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

By:

Michael A. Zarull & John H. Hartig

NWRI Contribution # 98-276

Please scan front cover

Verh. Internat. Verein. Limnol.	27	2349–2352	Stuttgart, December 2000

98-276

Aquatic ecosystem response to rehabilitative measures taken in the 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 (UNITED STATES & CANADA 1987, HARTIG & ZARULL 1992, 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 km², 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 m³ of PAH-contaminated sediment were removed as part of the effort to restore beneficial uses and rehabilitate the aquatic ecosystem. Prior to dredging, PAH concentrations ranged from 4.8 to 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 (Fig. 1). This increase in liver cancer cells is thought to be due to PAH redis-

0368-0770/00/0027-02349 $ 1.00

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

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

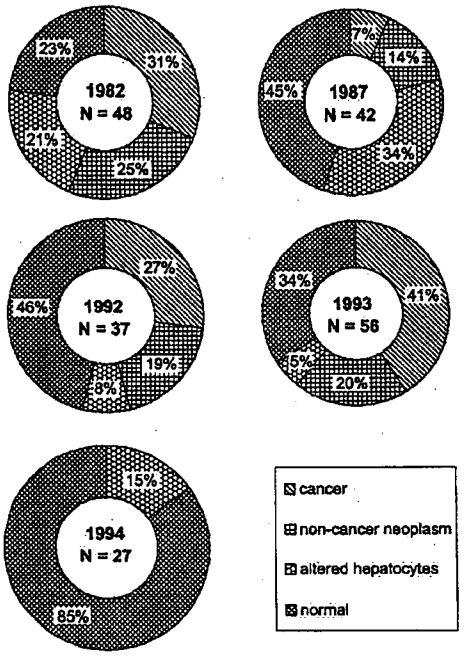

Fig. 1. Percentage of 3-year-old brown bullheads from the Black River having various liver lesions, during (1982) and after operation of the coking facility and post-contaminated sediment dredging (from BAUMANN & HARSHBARGER 1997).

tribution that occurred during the 1990 dredging. No instance of liver cancer was found in the 1994 samples (BAUMANN & HARSHBARGER 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 14 beneficial uses are impaired, including degraded fish and wildlife populations, and loss of fish and wildlife habitat (CANADA & ONTARIO 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 the 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 in the harbour. Management of colonial waterbirds is experimental and achieving specific populations of particular species is highly speculative (CANADA & ONTARIO 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

Regarding other wildlife including waterfowl, no target will be suggested, 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 a 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 (Fig. 2). The three main islands (approximately 100 m × 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

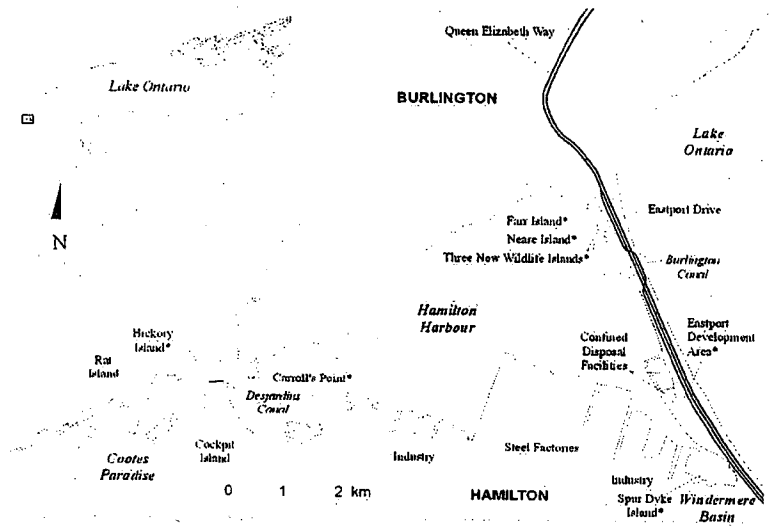

Fig. 2. Map of Hamilton Harbour showing the location of colonial waterbird nesting colonies (from PEKARIK et al. 1997).

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 10 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. 1997).

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.

References

BAUMANN, P. C. & HARSHBARGER, J. C., 1997: *Liver Neoplasm Trends in Black River Bullhead.* – Columbus, Ohio, United States. 18 pp.

CANADA & ONTARIO (COA), 1992: *Remedial Action Plan for Hamilton Harbour – Goals, Options and Recommendations. Vol. 1, Summary.* 44 pp.

HARTIG, J. H. & ZARULL, M. A., 1992: Towards defining aquatic ecosystem health for the Great Lakes. – *J. Aquat. Ecosyst. Health* 1: 97–107.

HARTIG, J. H., ZARULL, M. A., REYNOLDSON, T. B., MIKOL, G., HARRIS, V. A., RANDALL, R. G. & CAIRNS, V. W., 1997: Quantifying targets for rehabilitating degraded areas of the Great Lakes. – *Environ. Manage.* 21: 713–723.

PEKARIK, C., NICASSIO, A. N., BLOKPOEL, H., WESELOH, D. V., HALL, J., FINK, S., ANDERSON, C. & QUINN, J. S., 1997: *Management of Colonial Waterbirds Nesting in Hamilton Harbour: The First Two Years of Colonization of Artificial Islands and Population Trends. Technical Series No. 287.* – Canadian Wildlife Service, Ontario Region, Toronto, Ontario, Canada. 38 pp.

UNITED STATES & CANADA, 1987: *Great Lakes Water Quality Agreement of 1978 (as amended by protocol).* – Windsor, Ontario, Canada. 64 pp.

ZARULL, M. A. & HARTIG, J. H., 2000: Quantifying aquatic ecosystem health targets. – *Verh. Internat. Verein. Limnol.* 27: 2346–2348.

Authors' addresses:

MICHAEL A. ZARULL, NWRI, Canada Centre Inland Waters, PO Box 5050, Burlington, Ontario, Canada L7R4A6.

JOHN H. HARTIG, Greater Detroit American Heritage River Initiative, US Coast, Guard, Marine Safety Office, 110 Mt. Elliot Ave., Detroit, MI 48207-4380, USA.