore, a high degree of variability was observed in contaminant levels in livers of the two individuals collected in 2001, with levels of all contaminants (except mirex and hexachlorobenzene) in one mink found to be at least three times higher than those in the other individual. This is likely due to differences in the ages of the two individuals, since the individual with higher levels was older (i.e., 23 months old) while the less contaminated individual was younger (i.e., 13 months). Results of contaminant analyses in livers of three additional mink collected from the Niagara River region will be available in the near future (P. Martin, CWS, pers. comm.).

Table 7. Mean concentrations of contaminants (±SE, µg/g) in mink livers collected in 1988 and 1989 from Wainfleet township in the Niagara District (Haffner *et al.* 1998) and in 2001 from Black Creek in the Niagara River basin (CWS, unpublished). N denotes the number of individuals.

Year	N	DDE	PCB 1254:1260	Dieldrin	Mirex	Oxy-chlordane	H.E.[1]	HCB[2]
1988/ 1989	8	0.050± 0.027	0.287± 0.129	0.0003± 0.0002	0.0015± 0.0004	0.0035± 0.0012	0.0007± 0.0002	0.0001± 0.0004
2001	2	0.032± 0.015	0.560± 0.318	0.0039± 0.0038	0.0022± 0.0003	0.0170± 0.0135	0.0006± 0.0005	0.0003± 0.0002

[1] = Heptachlor epoxide
[2] = Hexachlorobenzene

Mean total mercury concentration (±SE) in liver from the two mink reported above was equal to 1.091 (±0.008) µg/g, a level associated with uncontaminated sites (Wren 1986). No contaminants data are available for otter likely due to the scarcity of otter in the Niagara River region.

IV. HABITAT – CURRENT STATUS

a) Wetlands

In total there are 117 evaluated wetlands in the Niagara River (Ontario) AOC, encompassing over 7000 ha in area and approximately 5.4% of the Niagara River (Ontario) watershed (Figure 10; OMNR, unpublished). Of these, 101 wetlands are recognized as provincially significant wetlands while 16 are locally significant wetlands. Thirteen wetlands are associated with Areas of Natural and Scientific Interest (ANSI) and an additional ten wetlands are candidates for recognition as ANSIs. Some wetlands in the Niagara River (Ontario) watershed remain to be evaluated. A complete listing of evaluated wetlands is provided in Appendix II.

Wainfleet Marsh and Bog, located near the town of Port Colborne, is the largest wetland in the Niagara River AOC (approximately 1527 ha in size) and is the largest remaining bog ecosystem in southern Ontario. The bog is home to an isolated population of eastern Massassauga rattlesnake (*Sistrurus catenatus catenatus*), a species identified as "threatened" both nationally and provincially. The Niagara Peninsula Conservation Authority, Ontario Ministry of Natural Resources and the Nature Conservancy of Canada own the largest portions of the wetland while some private owners own portions on the periphery of the bog. The smallest wetland, Jordan Station Marsh, is approximately 0.03 ha in size.

In total, four coastal wetlands are found along the Canadian side of the Niagara River encompassing a total area of approximately 141 ha (OMNR, unpublished; Environment Canada and Ontario Ministry of Natural Resources 2003; Table 8). All of these have been evaluated and range from approximately 10 to 53 ha in size, and have swamp and marsh components. Two wetlands are found in or adjacent to natural areas identified in the Natural Heritage Information Centre (NHIC) Natural Areas Database (NAD): Navy Island Marsh is associated with an ANSI and an International Biological Program (IBP) site and Miller's Creek is associated with an IBP site.

Figure 10. Ontario Ministry of Natural Resources evaluated wetlands within the Niagara River AOC (data specific to 1990-1998).

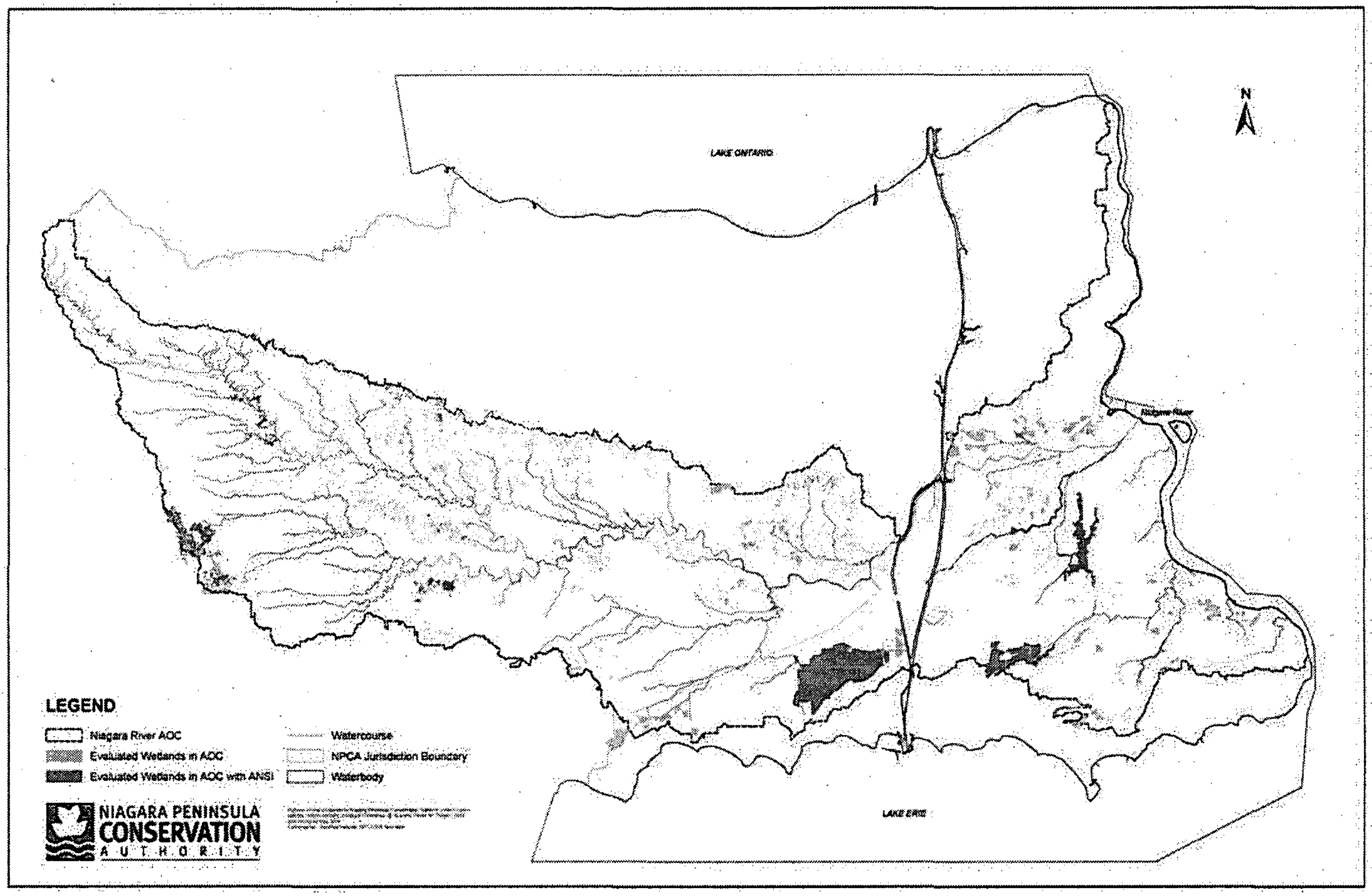


Table 8. Four evaluated coastal wetlands on the Canadian side of the Niagara River (as of 1996) with natural areas that overlap or are adjacent to the evaluated wetland (OMNR, unpublished; Environment Canada and Ontario Ministry of Natural Resources 2003). Natural areas, as identified in the Natural Heritage Information Centre (NHIC) Natural Areas Database (NAD) include: Area of Natural and Scientific Interest (ANSI) and International Biological Program (IBP) site.

No.	Wetland Name	Total Area (ha)	ANSI	IBP
1.	Navy Island Marsh	10.02	X	X
2.	Miller's Creek	39.47		X
3.	Frenchman's Creek	38.66		
4.	Black Creek Wetland	52.58		

The coastal wetlands of the Niagara River provide important habitat for a number of provincially significant plant, fish and bird species (Environment Canada and Ontario Ministry of Natural Resources 2003). Nine provincially significant plant species have been identified along the Niagara River including arrow-arum (*Peltandra virginica*), honey locust (*Gleditsia triacanthos*) and swamp rose-mallow (*Hibiscus moscheutos*). Fifty-nine species of fish that use coastal wetlands on a permanent or temporary basis have been reported from the Niagara River (Mandrak and Crossman 1992). Three provincially significant fish species, lake chubsucker (*Erimyzon sucetta*), grass pickerel (*Esox americanus*) and black bullhead (*Ameiurus melas*), use the Niagara River wetlands as year-round habitat. Coastal wetlands also provide important habitat for amphibians, reptiles, birds and mammals. The only reported occurrence of the northern dusky salamander (*Desmognathus fuscus*) in Ontario was in these wetlands (Environment Canada and Ontario Ministry of Natural Resources 2003). These wetlands also provide important nesting habitat for Black-crowned Night-Heron. No provincially significant reptile, amphibian or lepidopteran species were reported in coastal wetlands of the Niagara River. A complete listing of provincially significant species found in the coastal wetlands of the Niagara River is provided in Appendix III.

Wetland loss has been recognized as a significant issue in southern Ontario. In 1995, a pilot study by Environment Canada was undertaken using remote sensing and GIS techniques to determine original and current wetland coverage in the Niagara River AOC. Current wetland coverage for the Niagara River watershed as well as for subwatersheds within the AOC were then compared to rehabilitation guidelines used to identify priority areas for habitat restoration and protection. Estimates of original and current wetland coverage in the Niagara River AOC indicated a drop in wetland percentage in the AOC from 38.9% pre-settlement wetland coverage to 7.7% current wetland coverage (Environment Canada *et al.* 1998). Consequently, this identified the current wetland coverage for the Niagara River AOC as below the recommended 10% wetland habitat guideline for a major watershed. Six percent of each subwatershed in wetland habitat was also recommended as a guideline for subwatersheds: four out of sixteen subwatersheds were identified as below this guideline for wetland coverage. A listing of subwatersheds and corresponding original and current wetland areas within the Niagara River AOC is provided in Appendix IV. It should be noted that the apparent discrepancy between current wetland coverage for the Niagara River AOC using this method (i.e., 7.7%) and that reported above (i.e., 5.4%; OMNR unpublished) reflect differences only in the methodology used to estimate wetland extent and are not indicative of temporal changes in wetland coverage in the Niagara River AOC.

Wetlands within the Niagara River AOC are subject to a number of major stressors. Wetlands near municipal and industrial outfalls are vulnerable to eutrophication and contamination from toxic chemicals (Environment Canada and Ontario Ministry of Natural Resources 2003). Loss of, and stress to, wetlands associated with shoreline modification, wetland drainage for agriculture purposes and urban development continue to be of concern. The diversion of more than half of the flow of the Niagara River for power production causes dewatering of some marsh areas and puts additional stress on coastal wetlands. Mullie *et al.* (1996) speculate that loss of aquatic vegetation along the lower Niagara River may be responsible for lower waterfowl numbers observed in this area versus the upper portion of the river, above Niagara Falls.

The Important Bird Area (IBA) program is an international initiative which identifies and conserves essential habitat for breeding and non-breeding birds. In 1996, the Niagara River corridor was designated as an IBA, jointly by Canada and the United States, due to its significance as a staging area for migrating birds and as a wintering site. Nineteen species of gulls and over twenty five species of waterfowl have been recorded on the Niagara River during the fall and winter season (Knapton and Weseloh 1999). Four species of birds are found here in numbers that are globally significant: Bonaparte's Gull, Herring Gull, and Canvasback and Common Merganser.

b) Welland River

While the Welland River contributes less than 0.1% of the total flow to the Niagara River (Niagara River Remedial Action Plan 1995), the connection between the health of the Welland River watershed and the health of the Niagara River cannot be overlooked. The Welland River watershed encompasses 81% of the Niagara River (Ontario) Area of Concern and has a total drainage area of 88 000 ha (Niagara River Conservation Authority 1999). Water quality in the Welland River is considered to be poor, with high suspended-sediment levels, high phosphorus levels and low oxygen levels. Water level fluctuations due to operating practices of Ontario Power Generation have altered the natural flow patterns of the Welland River such that the impact extends 60 km upstream to the Port Davidson Weir. These twice-daily vertical fluctuations of 0.3 to 1.0 m have impacted the River's ability to naturally transport sediment out of the Welland River, resulting in continued sediment suspension in the water column. Poor quality fish and wildlife habitat, lack of diverse riparian and wetland habitat as well as barriers to fish migration were also identified as constraints affecting the ecological health of the watershed. The Welland River Watershed Strategy (Niagara River Conservation Authority 1999) was developed to improve the health of the watershed while addressing the needs of the community, which relies on its resources through partnerships with landowners, corporations, non-profit organizations and municipal, provincial and federal governments. Projects to mitigate the effects of water level fluctuations, as well as reduce sediment loading and nutrient loading to the Welland River through improved rural, urban and recreational practices have been implemented. Rehabilitation projects which create, enhance and preserve wildlife habitat, including habitat which is unique to the Niagara River area, have also been initiated.

V. CONCLUSIONS

The Niagara River watershed supports an abundant and diverse community of aquatic wildlife throughout the entire year. Since at least the late 1970s, three nesting colonial waterbird species, including the provincially significant Black-crowned Night-Heron, have nested on the Canadian side of the Niagara River. Colonial waterbird surveys performed by the Canadian Wildlife Service (CWS) in 1990/91 and 1999 indicated that numbers of nests have changed moderately during this period, with annual rates of decline reported for both Herring Gulls (-1.8%) and Ring-billed Gulls (-2.6%). Given the overall success of these species on the Great Lakes, it is unlikely that these populations are threatened. The annual rate of increase in nest numbers reported for Black-crowned Night-Heron (+1.1%), as a provincially significant species on the Niagara River, is encouraging. In general, numbers of colonial waterbird nests on the Canadian side are considerably lower (651 nests) compared to the U.S. side of the Niagara River where, in 1997/99, seven colonial waterbird species were reported and over 17 000 nests were counted. This is likely due to the more extensive shoreline and greater availability of suitable habitat found on the U.S. side of the Niagara River. New species to colonize the Canadian side of the Niagara River in the near future may include Common Terns and Double-crested Cormorants, the latter of which is cause for concern given the limited amount of available nesting habitat for Black-crowned Night-Herons, which also nest in trees. The Niagara River is an important staging area for thousands of gulls, including Bonaparte's Gull and Little Gull, during fall and spring migration. The Niagara River, unlike Lake Erie and portions of Lake Ontario, does not freeze over in winter, and is also a very dynamic area in terms of waterfowl usage. Waterfowl surveys of the Canadian side of the Niagara River reveal a large degree of variability in total numbers of overwintering waterfowl in the past decade. Estimates of waterfowl use may fluctuate with seasons and years due to a number of variables, including changes in food availability and habitat quality on the Niagara River and/or elsewhere on the Great Lakes. Bald Eagles have not returned to nest on the Niagara River since the mid-1940s when they were last reported, although some winter activity has been reported since 2001. A total of 11 amphibian species were reported in the Niagara River AOC by the binational Marsh Monitoring Program (MMP) and the Backyard Frog Survey in Ontario, of which spring peeper and chorus frog were among the most common species (Timmermans *et al.* 2003; CWS unpublished). In addition, the results of MMP data indicate that 18 marsh bird species were recorded in the Niagara River AOC from 1995 to 2002. Based on scores of abundance and diversity of marsh birds and amphibians relative to non-AOCs in the same lake basin, the Niagara River AOC was given an "impaired" rating in its ability to support a high diversity of marsh bird and amphibian species. Volunteer recruitment for marsh-bird monitoring in the Niagara River AOC is critical, since the number of MMP routes has decreased from three in 1999 to zero in 2002. Numbers of amphibian routes have also declined during this period. The abundance of mink was rated as common in the Niagara River District, while the abundance of otter was rated as scarce to absent.

Currently, contaminant levels in Herring Gull and Black-crowned Night-Heron eggs are low compared to levels reported in the 1970s and 1980s where the near-failure of reproduction was noted in a number of colonial waterbird species nesting on the Great Lakes (Gilman *et al.* 1977; Weseloh *et al.* 1983). Temporal trends of contaminants in Herring Gull eggs provide a useful measure of changes in contaminant availability to aquatic wildlife. Declines in contaminant levels over time were found in Herring Gull eggs collected from the Niagara River since the late 1970s. Declines in contaminants have also been reported in other Niagara River monitoring programs. Mean levels of DDE, PCBs and 2,3,7,8-TCDD in Herring Gull eggs collected from 1998-2002 in the Niagara River were found to exceed guidelines associated with the protection of piscivorous wildlife. While these levels of contaminants are below those expected to elicit population-level effects, subtle individual physiological effects may be present in some gulls. Brominated diphenyl ether (BDE) flame retardants, recently identified at elevated levels at other Great Lakes sites, may be of increasing concern for aquatic wildlife in the Great Lakes. Contaminant levels in waterfowl collected in 1988 were below those considered harmful to wildlife and human consumption. Elevated levels of contaminants, notably PCBs, have been detected in tissues of other species from the Niagara River, including snapping turtle and mink. Preliminary results, based on collections of snapping turtle eggs from Lyons Creek in 2002, indicate that levels of PCBs in some eggs exceed those considered safe for human consumption. Mean levels of PCBs and some other contaminants in mink liver from Black Creek in 2001 were also higher than mean levels previously reported in mink liver from the Niagara District in 1988/89; possible reasons for these differences may be related to differences in sampling location, exposure, or ages of individuals. Mercury levels in mink liver were below those associated with toxic effects.

Wetlands provide important habitat for fish, amphibians, reptiles, avian and mammal species. In total, there are 117 evaluated wetlands in the Niagara River AOC encompassing over 7000 ha and approximately 5.4% of the Niagara River (Ontario) watershed (OMNR, unpublished). A number of wetlands remain to be evaluated in the Niagara River (Ontario) AOC. Loss of wetlands has been associated with shoreline modification, wetland drainage and urban encroachment. A pilot study in 1995 by Environment Canada identified that current wetland coverage in the Niagara River AOC fell below the recommended 10% wetland habitat guideline for a major watershed. The Welland River watershed, which encompasses a substantial portion of the Niagara River (Ontario) AOC, also has poor water quality and attempts to mitigate the effects of altered water flow and introduce more favourable land-use practices have been implemented.

The water of the Niagara River and its watershed is an integral part of the community and its inhabitants in the Niagara area. Diverse populations and significant numbers of aquatic wildlife rely on the river's resources and habitat. As a result of extensive remediation activities, rehabilitation projects, community awareness and participation by a large number of agencies, the Niagara River and its watershed continue to move in a direction which is cleaner and better supports the human and wildlife populations which depend on it.

VI. REFERENCES

Barrett, G. 1995. *Numbers and distribution of overwintering waterfowl on the Niagara River, an IJC Area of Concern: 1986, 1987, 1994 and 1995.* Report submitted to Environment Canada, Canadian Wildlife Service. 44 pp.

Beardslee, C.S., and H.D. Mitchell. 1965. *Birds of the Niagara frontier region.* Bulletin of the Buffalo Society of Natural Sciences. Volume 22. Buffalo New York. 478 pp.

Bellerby, G., D.A. Kirk, and D.V. Weseloh. Staging Little Gulls, Larus minutus, on the Niagara River, Ontario: 1987-1996. *Can. Field Nat.* 114(4): 584-590.

Bishop, C.A., and A.D. Gendron. 1998. Reptiles and amphibians: shy and sensitive vertebrates of the Great Lakes basin and St. Lawrence River. *Environ. Monitor. Assess.* 53: 225-244.

Bishop, C.A., et al. 1992. *An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988), Vol.1.* Technical Report Series No. 152, Canadian Wildlife Service, Ontario Region.

Bishop, C.A., et al. 1994. Oroganochlorine contaminant concentrations in eggs and their relationship to body size, and clutch characteristics of the female common snapping turtle (Chelydra serpentina serpentina) in Lake Ontario, Canada. *Arch. Environ. Contam. Toxicol.* 27: 82-87.

Blokpoel, H., and G.B. McKeating. 1978. *Fish-eating birds nesting in Canadian Lake Erie and adjacent waters.* Can. Wildl. Serv. Prog. Note 87. 12 pp.

Blokpoel, H., and G.D. Tessier. 1996. *Atlas of colonial waterbirds nesting on the Canadian Great Lakes, 1989-1991. Part 3. Cormorants, gulls and island-nesting terns on the lower Great Lakes system in 1990.* Can. Wildl. Ser. Tech. Rep. Ser. No. 225. 40 pp.

Blokpoel, H., and G.D. Tessier. 1998. *Atlas of colonial waterbirds nesting on the Canadian Great Lakes, 1989-1991. Part 5. Herons and egrets in 1991.* Can. Wildl. Ser. Tech. Rep. Ser. No 272. 36 pp.

Braune, B.M., et al. 1999. *Chemical residues in waterfowl and gamebirds harvested in Canada, 1987-95.* Can. Wildl. Serv. Tech. Rep. Ser. No. 326. 422 pp.

Cuthbert, F.J., J. McKearnan, and A.R. Joshi. 2001. *Distribution and abundance of colonial waterbirds in the U.S. Great Lakes: 1997-1999.* Unpublished report to the U.S. Fish and Wildlife Service, Ft. Snelling, Mn.

Darnerud, P.A., et al. 2001. Polybrominated diphenyl ethers: occurrence, dietary exposure and toxicology. *Environ. Health Perspect.* 109 (suppl 1): 49–68.

de Solla, S.R., et al. 1998. Impact of organochlorine contamination on levels of sex hormones and external morphology of common snapping turtles (Chelydra serpentina serpentina) in Ontario, Canada. *Environ. Health Perspect.* 106: 253-260.

Environment Canada. 1994. *Environmental sensitivity atlas for Lake Erie (including the Welland Canal) and the Niagara River shorelines.* Environment Canada (Ontario Region). 73 pp.

Environment Canada and Ontario Ministry of Natural Resources. 2003. *The Ontario Great Lakes coastal wetland atlas: a summary of information (1983-1997).* 103 pp.

Environment Canada, Ontario Ministry of Natural Resources, and Ontario Ministry of Environment. 1998. *A framework for guiding habitat rehabilitation in Great Lakes Areas of Concern.* Canada-Ontario Remedial Action Plan Steering Committee. 76 pp.

Ewins, P.J., D.V. Weseloh, and P. Mineau. 1992. Geographical distribution of contaminants and productivity measures of Herring Gulls in the Great Lakes: Lake Huron 1980. *J. Great Lakes Res.* 18(2): 316-330.

Gebauer, M.B., and D.V. Weseloh. 1993. Accumulation of organic contaminants in sentinel mallards utilizing confined disposal facilities at Hamilton Harbour, Lake Ontario, Canada. *Arch. Environ. Contam. Toxicol.* 25: 234-243.

Gilman, A.P., et al. 1977. Reproductive parameters and egg contaminant levels of Great Lakes Herring Gulls. *J. Wildl. Manage.* 41(3): 458-468.

Government of Canada. 2003. *Canada's RAP Progress Report 2003.* Environment Canada, Restoration Programs Division. 64 pp.

Haffner, G.D., et al. 1998. Concentrations and distributions of polychlorinated biphenyls, including non-ortho congeners, in mink populations from southern Ontario. *J. Great Lakes Res.* 24(4): 880-888.

Hebert, C.E. 1998. Winter severity affects migration and contaminant accumulation in northern Great Lakes Herring Gulls. *Ecol. Applic.* 8(3): 669-679.

Hebert, C.E., et al. 1993. Organic contaminants in snapping turtle (*Chelydra serpentina*) populations from southern Ontario, Canada. *Arch. Environ. Contam. Toxicol.* 24: 35-43.

Hebert, C.E., et al. 1994. Temporal trends and sources of PCDDs and PCDFs in the Great Lakes: Herring Gull egg monitoring, 1981-1991. *Environ. Sci. Tech.* 28(7): 1268-1277.

Jermyn-Gee, K., et al. 2005. *An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1998-2001).* Volume 1. Can. Wildl. Ser. Tech. Rep. Ser. No. 417. 341 pp.

Kirk, D.A., et al. 2001. Using migration counts to assess seasonal movements, population status and trends in Bonaparte's Gulls on the Niagara River, Ontario. Unpublished manuscript. 31 pp.

Knapton, R., and D.V. Weseloh. 1999. *The Niagara River. an Important Bird Area.* Environment Canada. 31 pp.

Laing, D.K., and D.S. Badzinski. 2005. *Southern Ontario bald eagle monitoring project – 2004 final report.* Bird Studies Canada, Environment Canada, Ontario Ministry of Natural Resources. 26 pp.

Mandrak, N., and E.J. Crossman. 1992. *A checklist of Ontario freshwater fishes.* Royal Ontario Museum, Toronto, Ontario.

Mullie, A., R.K. Ross, and D.G. Dennis. 1996. *Overview of migrant waterfowl use of the Great Lakes Areas of Concern and other selected coastal sectors in southern Ontario.* Can. Wildl. Serv. Tech. Rep. Ser. No. 261. 144 pp.

National Audubon Society (2002). The Christmas Bird Count Historical Results [Online]. Available http://www.audubon.org/bird/cbc (2005).

Newell, A.J., D.W. Johnson, and L.K. Allen. 1987. *Niagara River project: fish flesh criteria for piscivorous wildlife.* New York State Department of Environmental Conservation, Technical Report 87-3.

Niagara River Conservation Authority. 1999. *Welland River watershed strategy.* 35pp.

Niagara River Remedial Action Plan. 1995. Stage 2 Report (Recommended Plan) – The Cleanup Connection. 129 pp.

Norstrom, R.J. 1988. Bioaccumulation of polychlorinated biphenyls in Canadian wildlife. In: *Hazards, decontamination, and replacement of PCBs*, ed. J.P. Crine, pp. 85-100. New York: Plenum Publ. Corp.

Norstrom, R.J., et al. 2002. Geographical distribution (2000) and temporal trends (1981-2000) of brominated diphenyl ethers in Great Lakes Herring Gull eggs. *Environ. Sci. Technol.* 36: 4783-4789.

Oldham, M.J., and W.F. Weller. 2000. *Ontario herpetofaunal atlas.* Natural Heritage Information Centre, Ontario Ministry of Natural Resources. http://www.mnr.gov.on.ca/MNR/nhic/herps/ohs.html (updated 15/01/2001).

Pekarik, C., et al. 1998. *An atlas of contaminants in the eggs of fish-eating colonial birds of the Great Lakes (1993-1997), Vol.1.* Technical Report Series No. 321, Canadian Wildlife Service, Ontario Region.

Pettit, K.E., et al. 1994. *An atlas of contaminants in the eggs of fish-eating colonial birds of the Great Lakes (1989-1992), Vol.1.* Technical Report Series No. 193, Canadian Wildlife Service, Ontario Region.

Russell, R.W., F.A.P.C. Gobas, and G.D. Haffner. 1999. Maternal transfer and in ovo exposure of organochlorines in oviparous organisms: a model and field verification. *Environ. Sci. Technol.* 33: 416-420.

Scheider, W.A., et al. 1998. Current status and temporal trends in concentrations of persistent toxic substances in sport fish and juvenile forage fish in the Canadian waters of the Great Lakes. *Environ. Monitor. Assess.* 53: 57-76.

Sergeant, D.B., et al. 1993. Mirex in the North American Great Lakes: new detections and their confirmation. *J. Great Lakes Res.* 19(1): 145-157.

Sheppard, R.W. 1970. *Birdlife of Canada's Niagara frontier.* Niagara Falls Nat. Club Spec. Publ. No. 3. Niagara Falls, Ontario. 85 pp.

Struger, J., et al. 1985. Organochlorine contaminants in Herring Gull eggs from the Detroit and Niagara Rivers and Saginaw Bay (1978-1982): contaminant discriminants. *J. Great Lakes Res.* 11(3): 223-230.

Suns, K., G. Hitchin, and D. Toner. 1991. *Spatial and temporal trends of organochlorine contaminants in spottail shiners (Notropis hudsonius) from the Great Lakes and their connecting channels (1975-1988).* Ontario Ministry of Environment, Water Resources Branch, Rexdale, Ontario.

Thompson, D.R. 1996. Mercury in birds and terrestrial mammals. In: *Environmental contaminants in wildlife; interpreting tissue concentrations*, eds. W.N. Beyer, G.H. Heinz and A.W. Ramon-Norwood, pp. 341-356. SETAC Special Publication, Lewis Publishers, Boca Raton, FL.

Timmermans, S.T.A., G.E. Craigie, and K. Jones. 2003. *Marsh Monitoring Program: Areas of Concern summary reports 1995-2002.* Prepared for Great Lakes Sustainability Fund and Canadian Wildlife Service, Environmental Conservation Branch, Ontario Region, Environment Canada. Bird Studies Canada.

Weseloh, D.V., S.M. Teeple, and M. Gilbertson. 1983. Double-crested Cormorants of the Great Lakes: eggs-laying parameters, reproductive failure, and contaminant residues in eggs, Lake Huron 1972-1973. *Can. J. Zool.* 61: 427-436.

Weseloh, D.V., P. Mineau, and J. Struger. 1990. Geographical distribution of contaminants and productivity measures of Herring Gulls in the Great Lakes: Lake Erie and connecting channels 1978/79. *Sci. Total Environ.* 91: 141-159.

Weseloh, D.V.C., C. Pekarik, and S.R. de Solla. 2006. Spatial patterns and rankings of contaminant concentrations in Herring Gull eggs from 15 sites in the Great Lakes and connecting channels, 1998-2002. *Environ. Monitor. Assess.* In press.

Williams, D.J., and M.L. O'Shea. 2004. *Niagara River Toxics Management Plan (NRTMP).* Interm progress report and work plan. Prepared for the Niagara River Secretariat. 16 pp.

Williams, D.J., et al. 2000. *The Niagara River upstream/downstream program 1986/87 – 1996/97: concentrations, loads, trends.* Environment Canada, Environmental Conservation Branch, Ontario Region, Ecosystem Health Division. Report No. 00-01/l., Environment Canada. 45 pp.

Wren, C.D. 1986. A review of metal accumulation and toxicity in wild mammals. *Environ. Res.* 40: 210-244.

APPENDIX I.

A complete listing of waterbird species and average numbers of birds reported per hour during Christmas Bird Counts conducted within two circles encompassing portions of the Niagara River: Niagara Falls (Ontario) and Buffalo (New York) from 1998-2002 (National Audubon Society 2002).

	Niagara Falls, Ontario (No. Birds/Hour)	Buffalo, New York (No. Birds/Hour)	Total - Niagara Falls and Buffalo (No. Birds/Hour)
Herring Gull	78.65	73.59	137.52
Ring-billed Gull	45.76	41.63	79.07
Bonaparte's Gull	43.07	10.03	51.10
Canada Goose	15.27	30.54	45.81
Long-tailed Duck	12.22	0.10	12.30
Common Merganser	9.70	8.56	18.26
Great Black-backed Gull	6.77	3.76	9.78
Greater Scaup	3.82	21.45	25.27
Common Goldeneye	3.76	14.10	17.86
Mallard	3.48	27.07	30.56
White-winged Scoter	3.23	0.02	3.24
duck sp.	2.73	0.07	2.77
gull sp.	1.91		1.91
Red-breasted Merganser	1.37	0.44	1.81
Bufflehead	0.85	2.39	3.24
American Black Duck	0.45	0.69	1.15
scaup sp.	0.35	0.21	0.37
American Wigeon	0.24	0.39	0.62
Ring-necked Duck	0.23	0.32	0.39
Double-crested Cormorant	0.20	0.06	0.26
Lesser Scaup	0.16	5.00	5.16
Great Blue Heron (Blue form)	0.14	0.35	0.49
Gadwall	0.14	0.54	0.67
Tundra Swan	0.12	0.72	0.74
Snow Goose (white form)	0.11		0.11
Redhead	0.11	0.22	0.33
scoter sp.	0.09		0.09
Canvasback	0.08	21.46	21.55
Common Loon	0.06	0.02	0.07
Hooded Merganser	0.05	0.41	0.46
Red-throated Loon	0.05		0.05
American Coot	0.04	0.35	0.31
Iceland Gull	0.04	0.02	0.05
Glaucous Gull	0.03	0.01	0.04
Killdeer	0.03	0.01	0.01
Northern Pintail	0.03	0.01	0.02
Lesser Black-backed Gull	0.03	0.05	0.06
Horned Grebe	0.02	0.05	0.05

	Niagara Falls, Ontario (No. Birds/Hour)	Buffalo, New York (No. Birds/Hour)	Total - Niagara Falls and Buffalo (No. Birds/Hour)
Thayer's Gull	0.01		0.01
Black Scoter	0.01	0.01	0.02
Little Gull	0.01	0.01	0.01
Snow Goose (blue form)	0.01		0.01
California Gull	0.01		0.01
Pied-billed Grebe	0.01	0.02	0.03
Black-legged Kittiwake	0.01		0.01
eider sp.	0.01		0.01
King Eider	0.01		0.01
Northern Gannet	0.01		0.01
Ruddy Duck	0.01	0.03	0.03
Wood Duck	0.01	0.01	0.01
Northern Shoveler	0.01	0.01	0.01
Black-headed Gull	0.01		0.01
Barrow's Goldeneye	0.01		0.01
Surf Scoter	0.01	0.01	0.01
Bald Eagle	0.01	0.09	0.02
Mute Swan	0.00	0.01	0.01
American Green-winged Teal		0.02	0.02
Purple Sandpiper		0.02	0.02
Total	**234.98**	**238.42**	**473.40**
No. Species/Categories	**56**	**45**	**58**

APPENDIX II.

Complete listing and corresponding size of evaluated wetlands within the Ontario Niagara River Area of Concern (OMNR, unpublished).

No.	Name	Significance	Area (ha)
1.	Abingdon NW	Provincial	8.28
2.	Abingdon SW Woodlots Mill Creek Tributary	Provincial	10.08
3.	Attercliffe Station Slough Forest	Provincial	126.84
4.	Beaver Creek	Provincial	81.79
5.	Beaver Creek 2	Provincial	134.99
6.	Big Forks Creek	Provincial	75.36
7.	Bismarck (NW) 16 Mile Creek Headwaters	Provincial	3.02
8.	Bismarck (NW) Beaver Creek Tributaries	Provincial	22.89
9.	Bismarck (NW) North Creek Tributaries	Provincial	1.47
10	Bismarck (NW) Parkers Creek Headwaters	Provincial	9.17
11.	Black Creek	Provincial	52.58
12.	Burnaby Wainfleet Airport	Provincial	2.96
13.	Caistor – Canborough Slough Forest Centre	Provincial	53.70
14.	Caistor – Canborough Slough Forest East	Provincial	65.11
15.	Caistor – Canborough Slough Forest West	Provincial	34.93
16.	Caistor Centre NE Area 1	Provincial	3.28
17.	Caistor Centre NE Area 2	Provincial	20.43
18.	Caistor Centre NE Area 3	Provincial	7.50
19.	Caistor Centre NE Area 4	Provincial	10.77
20.	Caistor Centre NE Area 5	Provincial	16.75
21.	Caistor Centre NW Woodlots Mill Creek Headwaters	Provincial	22.88
22.	Caistor Centre NW Woodlots Moores Creek	Provincial	5.42
23.	Caistor Centre NW Woodlots North Creek Headwaters	Provincial	5.60
24.	Caistor Centre SE Mill Creek Tributaries	Provincial	43.29
25.	Caistor Centre SE Moores Creek Tributaries	Provincial	11.26
26.	Caistor Centre SW Woodlot Mill Creek	Provincial	15.03
27	Caistor Centre SW Woodlot Moores Creek	Provincial	36.28
28.	Chamber's Corners Clay Plain	Provincial	4.04
29.	Chippawa Creek Conservation Area	Provincial	54.03
30.	Clements Tract	Provincial	59.07
31.	Draper's Creek	Provincial	59.83
32.	Dunnville Woodlots	Provincial	23.41
33.	East of Dunnville Woodlots	Provincial	28.66
34.	Ellsworth Drain Woodlots	Provincial	9.80
35.	Fish Carrier Tract Area 1	Provincial	6.73
36.	Fish Carrier Tract Area 2	Provincial	9.90
37.	Fish Carrier Tract Area 3	Provincial	21.36
38.	Fish Carrier Tract Area 4	Provincial	4.41
39.	Fonthill Kame Wetlands	Provincial	48.55
40.	Fort Erie 10	Provincial	33.48
41.	Fort Erie 11	Provincial	35.76
42.	Fort Erie 12	Provincial	19.01
43.	Fort Erie 13	Local	1.34
44.	Fort Erie 14	Provincial	4.08
45.	Fort Erie 16	Local	8.18
46.	Fort Erie 17	Provincial	17.08
47.	Fort Erie 23	Local	6.38

No.	Name	Significance	Area (ha)
48.	Fort Erie 25	Provincial	27.43
49.	Fort Erie 30	Local	97.06
50.	Fort Erie 32	Provincial	8.84
51.	Fort Erie 35	Provincial	22.47
52.	Fort Erie 37	Local	0.58
53.	Fort Erie 38	Local	8.31
54.	Fort Erie 40	Provincial	12.88
55.	Fort Erie 41	Local	1.81
56.	Fort Erie 43	Local	0.31
57.	Fort Erie 44	Provincial	0.98
58.	Fort Erie 45	Provincial	0.61
59.	Fort Erie 46	Provincial	6.34
60.	Fort Erie 47	Provincial	13.39
61.	Fort Erie 48	Provincial	29.84
62.	Fort Erie 49	Provincial	15.33
63.	Fort Erie 50	Provincial	11.96
64.	Fort Erie 8	Local	4.63
65.	Frenchman's Creek	Provincial	38.66
66.	Glanford Station West Wetland	Provincial	39.38
67.	Grassy Brook	Provincial	29.87
68.	Harold Mitchell Nature Reserve	Local	18.70
69.	Highway 20 & 24	Provincial	59.65
70.	Humberstone Marsh	Provincial	462.13
71.	Jordan Station Marsh	Provincial	0.03
72.	Lake Niapenco/Binbrook Conservation Area	Provincial	48.65
73.	Little Forks Creek	Provincial	12.92
74.	Little Forks Creek Woodlots	Provincial	26.14
75.	Lower Coyle Creek Wetlands	Local	30.69
76.	Lyon's Creek	Provincial	167.80
77.	Lyon's Creek North Wetlands	Provincial	144.26
78.	Lyon's Creek South Wetlands	Local	31.94
79.	Lyon's Creek Woodlot 36	Provincial	10.60
80.	Lyon's Creek Woodlot 43	Provincial	4.71
81.	Lyon's Creek Woodlot 44	Provincial	3.73
82.	Marshville Station Clay Plain	Provincial	29.62
83.	Mill Creek	Provincial	31.75
84.	Miller's Creek	Provincial	39.47
85.	Moulton Wetland East	Provincial	77.71
86.	Moulton Wetland West	Provincial	168.93
87.	Mud Lake	Provincial	68.81
88.	Navy Island	Provincial	10.02
89.	Nelles Tract	Provincial	17.03
90.	Niagara Falls Woodlot #1	Local	129.31
91.	North Cayuga Slough Forest (Young Tract)	Provincial	500.27
92.	Old Welland Feeder Canal	Local	72.52
93.	Ontario Waste Management Area	Provincial	7.10
94.	Oswego Creek	Provincial	88.00
95.	Parkers Creek Headwaters	Provincial	22.93
96.	Silverdale	Provincial	5.75
97.	Sinclairville Meander Basin Swamp	Provincial	78.46
98.	South Allanburg Slough Forests	Provincial	154.24

No.	Name	Significance	Area (ha)
99.	St. Ann's Slough Forest	Provincial	15.37
100.	St. Lawrence Seaway Authority Marsh	Local	5.55
101.	Tea Creek	Provincial	17.07
102.	Thompson Creek Wetland	Provincial	66.94
103.	Upper Coyle Creek Wetland Complex	Provincial	170.77
104.	Vaughan Woodlots	Provincial	14.34
105,	Wainfleet Marsh & Bog	Provincial	1526.97
106.	Warren Creek Wetland Complex	Provincial	65.62
107.	Welland Headwater Tributaries	Local	12.73
108.	Welland River Area 1	Provincial	67.26
109.	Welland River West	Provincial	325.54
110.	Welland Swamp	Provincial	9.66
111.	West of Marshville Station Swamp	Provincial	19.68
112.	Willoughby Marsh	Provincial	409.48
113.	Winslow NE	Provincial	52.14
114.	Winslow West Woodlot 1	Provincial	12.35
115.	Winslow West Woodlot 2	Provincial	15.53
116.	Winslow West Woodlot Area 3	Provincial	18.80
117.	Wolf Creek	Provincial	20.08

APPENDIX III.

Confirmed records of significant vascular plant, fish, reptile, amphibian, bird and lepidopteran species reported in coastal wetlands on the Canadian side of the Niagara River (from Environment Canada and Ontario Ministry of Natural Resources 2003). Numbers denote species groups and are as follows: 1-9: plant species; 10-12: fish species; 13: bird species. Status assigned by the Natural Heritage Information Centre (NHIC) for these species are as follows: S2: very rare in Ontario; S3: rare to uncommon 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: THR: Threatened; SC: Special Concern. Status assigned by Committee on the Status of Species at Risk in Ontario (COSSARO) (as of September 2002) are as follows: THR: Threatened. 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.	Arrow-arum	*Peltandra virginica*	S2	-	-
2.	Big Shellbark Hickory	*Carya laciniosa*	S3	-	-
3.	Honey Locust	*Gleditsia triacanthos*	S2	-	-
4.	Pin Oak	*Quercus palustris*	S3	-	-
5.	Red-rooted Nut Sedge	*Cyperus erythrorhizos*	S3	-	-
6.	Sharp-fruit Rush	*Juncus acuminatus*	S3	-	-
7.	Smith's Tufted Bulrush	*Scirpus smithii*	S2?	-	-
8.	Swamp Rose-mallow	*Hibiscus moscheutos*	S3	SC	-
9.	Swamp Star Sedge	*Carex seorsa*	S2	-	-
10	Black Bullhead	*Ameiurus melas*	S3	-	-
11.	Grass Pickerel	*Esox americanus*	S3	-	-
12.	Lake Chubsucker	*Erimyzon sucetta*	S2	THR	THR
13.	Black-crowned Night-Heron	*Nycticorax nycticorax*	S3B	-	-

APPENDIX IV.

Wetland Area by Subwatershed in the Niagara River Area of Concern. Note that current wetland coverage for the Niagara River AOC and Welland River watersheds fall below the 10% guideline for the watersheds. Furthermore, wetland coverage for subwatersheds which fall below the 6% guideline are indicated by "*" and are recommended as sites for restoration (Environment Canada *et al.* 1998).

Subwatershed	**Subwatershed Area (ha)**	**Wetland Area (ha)**	**Original % Wetland**	**Current % Wetland**
Niagara River North*	1092	1	12.30	0.10
Upper Welland Tributaries*	6374	158	26.82	2.47
Power Canal/Thompsons Creek*	6616	205	13.99	3.10
Middle and Upper Welland River*	21 019	1155	23.39	5.49
Lower Welland River	2016	121	14.67	6.00
Oswego Creek	18 511	1193	17.04	6.45
Fonthill Kame Tributaries	5254	354	28.09	6.74
Beaver/Sucker Creeks	8032	593	40.03	7.38
Big Forks Creek	9379	765	62.89	8.16
Little Forks/Unnamed Creek	2779	237	30.41	8.52
Wolf/Mill Creeks	5764	485	35.65	8.59
Welland Canals	10 236	978	41.49	9.56
Lyons/Grassy Creeks	9622	972	50.17	10.10
Niagara River South	18 518	2008	60.14	10.84
Old Feeder Canal/Mill River	7464	1027	91.18	13.76
AOC	**132 676**	**10 263**	**38.90**	**7.70**
Welland River Watershed	**113 066**	**8254**	**35.70**	**7.30**