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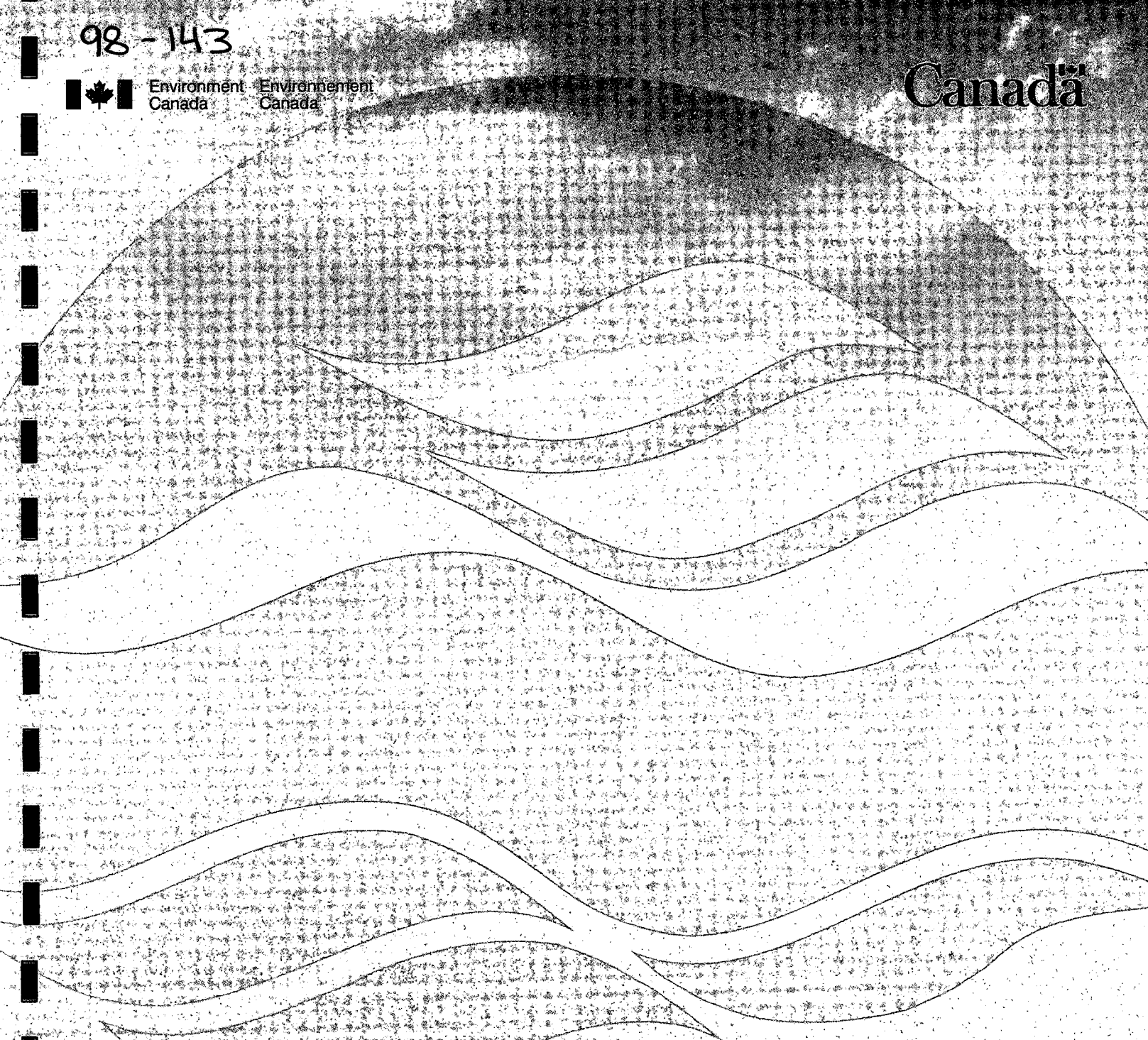

Aquatic Ecosystem response to Rehabilitative measures taken in Great Lakes Areas of Concern

BY:

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MANAGEMENT PERSPECTIVE

Title: Aquatic ecosystem response to rehabilitative measures taken in Great Lakes Areas of Concern.

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EC Priority Issue: This work was done as part of the GL2000 Program under, Restore Degraded Ecosystems. It also contains a report on work done in the United States, as part of a similar effort, under the 1987 Protocol Amending the 1978 United States-Canada Great Lakes Water Quality Agreement.

Current Status: This work was presented at the XXVII SIL Congress, held in Dublin, Ireland, August 8-14, 1998. Rehabilitative (restorative) measures continue to be implemented throughout the Great Lakes as part of the Remedial Action Plan Program. It is imperative that the ecosystem response to these measures be followed and investigated in an effort to derive both general ecosystem rehabilitation principles and to effectively implement what is "adaptive ecosystem management."

Next Steps: The response(s) of aquatic ecosystems to rehabilitative measures for the 14 beneficial use impairments described in Annex 2 of the Great Lakes Water Quality Agreement, will continue to be investigated.

AQUATIC ECOSYSTEM RESPONSE TO REHABILITATIVE MEASURES TAKEN IN GREAT LAKES AREAS OF CONCERN

Abstract

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One effort to further define ecosystem integrity has been through the development and adoption of quantitative objectives for 14 beneficial use impairments associated with Great Lakes Areas of Concern. Implementation of rehabilitative actions has proven to be economically, socially and technically challenging. Some of the measured ecosystem responses to specific rehabilitative actions are presented in this paper.

Aquatic ecosystem response to rehabilitative measures taken in Great Lakes Areas of Concern

Michael A. Zarull and John H. Hartig

Introduction

One effort to define ecosystem integrity has been through the development and adoption of quantitative objectives for 14 beneficial use impairments associated with Great Lakes Areas of Concern (AOCs). These targets were originally developed through a scientific symposium and were subsequently revised through both a "peer" and public review process. These guidelines are being used to assist the International Joint Commission to review Remedial Action Plans (RAPs), make recommendations on listing new AOCs and assist the governments of the United States and Canada to reach consensus on the problems and clean-up benchmarks (HARTIG & ZARULL 1992, UNITED STATES AND CANADA 1987, HARTIG *et al.* 1997, ZARULL & HARTIG 1999).

Agreement on these "listing/delisting" guidelines represents a significant milestone in the process of assessing ecosystem health in the Great Lakes because they are scientifically defensible, sensitive to public concerns and pragmatic. These guidelines are being applied at the working level within regulatory and resource management programs and represent a practical application of ecosystem integrity theory. They recognize that the AOCs will not be restored to pristine conditions, but rehabilitated to a "desired future state." Concurrence on problem definition and quantitative targets for each AOC provides clear direction for the selection of the remedial and preventative measures necessary for ecosystem rehabilitation.

This paper provides some examples of ecosystem objectives and quantitative targets

for two AOCs, as well as the rehabilitative actions taken to achieve these targets and the aquatic ecosystem responses to these measures.

Fish Tumours or Other Deformities

The Black River is one of four designated AOCs in the State of Ohio (USA); however, it is the only one that encompasses an entire watershed. Located in north-central Ohio, the Black River watershed covers 1,210 km^2, most of which is used for agriculture. The river ultimately discharges into Lake Erie at the City of Lorain. The problem statements contained in the Black River RAP indicates a number of beneficial use impairments, including the presence of fish tumours and other deformities.

Data from the early 1980s and 1990s indicate a history of fish tumour and other deformities in the Black River (mainstem and near shore), Ohio. Studies conducted by Dr. Paul Baumann of The Ohio State University and Ohio Sea Grant established a link between high polyaromatic hydrocarbons (PAHs) concentrations in Black River sediment and liver cancers in bullheads. Further research documented a decline in sediment PAH(s) and fish tumours concurrent with the closure of the USS/KOBE coking facility on the river.

In 1990, approximately 38,000 m^3 of PAH-contaminated sediment was removed as part of the effort to restore beneficial uses and rehabilitate the aquatic ecosystem. Prior to dredging, PAH concentrations ranged from 4.8-390 mg/kg in these sediments. Table 1 shows pre- and post-dredging levels of four common PAHs found in these sediments.

Subsequent research on hepatic tissue types (cancer, non-cancer neoplasm and altered hepatocytes) in resident brown bullheads showed an initial, significant increase in the incidence

of liver cancer cells after sediment removal, followed by a sharp decline in cancer and other abnormal cells (Figure 1). This increase in liver cancer cells is thought to be due to PAH redistribution that occurred during the 1990 dredging. No instance of liver cancer was found in 1994 samples (BAUMANN, P.C. & HARSHBARGER, J.C. 1997).

Loss of Fish and Wildlife Habitat

Hamilton Harbour is located at the extreme western end of Lake Ontario and is one of 11 designated AOCs wholly within the Province of Ontario (five more are considered binational). Eleven of the fourteen beneficial uses are impaired, including degraded fish and wildlife populations, and loss of fish and wildlife habitat (COA 1992). The rehabilitation of fish and wildlife communities in Hamilton Harbour is a three part process; i) reduce existing stressors (e.g., extreme oxygen demand, poor water clarity, presence of toxic substances, etc.,); ii) rehabilitate and create suitable habitat and; iii) restructure existing populations. Independent objectives and numerical targets were established for fish and wildlife. In the case of wildlife in Hamilton Harbour, the objectives focused on colonial waterbirds and the rehabilitative actions were directed at habitat.

"The overall objective is to have a self sustaining mixed community of colonial waterbirds generally with an increase of the rarer species and a reduction in the number of ring-billed gulls, which currently nest the harbour." "Management of colonial waterbirds is experimental and achieving specific populations of particular species is highly speculative (COA 1992). Below are the suggested interim targets for colonial waterbirds in Hamilton Harbour:

SPECIES	NUMBER OF PAIRS
Ring-billed gulls (*Larus delawarensis*)	5,000
Common terns (*Sterna hirundo*)	> 600
Herring gulls (*Larus argentatus*)	350
Caspian terns (*Sterna caspi*)	> 200
Double-crested cormorants (*Phalacrocorax auritus*)	200
Black-crowned night herons (*Nycticorax nycticorax*)	200

"Other wildlife including waterfowl:

No target will be suggested for other species of birds or animals, but a target for habitat has been suggested which will enhance wildlife populations generally. In addition, management of some species may be necessary as a result of habitat enhancement."

Wildlife Habitat Goals

1. Increase quantity of emergent and submergent aquatic plants in Hamilton Harbour, Cootes Paradise Grindstone Creek delta, and Grindstone Creek marshes to approximately 500 ha in accordance with the Fish and Wildlife Habitat Restoration Project.
2. Create an additional 344 ha of lagoon habitat for waterfowl.
3. Create 20 ha of colonial nesting habitat.

One of the actions taken was the construction of three islands in the northeast corner of the harbour during the winter of 1995-1996 to provide secure nesting habitat for six species of colonial waterbirds — Double-crested Cormorants, Black-crowned Night Herons, Herring Gulls, Ring-billed Gulls, Caspian Terns and Common Terns (Figure 2). The three main islands (approximately 100 m x 30 m) were placed 125 m, 55 m and 95 m, respectively, from a

restructured harbour shoreline. The islands were constructed to withstand the 25-50 year flood periods and elevated knolls and vegetation provide additional storm protection for birds nesting on the knolls and on the lee sides of the islands. Sections of the islands were specifically constructed (using soil, rock gravel, etc., and erecting "artificial trees" or nesting platforms) to attract and accommodate one of the six target species.

Five of the six target species nested on the created islands and substrates. At first, the Double-crested Cormorants did not nest on the new islands. Caspian Terns and Ring-billed Gulls occupied sub-areas and their accompanying substrates, which were designated for them. Whereas, Black-crowned Night Herons, Herring Gulls and Common Terns nested on the wildlife islands, but not on the substrates that were prepared for them and in the case of the gulls, measures had to be taken to keep them from interfering with the nesting habits of the terns. In both 1996 and 1997, all six species continued to occupy nesting sites elsewhere in the harbour.

The results of these habitat creation actions are encouraging since five of the six species established and maintained nesting colonies on the islands. However, only two of these species (Ring-billed Gulls and Caspian Terns) nested on the sub-areas specifically designed for their use. Temporal trends on the total number of nests for each of these six species throughout the harbour during the last ten years indicate that the number of Double - crested Cormorant nests increased significantly and the number of Black-crowned Night Heron nests declined significantly, while there have been no significant changes in the numbers of either Herring or Ring-billed Gull nests (PEKARIK *et al. 1992*).

There is a need for continued monitoring and adaptive management to ensure that the species are able to cohabit on the new islands in the long-term. The six species of colonial waterbirds are not exclusive to Hamilton Harbour, and their overall respective population

trends will influence management efforts on the three constructed islands.

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Table 1. Levels of four common PAHs (mg/kg) in Black River Sediment during (1980) and post (1984) coking facility operation, and post-dredging (1992),

Table 1

PAH COMPOUND	1980	1984	1992
Phenanthrene	390.0	52.0	2.6
Fluoranthrene	220.0	33.0	3.7
Benzo(a)anthracene	51.0	11.0	1.6
Benzo(a)pyrene	43.0	8.8	1.7

Figures

Figure 1: Percentage of age 3 brown bullheads from the Black River having various liver lesions, during (1982) and after operation of the coking facility and post contaminated sediment dredging (from BAUMANN & HARSHBARGER 1997) — see attached file Figure1.tif

Figure 2: Map of Hamilton Harbour showing the location of colonial waterbird nesting colonies. (from PEKARIK *et al. 1997)* — see attached file Figure2.tif

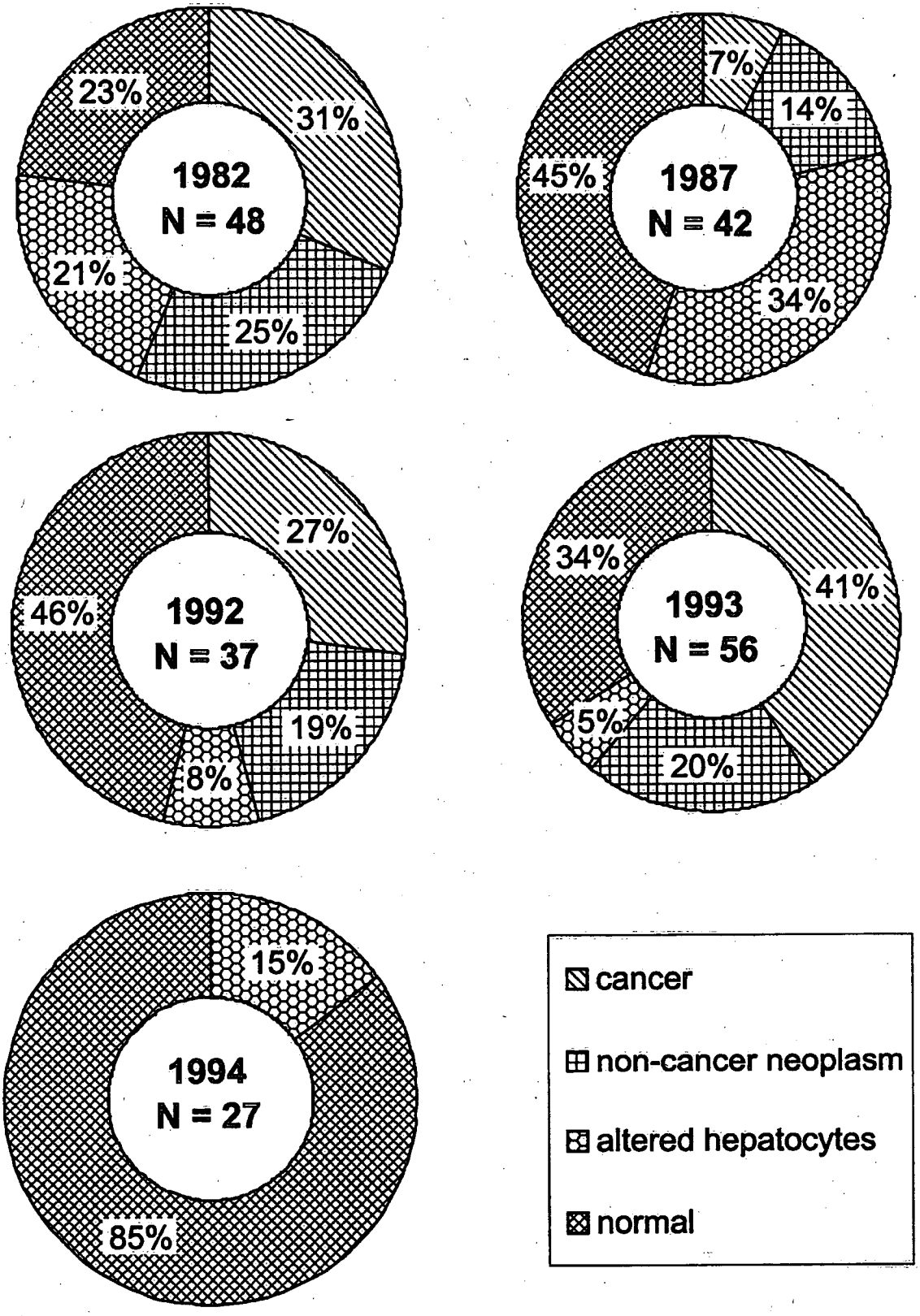

Figure 1: Percentage of age 3 brown bullheads from the Black River having various liver lesions, during (1982) and post (1987) after operation of the coking facility and post contaminated sediment dredging
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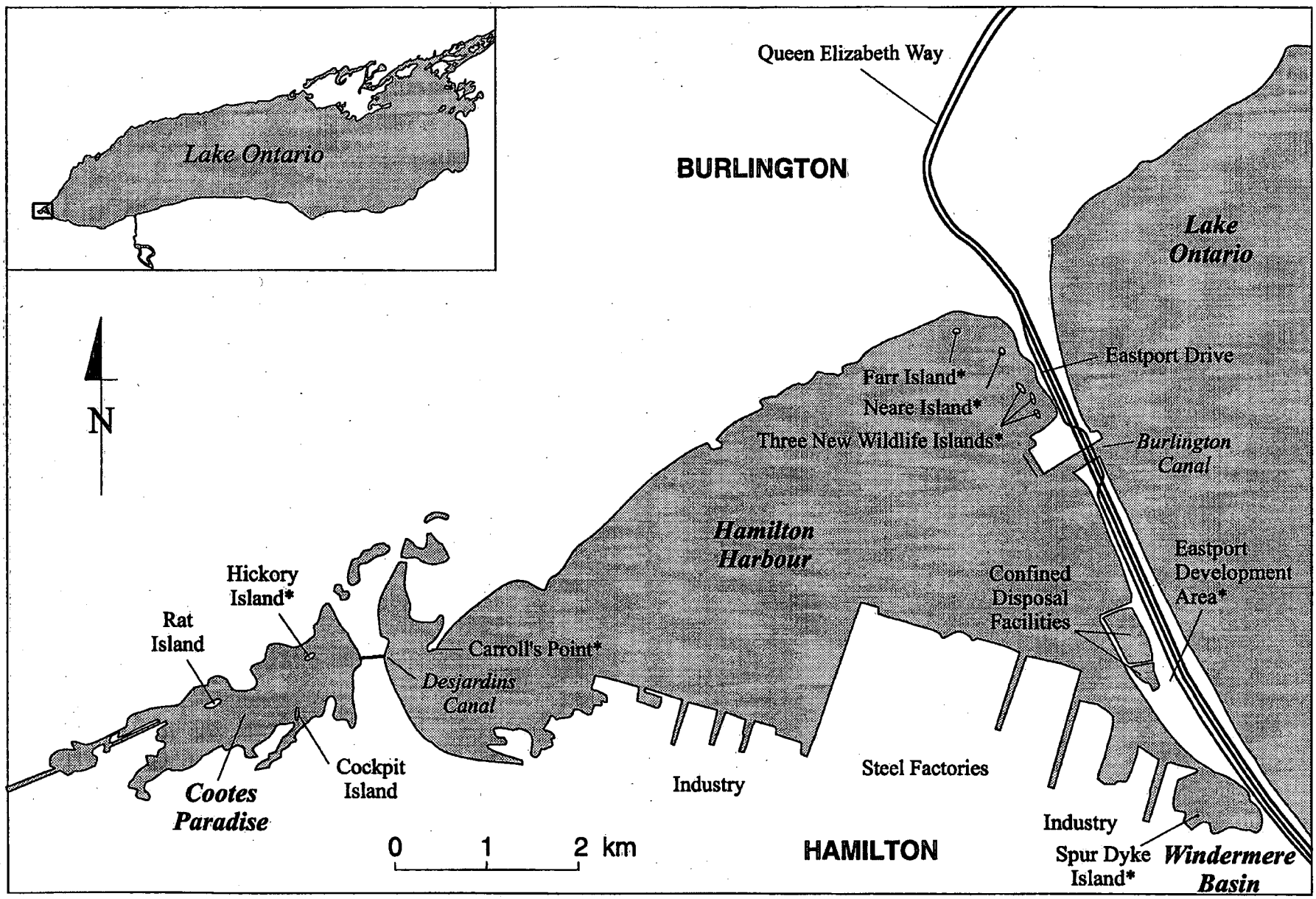

Figure 2. Map of Hamilton showing the locations of colonial waterbird nesting colonies. (from PEKARIK et al. 1997)

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