Section 10: Significant Ongoing and Emerging Issues

10.1 Introduction

The dynamic nature of Lake Erie means that things change, often unpredictably. Section 2 in the Lake Erie LaMP 2000 document described how the issues of concern in the lake had changed over time. Some of the issues were resolved through management actions over a short period of time, while others required long-term and ongoing management plans. Some goals, such as phosphorus concentrations in the lake, were considered achieved until zebra mussels invaded and concentrations began fluctuating again. The invasion of a host of new exotic species has created much alteration in the biological community. The ecosystem objectives for Lake Erie attempt to set goals for management actions in the areas of land use, nutrient management, contaminants and exploitation. It may be necessary to continually revisit these goals as new unexpected situations arise. This section provides some insight into issues that are currently important in the lake, as well as those that may be emerging as important future issues. The adaptive management approach of the LaMP process accepts the fact that change is inevitable. The challenge to the LaMP is to keep abreast of lake conditions, identify and encourage research in areas needed to make the appropriate management decisions, and modify management goals and actions when needed.

10.2 Update on Non-indigenous Invasive Species in Lake Erie

Section 11 of the Lake Erie LaMP 2000 document presented a detailed overview of the history of non-indigenous invasive species (exotics) in the lake. Since 2000, several more exotics have entered. Rarely can ecologists predict the effects of a non-indigenous invasive species in a new place. One has better luck in predicting which species may invade next by comparing the characteristics of species that have been successful invaders with those that have failed to become established. For example, ecologists have summarized features that have enhanced invasions including descriptions of successful colonizers (high fecundity, wide tolerance of abiotic factors), impact (economic and ecological), and habitats prone to invasion (i.e., accessible corridors between habitats, climatically matched regions, and disturbed or vacant niches) (Elton 1958, Lodge 1993, Ricciardi and MacIsaac 2000). Successful invaders produce many offspring, are quick to disperse, can tolerate a wide range of a given environmental factor, and invade an area that matches the climate of its home. But even if an invader becomes established, what is the chance that it will pose a problem?

The Lake Erie LaMP has identified exotic species as one of the key problems impairing Lake Erie ecosystems. Five of the 14 beneficial use impairments are due at least partially to exotic species: degradation of plankton, fish and wildlife populations; degradation of aesthetics; and loss of fish and wildlife habitat. The species that are of most concern in Lake Erie include: dreissenid mussels (zebra and quagga), round goby, spiny water flea, *Phragmites*, sea lamprey, Eurasian watermilfoil, and purple loosestrife.

Since the publication of the Lake Erie LaMP 2000 document, there have been reports on effects of exotic species on native species, documentation of new invaders, evidence of avian botulism (with the possible link to invasive fishes), and the development of a Canadian "National Code on the Introductions and Transfers of Aquatic Organisms." This section highlights the changes since the 2000 report.

Blooms of the toxic colonial cyanobacteria, *Microcystis aeruginosa*, have been linked to the feeding habits of the zebra mussel (*Dreissena polymorpha*) (Vanderploeg et al. 2001). *Microcystis* blooms, typically caused by excessive phosphorus loading, were common in the formerly eutrophic western basin of Lake Erie. The subsequent trophic changes in Lake Erie in response to phosphorus abatement programs initiated under the Great Lakes Water Quality Agreement of 1972, resulted in the decline of *Microcystis* blooms (Makarewicz and Bertram 1991). However, *Microcystis* blooms were recently reported from satellite observations in western Lake Erie and Saginaw Bay (Lake Huron), where zebra mussels are established (Budd et al. 2001). Vanderploeg et al. (2001) hypothesized that zebra mussels induced a shift in algal abundance by ingesting all algae except *Microcystis*. Zebra mussels selectively feed on algal competitors of *Microcystis* and at the same time spit back *Microcystis* into the water column. This behaviour results in the dominance of *Microcystis* and a reduction in other algal species, explaining the paradox of the association between *Microcystis* blooms and filter-feeding dreissenids. The extensive and surprising *Microcystis* blooms of 1998 have not been repeated to that extent in the three years since. However, *Microcystis* is being documented in plankton samples collected throughout the lake. Forecasting future blooms remains unpredictable (Culver, personal communication 2002).

Researchers forecasted that two exotic zooplankton species, *Cercopagis pengoi* (present in Lake Ontario in 2000) and *Daphnia lumholtzi* (inhabiting reservoirs in Ohio and Michigan in 2000) were likely to invade Lake Erie (Lake Erie LaMP 2000). Drs. Igor Grigorovich and Hugh MacIsaac (University of Windsor) have confirmed that both species are well established in the western basin of Lake Erie near the inflow of the Detroit River. The presence of *Cercopagis pengoi*, the fishhook waterflea, represents a significant range expansion, suggesting that the most likely vector is ballast water discharge (MacIsaac, personal communication). *Cercopagis pengoi* reproduces parthenogenically, enabling the species to establish quickly. Owing to its large size, it likely will affect both phytoplankton and zooplankton populations, and might even compete with young-of-the-year-fish for prey (www.epa.gov/glnpo/monitoring/exotics/cercopagis.html).

Daphnia lumholtzi, native to Australia, Africa and southwest Asia, is thought to have arrived in reservoirs in the United States when the Nile perch was introduced to Texas to enhance the sport fishery (Havel, personal communication). The species, which was reported in Missouri and Texas in the early 1990s (Havel and Herbert 1993; Havel et al. 1995), has quickly spread north. Muzinic (2000) published the first record of *D. lumholtzi* in the Great Lakes in specimens collected from East Harbor State Park, in Ohio (western Lake Erie) using vertical plankton net tows. *Daphnia lumholtzi* likely will become a successful invader because of its ability to avoid predation, not because it is a better competitor for the available food supply (Goulden et al. 1995).

The invasion of the zebra mussel (*Dreissena polymorpha*) in the Great Lakes has resulted in “catastrophic” declines of native mussels in infested waters, and severely restricted the range of the northern riffleshell in Canada. Analyses of the diversity and composition of freshwater mussel communities in the lower Great Lakes basin has revealed a pattern of species loss and changing community composition throughout the basin, particularly in the formerly species-rich Lake Erie and Lake St. Clair drainages (Metcalfe-Smith et al., 1998a). Coastal wetland areas, such as Metzger’s Marsh (a diked wetland) and tributaries in the Lake Erie watershed now act as “refuges” for many species of native unionids. Native unionid species occurring in the Canadian waters of the lower Great Lakes drainage basin were ranked by their vulnerability to zebra mussels. Under this ranking scheme, nine out of 35 native unionids were ranked as highly vulnerable to zebra mussels (Metcalfe-Smith et al., 1998b). Species most at risk from impact of zebra mussels occur mainly in the Great Lakes themselves or in the lower reaches of the larger tributaries, while headwater species are less likely to cohabit with zebra mussels throughout most of their ranges.

Lake Erie, excluding tributaries, has 34 exotic fish species. Nineteen species are established and 15 others are reported (Lake Erie LaMP 2000). As an example of the increasing impact of exotic species on Lake Erie, non-indigenous species now comprise 75% of the commercial fish catch in Lake Erie (Corkum et al. 2001a).

Aquarium, water garden and bait fish introductions are a global problem and an important vector of non-indigenous invasive species. Although one in every four fish species introductions in the United States results from the aquarium trade, little effort is directed toward public awareness of aquarium releases in the Great Lakes basin (Dextrase and Paleczny 2000). Of nine fish species associated with aquarium and water garden release in Ontario, three species have been reported in Lake Erie: goldfish (*Carassius auratus*), pacu (*Colossoma* sp.), and suckermouth catfish (*Panaque* sp.) (Dextrase and Paleczny 2000). The Ontario Federation of Anglers and Hunters has established a “Fish Rescue Program and Awareness Initiative.” The organization has established a network to hold unwanted pets until a new owner is found (toll free hot line: 1-800-563-7711). Unfortunately no regulations exist to control aquaria and pond water release.


Photo: Lake Erie Management Unit, OMNR

In 2000, there were unusual sightings of the Chinese bighead carp, *Hypophthalmichthys nobilis*. On 16 October 2000, the third specimen ever of Chinese bighead carp was caught in a trapnet on the west side of Point Pelee in the western basin of Lake Erie (T. Johnson, personal communication). The fish is native to eastern China and introduced into the United States in 1973. The October sighting was probably the result of fish escape from aquaculture ponds in Ohio (T. Johnson, personal communication). The Chinese bighead carp is a filter feeder and if ever established, the species may compete with native fishes for plankton.

Of all the exotic fishes in Lake Erie, the one most troublesome is the recently established round goby, *Neogobius melanostomus*. Concerns about the round goby include:

- Their ability to transfer contaminants through the food web;
- Their detrimental effect on native species;
- Their ability to proliferate owing to their multiple spawning habitats;
- The potential expansion of gobies by anglers using bait buckets; and,
- Economic costs of gobies as bycatch in nets of commercial fishers (Corkum et al. 2001b).

The extent of the potential impact of the round goby is not yet fully realized because literature from its native range (Black and Caspian seas and associated waters) and invaded areas is limited, and researchers have not yet had sufficient funding to address many of the concerns. A special section on “The Round Goby Invasion”, recently published in the Journal of Great Lakes Research (volume 27, issue 3), addresses some of these shortcomings (Charlebois et al. 2001). Janssen and Jude (2001) document the local extinction of mottled sculpins (*Cottus bairdi*) by the round goby in Calumet Harbor, southern Lake Michigan owing to competition for food resources (small fishes), space (medium sized fishes) and spawning sites (large fishes). Recruitment failure of mottled sculpins was attributed to spawning interference by the round goby (Janssen and Jude 2001). Declining populations of mottled sculpins, greenside darters and channel darters around the Lake Erie islands in the western basin are also thought to be associated with the increasing number of round gobies (R. Thoma, personal communication).

Several agencies have monitored movement of the round goby and their contribution to the diet of predators in Lake Erie (T. Johnson and C. Knight, personal communication). The round goby first entered the western basin of Lake Erie in 1993 and by 1999 had spread throughout the lake. The round goby contributes significantly to the diet of smallmouth bass (*Micropterus dolomieu*), stonecats (*Noturus flavus*), burbot (*Lota lota*), and yellow perch (*Perca flavescens*), but is a minor component in the diet of walleye (*Stizostedion vitreum*) and white bass (*Morone chrysops*) (T. Johnson, personal communication). Clearly, the round goby will be influential in transferring energy from the lake bottom up through the food chain. Studies on bioenergetics of the round goby and its effect on the Lake Erie food web are in progress (T. Johnson, personal communication). Additional tools such as species-specific piscicides are being investigated for potential control of the round goby (Schreier et al. 2001).

Fisheries managers are concerned that round goby may move from the Great Lakes basin south to the Mississippi River basin where the goby may adversely affect other native biota. The La Crosse, Wisconsin, Fisheries Office personnel use baited minnow traps to monitor the movement of the round goby en route to the Mississippi River from Lake Michigan, a distance of 536 km (Steingraeber and Thiel 2000). Annual movement of the round goby along the Calumet Sag Channel between Lake Michigan and the Des Plaines River is about 25 km per year. However, round goby movement in lakes may differ depending on prevailing currents. An electrical barrier is being constructed on the Des Plaines River, Illinois, to reduce the risk of non-indigenous fishes from moving between the Great Lakes and Mississippi basins. Unfortunately, the round goby has moved downstream from the barrier location. However, the structure may eliminate the transfer between basins of other non-indigenous species such as the bighead (*Hypophthalmichthys nobilis*) and silver (*H. molitrix*) carp, which are now in the lower Illinois River and are moving north to the Great Lakes.

The federal policies that relate to exotic species in the Great Lakes include the U.S. Lacey Act, the U.S. National Invasive Species Act, the Canadian Fisheries Act and the Canada-Ontario Agreement. The original U.S. Non-indigenous Aquatic Nuisance Prevention and Control Act (1990) was reauthorized in 1996 as the National Invasive Species Act. The Province of Ontario and the eight U.S. states bordering the Great Lakes all have restrictions on non-indigenous invasive species, but policies are inconsistent. Recently, a draft document has been prepared for a Canadian "National Policy/Code on Introductions and Transfers of Aquatic Organism" that will apply to all intentional introductions for stocking or aquaculture. Environment Canada hosted a national workshop on invasive alien species in November 2001. The objectives of this workshop were to: identify and clarify fundamental issues in the management of invasive alien species; develop a draft framework for a national plan that identifies key policy and management options; and outline a process to develop a draft Canada-wide plan by fall 2002.

Chartered under U.S. federal law, the Great Lakes Panel on Aquatic Nuisance Species is responsible for advancing prevention and control efforts in the Great Lakes-St. Lawrence system. Currently they are pursuing a policy on ballast water management. The recommendations in the policy include: establish criteria for ballast water management practices and treatment technologies; promote a regional (and binational) approach to ballast water management; apply regulations and guidelines to all vessels including those with no ballast on board; and evaluate ballast water management practices and treatment technologies. Several demonstration projects are underway to test ballast water treatment technologies on board freighters.

Photo: Lake Erie Management Unit, OMNR

10.3 Botulism E

Researchers have suggested a possible link between the round goby and avian botulism, a disease of wild migratory birds caused by *Clostridium botulinum* (Domske and Obert, personal communication). Birds such as ducks, gulls, and loons are paralyzed or die after exposure to a toxin produced by the botulism bacteria. Fish-eating birds exhibit type E botulism poisoning. In one case, botulism-infected birds in Lake Erie had a higher incidence of round goby in their guts compared with uninfected birds. Low oxygen concentrations combined with temperature inversion may stress round goby inducing them to swim to the surface and drift shoreward, enabling birds to feed on fish that harbor the anaerobic bacteria that contain the toxin. Ward Stone (New York, Department of Environmental Conservation) has identified botulism type E toxin in freshwater drum, smallmouth bass, lake sturgeon and in round gobies retrieved from the guts of smallmouth bass.

The Canadian Wildlife Service reported that the fish die-off (likely caused by temperature inversion) of freshwater drum and the round goby at Wheatley on August 16, 2001 did not result in any unusual bird mortalities. However, after a similar die-off of fish near Port Dover, also on August 16, there were 38 dead birds, one mudpuppy, three shorebirds and a report of a sick great blue heron. On October 29, 2001, the Canadian Wildlife Service reported die-offs of the common loon, ring-billed gulls, red-breasted mergansers, gadwalls, and long-tailed ducks (old squaw) along the northeast shore of Lake Erie between Port Dover and Dunnville. In addition, there were dead fish along the beach including round goby, carp, and catfish as well as a mudpuppy. Specimens were sent to the Canadian Cooperative Wildlife Health Centre at the University of Guelph for assessment.

Similar mortalities of fish and birds occurred along the New York shoreline of Lake Erie during the same period. Among fish found dead along the New York shoreline in September 2001, 81% were freshwater drum (Figure 18) with the remainder consisting of nine other species. Bird collections in fall 2000 revealed an estimated 5,000 to 6,000 birds died that year, with red-breasted merganser the most common species (Figure 19). Estimates of dead common loons in New York were over 500 birds in 2000, and over 1000 birds in 2001. In addition, seven dead lake sturgeon (a threatened species in New York) were found in 2000, while 27 individuals were collected in 2001.

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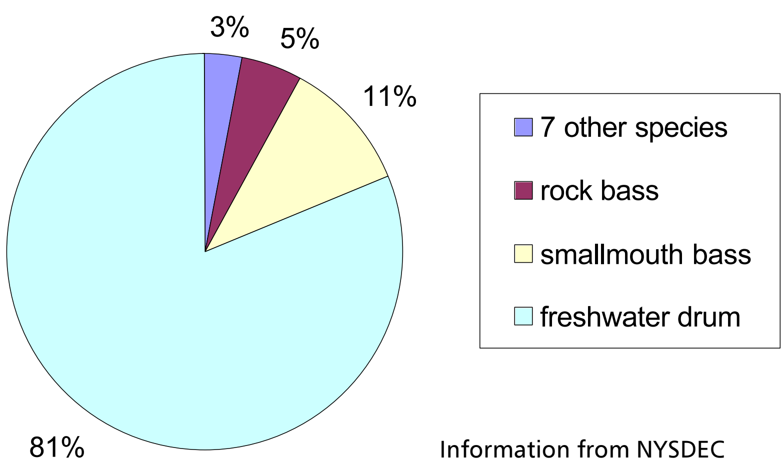
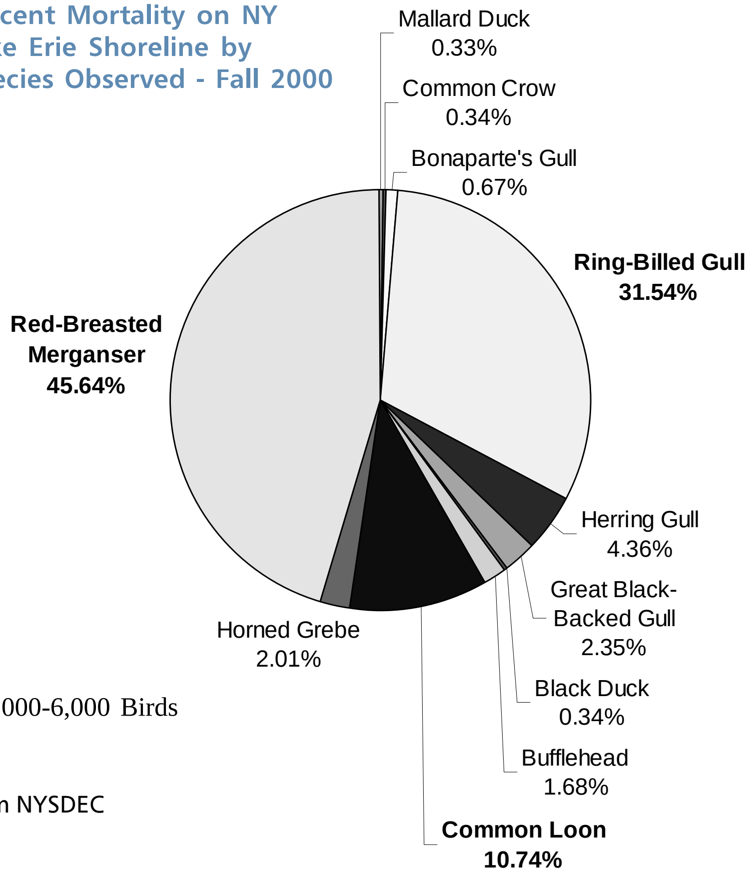
Figure 19: Frequency of Dead Fish Species Observed Along NY Lake Erie Beaches, September, 2001



Information from NYSDEC

Figure 20: Percent Mortality on NY Lake Erie Shoreline by Species Observed - Fall 2000



Mortality: 5,000-6,000 Birds

Information from NYSDEC

10.4 Phosphorus Changes in Lake Erie

Since 1965, phosphorus loads to Lake Erie have been reduced by roughly 50% to approximately 11,000 metric tonnes per year, the target goal set in the Great Lakes Water Quality Agreement. Most of the reduction came from better treatment of municipal sewage sources. Over the 30 years since inception of the controls, Environment Canada and U.S. EPA collected water samples for the purpose of following the recovery of the lake. Since the loading target was reached in the mid 1980s, the zebra mussel invasion and other exotic species have changed the biology of the lake and the associated internal nutrient processing. Thus, there is interest in understanding what drives phosphorus concentrations today.

Phosphorus concentrations reached record lows in 1995. Decreases in phosphorus concentrations coincident with the increase in zebra mussel populations were comparable to those caused by nutrient load reductions up to 1985. The largest changes in phosphorus of 5 to 6 ug/l pre zebra mussels and 5 to18 ug/l post zebra mussels occurred in the west central and west basins, respectively. Changes in the central and east basins were 2.5 to 4 ug/l both pre and post zebra mussels. One mechanism for this may have been the actual growth of the zebra mussel organism. For example, as the planktonic mussel larvae grew over a few weeks and then sank to the bottom, they took phosphorus with them. This was a new sedimentation flux that removed phosphorus from the water column.

The low phosphorus concentrations stimulated concerns that existing phosphorus controls were no longer appropriate now that the biology of the lake had changed. Despite ongoing recovery of walleye populations during nutrient controls, loss of productivity for fisheries was feared. Inferred from chlorophyll concentrations (Charlton et al. 1999) though, primary production was reduced much more by nutrient controls prior to the onset of the mussels than after the mussels arrived.

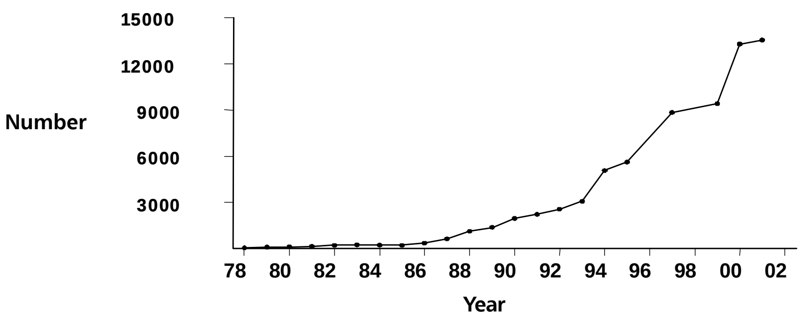
From 1995 to 2000 phosphorus concentrations rebounded in the west, west central, and central basins by almost 10 ug/l. Some of the concentrations in the central basin during 2000 approximated those in the early years of phosphorus controls. Recovery of phosphorus concentrations also occurred in the east basin to a lesser extent. Concentrations are slightly below the recommended 10 ug/l in the east basin but are somewhat above 10 ug/l in the central basin. One explanation for the phosphorus increases may be that the growth rate of mussel populations has slowed and nutrients are now recycling back into the water. On the other hand, increased phosphorus loads may have caused the increases.

Unfortunately, studies of mussels and other exotic species are insufficient to explain their part in the recent phosphorus variations. Furthermore, phosphorus-loading statistics are no longer consistently available so it can't be determined if the concentration variations are simply caused by load variations. Due to loss of resources and discontinuation of research and monitoring efforts, opportunities to learn how the lake functions are being lost and capabilities to make informed management decisions are reduced.

10.5 Double Crested Cormorants in the Great Lakes

Double-crested cormorants are colonial waterbirds that nest on the ground or in trees, often mixed in with other species. They have an extensive range in North America, occurring throughout the interior as well as on both coasts. The first report of cormorant nesting on the Great Lakes occurred between 1913 and 1920, and by 1950 the breeding population was at 900 pairs (Weseloh et al. 1995). Human persecution and environmental contaminants led to the virtual extinction of cormorants on the Great Lakes by the early 1970s. From 1970 to 1991 the Great Lakes cormorant population increased from 89 nests to more than 38,000 nests. The population has increased at an annual rate of 23 percent from 1990 to 1994 (Tyson et al. 1999). Major factors leading to an increase in the Great Lakes population were reduced contaminants and persecution plus an abundance of prey fish (Weseloh et al. 1995, Blokpoel and Tessier 1996). By 1999, there were almost 100,000 nesting pairs in the Great Lakes. On Lake Erie, there has been a dramatic increase in the number of nests. In 1978 there were 58 nests, and by 2001 there were more than 13,000 cormorant nests (Figure 20).

Figure 21: Number of Cormorant Nests on Lake Erie



With the burgeoning cormorant population there has been an increase in conflicts with commercial and sport fisheries in the Great Lakes. The common opinion of many fishers is that cormorants have a negative impact on the fish communities. In response to these concerns, diet and related studies were conducted to identify impacts of cormorant feeding on Great Lakes fisheries. Studies conducted worldwide have repeatedly shown that while cormorants can, and often do, take fish species that are valued in commercial and sport fisheries, those species usually comprise a very small proportion of the birds' diet. One Lake Erie study found that the number of these fish (i.e. yellow perch, smallmouth bass, and walleye) consumed by cormorants was less than five percent of the total diet (Bur et al. 1999). Research has not yet established conclusively

Photo: New York Department of Environmental Conservation, Rodger Klindt

whether cormorants have the ability to deplete local populations of fish.

Cormorants can affect other colonial waterbirds at mixed breeding colonies, both directly (by physical displacement) and indirectly (by altering the vegetation) (Trapp et al. 1999). These birds often inadvertently kill trees and vegetation with their feces. Some of these areas include stands of uncommon or rare floral species. For example, cormorant feces are negatively impacting the rare Kentucky coffee tree, *Gymnocladus dioicus*, on Middle Island and other islands in western Lake Erie. Vegetation alteration may affect the ecological balance of a site, and lower property, recreational, and aesthetic values. Lake Erie's West Sister Island has the largest colonial waterbird population in the Great Lakes.

Since 1972, depredation permits allowing the taking of double-crested cormorants have been authorized on a case-by-case basis, usually when negative impacts on aquaculture operations and habitat have been demonstrated. Most permits were for birds causing depredation problems at aquaculture operations. The U.S. Department of Agriculture's Wildlife Services Division is responsible for documenting economic losses.

The persistence of conflicts associated with double-crested cormorants, widespread public and agency dissatisfaction with the status quo, and the desire to develop a more consistent and effective management strategy for double-crested cormorants led the U.S. Fish & Wildlife Service to prepare a national cormorant management plan for the contiguous United States. The purpose of the draft environmental impact statement on double-crested cormorants is threefold: to reduce resource conflicts associated with double-crested cormorants in the contiguous United States; to enhance the flexibility of natural resource agencies in dealing with cormorant-related resource conflicts; and to ensure the conservation of healthy, viable cormorant populations.

The Double-Crested Cormorant Management Plan describes and evaluates the anticipated environmental effects of six management alternatives: 1) continue current cormorant management practices (no action); 2) implement only non-lethal management techniques; 3) expand current cormorant damage management practices; 4) establish a new Depredation Order to address public resource conflicts; 5) reduce regional cormorant populations; and 6) establish frameworks for a cormorant hunting season. Alternatives were analyzed with regard to their potential impacts on cormorant populations, fish, other birds, vegetation, federally listed threatened and endangered species, water quality and human health, economic impacts, fish hatcheries and environmental justice, property losses, and aesthetic values. Management alternative number 4 is the proposed action.

10.6 Lake Erie Water Levels

Lake Erie water levels have declined from near-record high levels in June 1997 to below-average conditions since May 1999. This is a result of low water supplies from the upper lakes beginning in mid-1997. At the beginning of 2002, Lake Erie was 12 cm (4.7in) below average, but 6 cm (2.4 in) higher than levels experienced one year earlier.

Water levels fluctuate according to the climate of the region. Since it is not possible to accurately forecast weather conditions several months in advance, staff of Environment Canada and the U.S. Army Corps of Engineers prepare a six-month forecast of the probable range of future water levels assuming wet and dry supply conditions. This six-month forecast (Figure 22) is provided in the Monthly Water Level Bulletins published in Canada by the Canadian Hydrographic Service and in the United States by the U.S. Army Corps of Engineers. If dry conditions prevail over the first six months of 2002, by summer the level of Lake Erie could be ten or more centimeters (3.9 in) lower than levels experienced during 2001, but still well above the period-of-record minimum levels recorded in 1934. If, however, wet conditions are experienced, levels could equal or exceed those recorded during 2001 and could climb a few centimetres above average. Please consult the Canadian Hydrographic Service website (http://chswww.bur.dfo.ca/danp/) or the U.S. Army Corps of Engineers website (http://huron.lre.usace.army.mil/levels/bltnhmpg.html) for up-to-date information on current and forecasted water levels.

Photo: Ohio Division of Wildlife

Figure 22: Recent and Historic Lake Erie Water Levels (Source: Canadian Hydrographic Service)

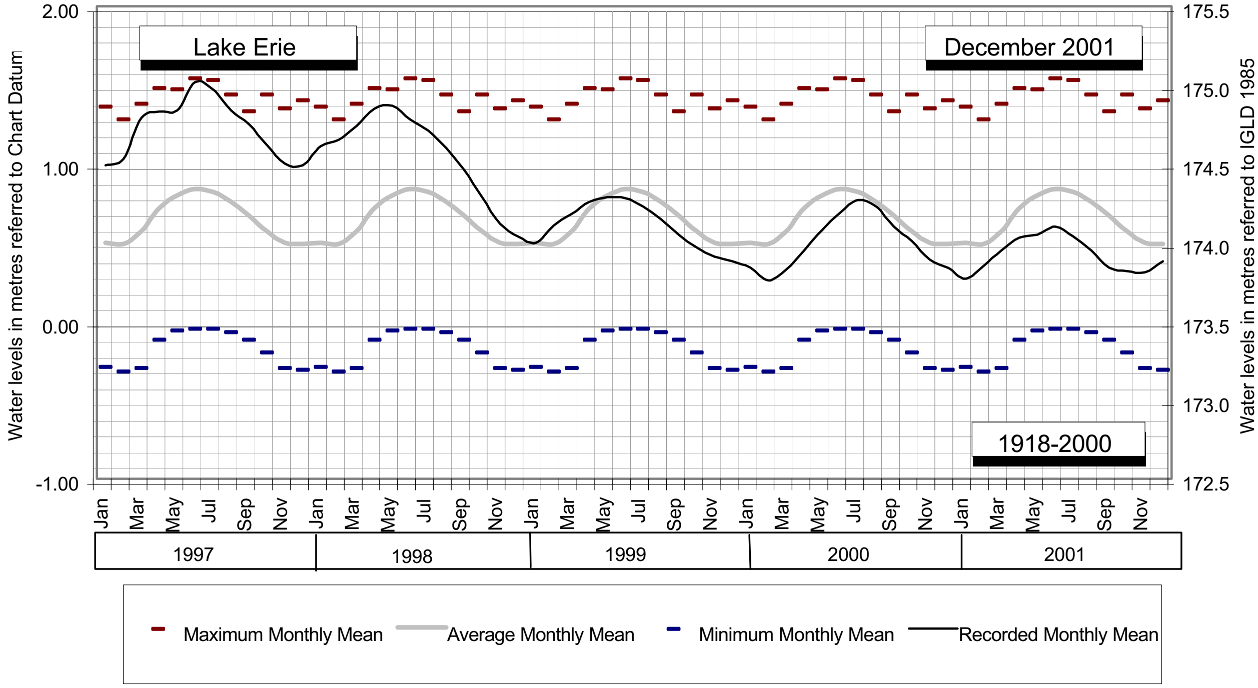


Figure 23: Monthly Water Level Bulletin Including 6 Month Forecast (Source: Canadian Hydrographic Service)