LAKE ERIE WILDLIFE: AN ANNOTATED BIBLIOGRAPHY

Jeff P. Bruce

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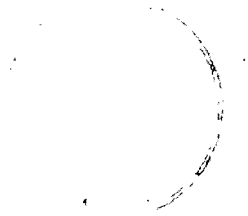

ABSTRACT

The bibliography consists of 419 citations of wildlife material pertaining to the aquatic ecosystem of Lake Erie, in the North American Great Lakes. Many of the citations are annotated. Information is included on birds, mammals, herpetofauna and aquatic vegetation. The references were derived from published literature, as well as government documents and unpublished reports.

RÉSUMÉ

La bibliographie comprend 419 ouvrages sur la faune de l'écosystème aquatique du lac Érié (Grand Lacs). Bon nombre de ces références sont annotées. Les ouvrages en question portent sur les oiseaux, les mammifères, la faune erpétologique et la flore aquatique. Il s'agit de publications, de documents gouvernementaux et de rapports non publiés.

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INTRODUCTION

In recent years there has been a considerable increase in general concern for the Lake Erie ecosystem. This stems largely from the fact that the Lake Erie basin is home to over 13 milion humans, and because this lake supports the richest (in money terms) freshwater fishery anywhere in the world. This fishery, and other components of the aquatic ecosystem appear to have experienced dramatic changes due to reductions in loadings of phosphorous, as well as the invasion in the late 1980s of Zebra and Quagga Mussels. The Lake Erie Lakewide Management Plan (LaMP) is a binational initiative, headed by federal government departments (Environment Canada, and the U.S. Environmental Protection Agency). It aims to improve our understanding of the Lake Erie ecosystem, and to produce informed and balanced management prescriptions to help remediate effects of past anthropogenic stresses on the lake, as well as to conserve healthy, self-sustaining communities of fish and wildlife. This bibliography will be of great use to resource managers and scientists alike, who are working towards this end point for the lake.

This bibliography includes information on wildlife species from a wide range of taxa, which are all components of Lake Erie's aquatic ecosystem, including the watershed. We have narrowed the focus mainly to ornithological, mammalian and herpetofaunal components, and the habitats in which they are found, since these animal groups comprise the bulk of the available literature on Lake Erie wildlife.

Citations are arranged by taxonomic group, and by the senior author within each group. Some key references contain information on a number of taxonomic groups, and so these can be found in more than one section in this bibliography. In many cases an abstract or summary of the contents of a report or scientific paper has been provided. Where abstracts were unavailable, only the citation appears.

The following sources of reference material were consulted:

Biological Abstracts
Environmental Information Access
General Science Index
Science Citation Index
Wildlife Review
Zoological Records

Literature was retrieved from the following libraries, instituions and organizations:

Canadian Wildlife Service, Canada Centre for Inland Waters, Burlington, ON
Canadian Wildlife Service, London, ON
Canadian Wildlife Service, Toronto, ON
Central library, Canada Centre for Inland Waters, Burlington, ON
Long Point Bird Observatory, Port Rowan, ON
Long Point Waterfowl and Wetlands Research Foundation, Port Rowan, ON
Ohio Department of Natural Resources, Columbus, OH
Ontario Ministry of Natural Resources, Aylmer, ON
Ontario Ministry of Natural Resources, Simcoe, ON
Schmon Library, Brock University, St. Catherines, ON
Taylor Library, University of Western Ontario, London, ON
Tifft Nature Preserve, Buffalo, NY
Thode Library, McMaster University, Hamilton, ON
Zoology and Palaeontology Library, Royal Ontario Museum, Toronto, ON
Zoology Library, University of Toronto, ON

BIRDS

Alison, R.M., D.G. Dennis, and G.B. McCullough. (no date). Successful Redhead (*Aythya americana*) introduction at Long Point, Ontario. Unpublished Report to Ontario Ministry of Natural Resources and Canadian Wildlife Service, London, Ontario.

Andrews, R. 1952. A study of waterfowl nesting on a Lake Erie marsh. M.Sc. thesis, The Ohio State University, Columbus, Ohio.

Angehrn, P.A.M., H. Blokpoel, and P. Courtney. 1979. A review of the status of the Great Black-backed Gull in the Great Lakes area. Ontario Field Biologist 33(2): 27-33.

Numbers of Great Black–backed Gulls overwintering on the upper St. Lawrence River and the lower Great Lakes system appear to have increased during the period 1946–1977. Band recoveries suggest that many of those birds come from colonies in the St. Lawrence River estuary. There are 10 recorded cases of single nests in the Great Lakes. There is no indication that the Great Black–backed Gull is invading the Great Lakes as a nesting species.

Baillie, J.L. 1947. The Double-crested Cormorant nesting in Ontario. Canadian Field-Naturalist 61(4):119–126.

Bain, G.A.C. 1980. The relationship between preferred habitat, physical condition and hunting mortality of Canvasbacks (*Aythya valisineria*) at Long Point, Ontario. M.Sc. thesis. University of Western Ontario, London, Ontario.

Canvasbacks (*Aythya valisineria*) and Redheads (*A. americana*) are important components of the total diving duck kill at the Long Point Waterfowl Management Area. Evidence suggests that these species each occupy two distinct habitats and that differences in physical condition and hunting vulnerability occur between the two habitats. Canvasbacks and Redheads in the Waterfowl Management Area marsh are in nontraditional habitat during fall migration and are on average in poorer physical condition than those occupying the traditionally preferred areas. The data indicate that hunters based in the management area marsh do not harvest a random sample of the staging birds. Individual birds occur most commonly in the marsh and apparently are more vulnerable to hunting.

No definite reasons for Canvasback and Redhead occurrence in the marsh habitat could be ascertained although it appears that they may be using it as a sanctuary and as an area to acquire an alternate food source during times of stress.

Condition indices were developed for both species. Omental fat was the most reliable indicator of total body lipids.

Bendall, S. 1976. Long Point: Canada's bird observatory. Ontario Naturalist 16(2): 10-15.

This is a written review of the history of Long Point from its early days to the establishment as a permanent station. The author details the banding activities along with programs directed at rare and endangered species.

Best, D.A., M. Gilbertson, and H. Hudson. 1990. Proceedings of the expert consultation meeting on Bald Eagles. Report to the International Joint Commission, Windsor, Ontario.

The Biological Effects Subcommittee of the Science Advisory Board's Ecological Committee held a workshop February 12 and 13, 1990 to discuss the status of the Bald Eagle in the Great Lakes basin. The eagle has suffered past population declines due to habitat degradation by persistent toxic chemicals as well as habitat destruction by agriculture, logging and development.

The Bald Eagle has been proposed a an ecosystem indicator that would reflect the suitability of the Great Lakes to support a diversity of life. Because eagles integrate many habitat components, all of which must be suitable for sustained survival, the eagles reproductive success mirrors the health of the Great Lakes Basin Ecosystem.

Two additional meetings have been held subsequent to the February workshop. These meetings discussed the standardization of research methods and reporting, and the creation of an accessible database for all concerned agencies. Future research needs such as the creation of habitat suitability indices (HSIs) that quantify the attributes of habitat for eagles were also discussed.

The future looks promising as Bald Eagle numbers continue to increase in the United States and Canada, but continued protection and management is needed to successfully maintain these recovering populations. A coordinated effort will help facilitate this goal.

Bishop, C.A., and D.V. Weseloh. 1990. Contaminants in Herring Gull eggs from the Great Lakes. A State of the Environment Fact Sheet, No. 90-2.

Bishop, C.A., D.V.C. Weseloh, N.M. Burgess, J. Struger, R.J. Norstrom, R. Turle, and K.A. Logan. 1992. An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988). Volume 1 Accounts by species and location: Volume 2 Accounts by Chemical. Technical Report Series No. 152&3. Canadian Wildlife Service, Ontario Region.

Bishop, C.A., M.D. Koster, A.A. Chek, D.J.T. Hussell, and K. Jock. (in press). Chlorinated hydrocarbons and mercury in sediments, Red-winged Blackbirds (*Agelaius phoeniceus*) and Tree Swallows (*Tachycineta bicolor*) from wetlands in the Great Lakes - St.Lawrence River Basin. Environmental Toxicology and Chemistry.

In 1991, we collected Red–winged Blackbird (*Agelaius phoeniceus*) eggs and Tree Swallow (*Tachycineta bicolor*) eggs and nestlings, and sediment samples from 12 wetland sites in the Great Lakes and St. Lawrence River basin. We analyzed for chlorinated hydrocarbons and total mercury and found that biota contained contaminant concentrations which were one to two orders of magnitude above those in sediments. Maximum concentrations (wet weight) of contaminants were found in Akwesasne, St. Lawrence River (PCBs = 18,558.8 ng/g in Red–winged Blackbird eggs, oxychlorda = 58.8 ng/g axl, mirex = 40.1 ng/g in Tree Swallow eggs); Mud Creek, Lake Erie (total mercury = 0.079 ug/g; pp'–02–43762 ng/kg in Tree Swallow eggs), and Cootes Paradise (211.4 ng/g dieldrin and 115.6 ng/g heptachlor epoxide in Tree Swallow nestlings). Despite the migratory habits of Red–winged Blackbirds and Tree Swallows, agreement among biota and sediment in geographic variation of contaminant concentrations supports the use of these animals as biomonitors of persistent chemicals. Although chlorinated hydrocarbon concentrations in Red–winged Blackbird eggs were significantly correlated with sediment contamination, the local nature of the Tree Swallow chick diet suggests that nestlings would be the best indicator of local contaminant trends.

Blokpoel, H. 1983. Gull problems in Ontario. Canadian Wildlife Service Information Leaflet.

The gull problem is to a large extent the result of the rather wasteful life style of man and the opportunistic behaviour of gulls, especially Ring–billed Gulls. In some areas (such as the Toronto waterfront) man has provided not only good foraging areas but has also developed new nesting

habitat. In those situations nuisance problems are likely to be more serious, and more difficult to alleviate, than elsewhere.

Blokpoel, H., and G.B. McKeating. 1978. Fish-eating birds nesting in Canadian Lake Erie and adjacent waters. Canadian Wildlife Service Progress Note No. 87, Ontario Region.

An inventory in 1977 of gulls and terns nesting in the Canadian parts of Lake Erie, the Detroit River, and the Niagara River produced the following results: 1171 nests of Herring Gulls (*Larus argentatus*), 15 130 nests of Ring–billed Gulls (*L. delawarensis*), and 1583 nests of Common Terns (*Sterna hirundo*). Lack of reliable, historical data made it impossible to determine any recent changes in numbers for the two gull species. Most Common Tern colonies have declined in recent years; their most important colonies on Lake Erie are being affected by various types of disturbance.

This paper also reports observations in 1977 of colonies of Double–crested Cormorant (*Phalacrocorax auritus*), Great Egret (*Casmerodius albus*), Cattle Egret (*Bubulcus ibis*), Great Blue Heron (*Ardea herodias*), and Black–crowned Night-heron (*Nycticorax nycticorax*). In 1977 there was one, small, rather threatened colony of cormorants on Lake Erie. The Black–crowned Night-Heron appears to be the second most numerous fish–eating bird species on Lake Erie, as well as on the lower Great Lakes in general. The archipelago in the western basin of Lake Erie is of great importance as nesting habitat for several heron species, two of which nest in very few places elsewhere in Canada.

Blokpoel, H., and G.T. Haymes. 1979. Origins of Ring-billed Gulls at a new colony. Bird-banding 30(3): 210-215.

Band numbers of Ring billed Gulls nesting in the recently established colony on the Eastern Headland of the Toronto Outer Harbour were obtained by trapping banded birds on their nests or by reading bands through binoculars. Analysis of the banding information showed that the number of birds contributed to the Eastern Headland from any particular colony of origin was largely determined by a function of (1) the distance between that colony of origin, and the Eastern Headland and (2) the number of chicks fledged at the colony of origin.

Blokpoel, H., and P.A. Courtney. 1982. Immigration and recruitment of Ring-billed Gulls and Common Terns on the lower Great Lakes. Canadian Wildlife Service Progress Note No. 133.

The rates at which Ring–billed Gulls (*Larus delawarensis*) and Common Terns (*Sterna hirundo*) moved from their natal colonies to colonies at the Eastern Headland (Lake Ontario) and Port Colborne (Lake Erie) were examined. Band numbers for the two species at both colony sites were obtained in 1978 by reading them through binoculars or by trapping banded birds on their nests. Analysis of that information showed that the number of banded immigrants was largely determined by (a) the distance between the receiving colony and the natal colonies, and (b) the number of banded chicks fledged on the natal colonies.

The rates at which Ring–billed Gulls moved to the Eastern Headland from their natal colonies were used in an effort to determine where the 22 735 pairs that nested there during the peak of the nesting season in 1978 had come from (in 1973 only 21 pairs nested at the headland). The total number of immigrants from all known colonies larger than 400 pairs and within 550 km of the headland was estimated. At least 62% of the 45 470 individuals were 3– to 6–year–old birds that had immigrated from 44 different natal colonies or that had been recruited from the headland itself. The remainder nesting in 1978 presumably consisted of birds younger than 3 years, older than 7 years, and of any age from colonies that were either unknown or for which population information was lacking.

Blokpoel, H., and G.D. Tessier. 1986. The Ring-billed Gull in Ontario: a review of a new problem species. Canadian Wildlife Service Occasional Paper 57.

1. In 1984 there were an estimated 700 000 pairs of Ring–billed Gulls nesting in about 170 colonies in the Great Lakes and the St. Lawrence River down to Trois– Rivieres, Quebec. At the end of the 1984 breeding season the population in the area was probably in excess of 3 000 000 individuals. About two–thirds of that population was located in Canada, with the remainder in the USA.

2. The estimated average annual growth rate of the Great Lakes nesting population was 7.9% during the period 1967–76 and 11.0% during 1976–84.

3. The Ring–billed Gull is a highly adaptable bird that thrives in man–altered environments. It has a varied diet (including garbage, fish, offal, and handouts), nests on many kinds of man–made sites, and has lost most of its fear of man. It is likely that unless man interferes the full population will continue to increase for several more years.

4. In Ontario, the number of problems caused by the Ring–billed Gull is rapidly increasing. The gulls pose a threat to flight safety; cause serious damage to crops; are a potential health hazard to people, cattle, and fowl; and are an unacceptable nuisance in many parks, marinas, beaches, playgrounds, and other public areas.

5. Gulls can be frightened away from areas where they are not wanted by persistent harassment, using a variety of methods (shellcrackers, live shells, blank shells, distress calls, gas bangers, and birds of prey). Gulls can be physically excluded from areas where they are not wanted by installing monofilament lines or stainless steel wires. Some sites can be made less attractive to gulls by preventing people from feeding them and from littering.

6. In many problem situations, local gull control is unpractical and, where it is practical, it often shifts the problem but does not eliminate it. Local gull control does not normally result in a reduction of the total gull population, which is the underlying cause of the various gull problems. Despite these shortcomings, local gull control will continue to be the major answer to gull problems in the immediate future.

7. Reduction of the total population of Ring–billed Gulls would require strong justification, because it would involve an on–going, costly, and complicated program. Such a program would have to be biologically sound and socially acceptable. To be succesful the program would have to cover the heartland of the eastern population, i.e. the Great Lakes and the St. Lawrence River down to Trois– Rivieres. Thus such a program would require co–operation between Canada and the USA.

Blokpoel, H., G.D. Tessier, and A. Harfenist. 1987. Distribution during post-breeding dispersal, migration, and overwintering of Common Terns color-marked on the Lower Great Lakes. Journal of Field Ornithology 58(2): 206-217.

Common Terns (*Sterna hirundo*) were marked with colored wing tags at two colonies in the lower Great Lakes. Sightings of these birds were used to examine their post–breeding dispersal in the Great Lakes, migratory routes, and winter distribution. Adults and juveniles disperse along the shores of Lake Erie and Ontario from July through October: 97.1% of adults and 80.8% of juveniles that were sighted on the Great Lakes were seen on Lake Erie. Only five color–marked adults were observed south of the Great Lakes and north of Florida. These sightings were consistent with an Atlantic coast fall migration route.

Between December and March, Great Lakes adult and juvenile Common Terns winter on the U.S.

Gulf coast, the Caribbean, Central America, and north coast of South America. Adults also winter on the Atlantic coast of Florida and the west coast of South America.

Blokpoel, H., and G.D. Tessier. 1991. Distribution and abundance of colonial waterbirds nesting in the Canadian portions of the Lower Great Lakes system in 1990. Canadian Wildlife Service Technical Report Series No. 117.

The Canadian portions of the lower Great Lakes system (St. Clair River, Lake St. Clair, Detroit River, Lake Erie, Niagara River, Lake Ontario, and the St. Lawrence River from Kingston to Cornwall) were surveyed during the 1990 breeding season and nest counts were made at all colonies of Double–crested Cormorant (*Phalacrocorax auritus*), Ring–billed Gull (*Larus delawarensis*), Herring Gull (*L. argentatus*), Great Black–backed Gull (*L. marinus*), Common Tern (*Sterna hirundo*), and Caspian Tern (*S. caspia*).

In 1990 the breeding populations for these size colonial waterbird species were as follows. Double– crested Cormorant: 11 colonies (with 4,698 nests); Ring–billed Gull: 27 colonies (with 283,405 nests); Herring Gull: 36 colonies (with 5,507 nests); Great Black–backed Gull: 3 colonies (with 8 nests); Common Tern: 13 colonies (with 2,348 nests); and Caspian Tern: 3 colonies (with 765 nests).

During 1976/77–1990, average annual rates of change of population size were as follows. Double– crested Cormorant: + 40.4%; Ring–billed Gull: between +12.3% and +13.3%; Herring Gull: between +8.1% and +8.7%; Common Tern: between –1.9% and –2.0%; and Caspian Tern: +22.1%. These observed population changes are briefly discussed.

Blokpoel, H., and W.C. Scharf. 1991. Status and conservation of seabirds nesting in the Great Lakes of North America. Pp. 17-41. in J.P. Croxall (ed.). Seabird status and conservation: a supplement. Technical Publication 11, International Council for Bird Preservation, Cambridge, UK.

Eight seabird species nest on the Great Lakes, though only six breed commonly. The Ring–billed Gull (*Larus delawarensis*) is the commonest, with an estimated nesting population of 648,000 pairs in 1984. Its population has been increasing since the early 1960s. The second most numerous species is the Herring Gull (*Larus argentatus*) with a population probably exceeding 40,000 pairs. After having almost disappeared as a nesting species on the Great Lakes, the Double–crested Cormorant (*Phalacrocorax auritus*) is undergoing a population explosion: in 1987 the population was 13,600 pairs. The Caspian Tern (*Sterna caspia*) is also increasing with 5,700 known nests in 1987. Forster's Tern (*Sterna forsteri*) appears to be increasing in the Canadian portions of the Great Lakes while numbers fluctuate in the U.S. Great Lakes. The total population is likely less than 1,500 pairs. Common Terns (*Sterna hirundo*) are declining in some parts of the Great Lakes, but there is no recent assessment of the total population. The Little Gull (*Larus minutus*) nests occasionally in the Great Lakes. The Great Black–backed Gull (*Larus marinus*) breeds regularly, in small numbers, in Lake Ontario. Forster's Terns nest mainly in large marshes. The other five common nesters breed on small natural islands and, increasingly, on man made habitats, both insular and on the mainland. Natural threats include high lake levels and storm waves (all species), excessive predation and encroachment on nesting habitat by gulls and vegetation (Common Tern and Caspian Tern), and destruction of marshes (Forster's Tern). Human threats include the release of toxic contaminants in the birds' environment, changes in abundance and species composition of prey fish, alteration and destruction of habitat, and disturbance of nesting birds (all species). Conservation efforts should be primarily aimed at protecting important colonies of Caspian, Common, and Forster's Terns, as well as the single Little Gull colony, from human disturbance and development, excessive nest site competition with gulls, and excessive predation. Further reductions in the release of toxic chemicals will benefit the entire Great Lakes ecosystem and especially colonial waterbirds.

Blokpoel, H., and W.C. Scharf. 1991. The Ring-billed Gull in the Great Lakes of North America. Pp. 2372-2377 in H. Blokpoel and A.L. Spaans (eds.) Superabundance in gulls: causes, problems and solutions. Proceedings of Symposium 44, Acta XX Congressus Internationalis Ornithologici.

European colonists decimated the original Ring–billed Gull (*Larus delawarensis*) population on the Great Lakes. The population increased from 27,000 pairs during 1940–1960 to 710,000 pairs in 1990. Bird protection laws changed human attitudes towards gulls and gulls, in turn, lost most of their fear of people. By capitalizing on opportunies provided by humans, many gulls have become "urbanized", i.e. they feed, rest and nest in or near urban areas. Gull problems include conflicts with interests of people (flight safety hazards, disease transmission, crop damage, roof–nesting, interference with industrial operations, and general nuisance) and of other bird species. Problems are dealt with on a site–by–site basis using the following approaches: (1) scaring gulls, (2) excluding gulls, (3) removing or modifying attractions, and (4) preventing gull reproduction.

Blokpoel, H., and G.D. Tessier. (in prep). Control of Ring-billed Gull colonies at urban and industrial sites in southern Ontario, Canada.

At eight urban or industrial sites in southern Ontario colonies of Ring-billed Gulls (*Larus delawarensis*) were controlled to ameliorate problems caused by the gulls and their young. At the Nanticoke Generating Station on Lake Erie a growing colony was eliminated by collecting eggs and subsequent harassment of adults. One colony at the Stelco Yards in Hamilton Harbour was eliminated by installing a gull exclosure and collecting eggs from nests outside the exclosure and another was controlled by frequently destroying nests and eggs. At Toronto Island Airport an incipient colony was controlled by collecting eggs and harassing adults. At Mugg's Island, Toronto Harbour, control efforts included construction of a large gull exclosure and repeated egg collection. Large-scale gull-scaring operations during 1984-86 at the Eastern Headland, Toronto Harbour, included the use of tethered raptors, distress cries and pyrotechnical devices. An incipient colony at Bluffer's Park, just east of Toronto on Lake Ontario, was eliminated by collecting eggs repeatedly. A colony on the yards of the St. Mary's Cement Company in Bowmanville was reduced by alteration of habitat and harassment of the adults.

Bowerman, W.W. 1993. Regulation of Bald Eagle (*Haliaeetus leucocephalus*) productivity in the Great Lakes basin: An ecological and toxicological approach. Ph.D. thesis, Michigan State University.

The Bald Eagle population, within and adjacent to the Great Lakes Basin, constitutes the greatest single population within the contiguous United States. Bald Eagles were largely extirpated from the Great Lakes by the mid–1960s, due to the effects of DDE. Eagles began to repopulate and raise young again along the shores of the Great Lakes, with the exception of Lake Ontario, by the 1980s.

The studies reported here focused on factors limiting Bald Eagle populations. Ecological factors investigated included food habits, nest tree use, winter habitat use, and the identification of potential nesting habitat. Bald Eagles primarily foraged on fish (suckers, bullheads, northern pike, carp, and freshwater drum). Eagle nests were built primarily in white pines, but in cottonwoods near Lake Erie. Potential nesting habitat exists along the shorelines of all Great Lakes, primarily along Lakes Huron and Superior. Habitat availability, however, may limit the Lake Erie subpopulation, which has little unoccupied habitat and great density of nesting eagles.

Toxicological aspects investigated included monitoring concentrations of PCBs and p,p'–DDE in plasma, mercury and selenium in feathers. Hematological biomarkers were used to assess health of eaglets. Bill deformities in nestlings were also investigated. Concentrations of p,p'–DDE or PCBs, but not mercury or selenium, were significantly, and inversely correlated with regional reproductive productivity and success rates. Lesser reproductive productivity in some lesser contaminated areas are believed to be related to greater nesting density.

Reproductive productivity of Bald Eagles within this population is primarily regulated by concentrations of organochlorine compounds along the shorelines of the Great Lakes, and density dependent factors in the interior, relatively uncontaminated areas. The continuing recovery of this population will depend on maintaining greater productivity in interior areas to compensate for lesser fecundity and greater adult mortality along the shorelines of the Great Lakes.

Bradstreet, M.S.W. 1977. The biological inventory of Long Point, Lake Erie: an overview. Unpublished Report to the Nature Conservancy of Canada, Toronto, Ontario.

Bradstreet, M.S.W., G.W. Page, and W.G. Johnston. 1977. Shorebirds at Long Point, Lake Erie, 1966-71: Seasonal occurrence, habitat preference, and variation in abundance. Canadian Field-Naturalist 91(3): 225-236.

Occurrence, habitat preference, and seasonal and annual variations in shorebird abundance at Long Point, Lake Erie, from 1966 to 1971 are documented. Significant declines in shorebird numbers were noted between 1967 and 1971 for species that fed at pools on the beach, but not for species that fed along the interface between the beach and Lake Erie. It is suggested that a change in Lake Erie's water level was the most important factor causing variations in shorebird numbers at Long Point. Some implications of habitat deterioration along shorebird migration routes are discussed.

Brooks, R.J., and E. Nol. 1978. The Piping Plover (*Charadrius melodus*) and the Killdeer (*Charadrius vociferus*) on Long Point, Ontario. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Brooks, R.J., and E. Nol. 1980. Factors affecting nesting success of shore-birds on Long Point, Ontario. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Brown, K.M. 1992. The influence of investigator disturbance on the aggressive behaviour and breeding success of Ring-billed Gulls (*Larus delawarensis*). M.Sc. thesis. Brock University, St.Catharines, Ontario.

Increased losses of eggs and chicks resulting from human intrusion (investigator or other) into seabird colonies has been well documented. In 1990/91, I studied the effects of investigator disturbance on aggressive behaviour and breeding success of individual pairs of Ring–billed Gulls nesting at two colonies near Port Colborne, Ontario. The insular colony was on an artificial breakwall, associated with the Welland Ship Canal, approximately 1 km off the north shore of Lake Erie. The mainland colony was adjacent to the canal approximately 1 km east of the breakwall. The frequencies of adult threat and assault behaviours, chick movement and adult attacks on chicks were recorded by continuous scan sampling 30 min prior to, 30 min during and 60 (2 x 30) min after investigator disturbance. The frequency of threat and assault behaviours increased during the period of investigator activity in the colony while the duration of wingpulls and beakpulls decreased. Significantly more chicks ran ("runners") from their natal territories during disturbances and "runners" were more frequently attacked than " territorial" chicks. No chicks were fatally attacked during disturbance and "runners" returned to their natal territories quickly after disturbance.

Breeding success was determined for pairs nesting in study plots subjected to two levels of disturbance (normal and moderate). The disturbance level of each plot differed in visitation frequency and activities performed on each visit. Investigator disturbance had no effect on the hatching success or fledging success (taken as 21 days of age) of Ring–billed Gull study pairs at either colony.

Brown, K.M., and R.D. Morris. 1994. The influence of investigator disturbance on the breeding success

of Ring-billed Gulls (*Larus delawarensis*). Colonial Waterbirds 17(1): 7-17.

Increased losses of eggs and chicks resulting from human intrusion (investigator or other) into seabird colonies have been well documented. From 1989 to 1991, we studied the effects of investigator disturbance on the breeding success of individual pairs of Ring–billed Gulls (*Larus delawarensis*) nesting at two colonies near Port Colborne, Ontario, Canada. The insular colony was on an artificial breakwall, associated with the Welland Ship Canal, approximately 1 km off the north shore of Lake Erie. The mainland colony was adjacent to the Canal approximately 1 km east of the breakwall. Clutch size, hatching success/pair and fledging success/pair were measured for pairs nesting in study plots subjected to various levels of investigator disturbance. The disturbance level of each study plot varie with respect to visitation frequently and investigator activities performed on each visit. Chicks were considered fledged at 21 days old.

Visits into the study areas before and during the egg–laying period had no significant effect on nesting density or clutch–size distribution. Similarly, visits during the incubation phase had no effect on the hatching success of study pairs. Finally, while we did not enter the study areas during the brooding period, we established that visits during hatching had no effect on the hatching or fledging success of study pairs. The abundance of available cover provided shelter in which mobile chicks crouched during disturbances (investigator or other).

Bryant, J.E. 1965. Great Lakes water levels and migratory waterfowl, Ontario. Unpublished Brief to International Joint Commission on Great Lakes Levels. Windsor, Ontario, Canadian Wildlife Service, Department of Northern Affairs and National Resources.

In the present study two goals were established from the beginning. The first was to continue Young's work on certain key physical and chemical properties of the marsh and his observations of waterfowl. The second goal was the selection and intensive study of certain small areas found to be particularly attractive to nesting ducks in the spring. Observations of territorial waterfowl made during May of both 1961 and 1962 revealed that most of the breeding pairs that established spring territories in the marsh did so in two locations: the pond between the Oak Ridges and Courtright Ridge. It was decided that an intensive study of the ecology of these two areas was in order. The results of such a study, it was felt, should disclose the factors that lead to poor brood production even in parts of the marsh attractive to mated ducks in the spring. We also reasoned that since these spots were strongly preferred by breeding pairs over all other similar sized areas in the marsh, any attempts at improving the habitat for waterfowl reproduction through management would be most apt to succeed in these locations.

Burness, G.P. 1992. Foraging ecology and parental behaviour in the Common Tern (*Sterna hirundo*). M.Sc. thesis. Brock University, St.Catharines, Ontario.

One component of successful parenting is related to efficiency in foraging behaviour. The relationships among chick feeding, the size and type of food package, and length of parental foraging trips has not been well studied in seabirds. In addition, relatively few data have been collected on the activities of seabirds when foraging away from the nest site. The objectives of this study were: (1) to contrast productivity, feeding rate, and attendance patterns of individuals carrying a novel transmitter with a control group of birds; (2) to use radio–telemetry to assess the variability in foraging locations within and between individual male Common Terns; (3) to determine the seasonal variation in chick diet; (4) to determine for each transmittered bird, the relationships among the foraging patterns, parental behaviour, and seasonal reproductive success.

The study took place over two years (1990–91) on a concrete breakwater 1 km offfshore on Lake Erie near Port Colborne, Ontario. Ten pairs of terns in 1990 and 12 pairs in 1991 were radio–tracked by boat or car during the chick rearing stage. Concurrent behavioural observations documented the time each sex spent foraging or at the nest. The frequency and prey species

composition of feeds to chicks were also recorded.

The transmitters had negligible effects on the feeding frequency and brood attendance patterns of transmitter carrying birds. Peak nesting transmittered birds in 1990 and 1991 exhibited some inter–individual variability in foraging locations, however intra–individual variability was low. Birds foraged primarily to the west and northwest of the colony. Late nesters exhibited greater inter–individual variability, however intra–individual variability remained low for most birds. Neither group demonstrated sufficient variability to support the regular use of this colony as an "information centre".

Individual transmittered birds had unique and predictable foraging patterns, and corrresponding differences in feeding frequencies and brood attendance patterns, yet productivity was essentially equal between nests due to the impact and importance of stochastic events. Individuals that were recaptured in 1991 exhibited very similar foraging patterns to 1990, suggesting little variability between years. Conservation of foraging patterns between years may have potential implications for mate choice decisions in future breeding seasons.

Prey species delivered to chicks differed between morning and evening for peak and late nesters in 1990, but not in 1991. Peak nesters in 1990 fed significantly more Rainbow Smelt (*Osmerus mordax*) than Emerald Shiner (*Notropis atherinoides*); this trend was reversed for late nesters who also fed large numbers of unidentified larval fish. No significant differences were found in 1991. Seasonal changes in prey species delivered to chicks is believed to be attributable to the temperature tolerances of the smelt and shiners, and the presence of large schools of larval fish during the late nesting season.

Burness, G.P., and R.D. Morris. 1992. Shelters decrease gull predation on chicks at a Common Tern colony. Journal of Field Ornithology 63(2): 186-189

Predation by gulls on Common Tern (*Sterna hirundo*) chicks at a colony near Port Colborne, Ontario has annually resulted in reduced breeding success among late nesting terns. Small chick shelters were designed and their efffectiveness at reducing larid predation rates was tested. Observations of predation on chicks were performed before and after shelters were placed next to each of 30 nests. Predation on chicks was commonly observed prior to shelter placement and declined to zero thereafter. The number of chicks that disappeared was significantly reduced after shelter placement. In view of the declining Common Tern population on the Great Lakes, efforts to minimize predation are imperative.

Burness, G.P., and R.D. Morris. 1993. Direct and indirect consequences of Mink presence in a Common Tern colony. Condor 95: 708-711.

Burness, G.P., R.D. Morris, and J.P. Bruce. 1994. Seasonal and annual variation in brood attendance, prey type delivered to chicks, and foraging patterns of male Common Terns (*Sterna hirundo*). Canadian Journal of Zoology 72(7): 1243-1251.

The study took place over 2 years (1990 and 1991) on a concrete breakwater located 1 km offshore on Lake Erie near Port Colborne, Ontario. Ten male Common Terns (*Sterna hirundo*) in 1990 and 12 in 1991 were radio–tracked by boat or car during the chick–rearing stage. Concurrent behavioural observations of the radio–tagged birds and 23 additional control birds documented the time each sex spent away from or at the nest. The frequency and prey species/size composition of feeds to chicks were recorded. Individuals that carried transmitters had predictable foraging patterns. In peak– (clutch initiation in early May) and late–nesting males (clutch initiation in late June) intra–individual variability was low. Late–nesting males exhibited greater interindividual variability than peak–nesting males. Adults recaptured in 1991 exhibited similar foraging patterns to those they expressed in 1990. There were diurnal, seasonal, and interannual variations in prey

delivered to chicks. We suggest that these were due to the temperature tolerances of the prey, rainbow smelt (*Osmerus mordax*) and emerald shiner (*Notropis atherinoides*), that controlled their vertical distribution in the water column, and to the presence of large schools of larval fish during the late nesting season.

Calvert. E.W. 1920. Notes on the fauna and flora of East and Middle Sister and North Harbor Islands, Lake Erie. Canadian Field-Naturalist 34: 109-110.

Campbell, L.W. 1947. American Egrets nesting on West Sister Island in Lake Erie. Auk 64: 461-462.

Cartar, R. 1974. The status of the Piping Plover at Long Point, Ontario, 1966-1975. Ontario Field Biologist 30(2): 42-48.

Population numbers and breeding success of the Piping Plover at Long Point, Ontario, from 1966–1975 are examined. When compared to the preceding six–year period, a general decline in population is apparent.

Chapman, B.A., and J.W. Parker. 1985. Foraging areas, techniques, and schedules of wintering gulls on southeastern Lake Erie. Colonial Waterbirds 8(2): 135-141.

Foraging areas, techniques, and schedules of wintering Herring Gulls, *Larus argentatus*, Ring–billed Gulls,*L. delawarensis*, and Bonaparte's Gulls, *L. philadelphia,* were studied in Dunkirk Harbour on southeastern Lake Erie. All three species foraged in the outflows, breakwall, pier, and open water areas of the harbour, but beach and park areas were used only by the two larger species. The same area often was used differently by each species and age class within a species. Bonaparte's Gulls used only the techniques of plunge and surface diving. Ring–billed and Herring Gulls used these techniques as well as scavenging and foraging for invertebrates by walking along the shore. Adult and first year Bonaparte's and Ring–billed Gulls had bimodal patterns in daily foraging activity. All species showed seasonal changes in foraging patterns that correspond to the onset and passing of severe winter climatic conditions. Uniformly greater levels of foraging activity were observed in first–year gulls.

Chardine, J.W., and R.D. Morris. 1983. Herring Gull male eat their own eggs. Wilson Bulletin 95(3): 477-478.

Cheskey, T. 1994. Conservation of significant birds of the Long Point area: Description, issues and direction. Technical Paper 6. In: J.G. Nelson and P. L. Lawrence (eds.). Long Point Environmental Folio Publication Series, Heritage Resources Centre, University of Waterloo.

The landscape of the Long Point Biosphere Reserve and its hinterland may be the most significant region for breeding birds in Southern Ontario. The wetlands and litoral habitats associated with the peninsulas are provincially and nationally significant as breeding and staging grounds for numerous species of conservation interest. Hinterland forest in the interior forms an impressive landscape of large, interconnected forest patches that maintain one of the largest concentrations of vulnerable, area sensitive and rare species of landbirds in Southern Ontario. The avian communities in this forested landscape may be one of the closest facsimilies to a pre–European forest bird community in all of Southern Ontario. Species of conservation interest cluster in the largest patches of natural forest on the Norfolk sand plains to the west of and including Turkey Point and Spooky Hollow.

Fragmentation of forest patches, house building within natural areas, logging, and intensive agriculture threaten the future viability of significant populations. A landscape level plan and action is needed to promote the enhancement of connectivity between patches, and betwen landscapes through the creation and restoration of corridors. In this plan, the consolidation of existing forested

areas through the reforestation of gaps, and restoration of buffers is needed. Finally, the Regional Municipality should designate and protect the regionally significant natural areas in their Official Plan.

Many local stakeholders need to become involved in specific projects aimed at restoring the connectivity within the landscape by creating and restoring corridors between forest patches, and between landscapes. At the same time, large natural areas should be made larger in a way that maximizes the amount of available forest interior habitat. The forest interior habitat is possibly the single most important aspect contributing to the avian significance of the hinterland area of the Long Point Biosphere Reserve.

Clark, A.R., P. Madore, J. Plank, and J. Robinson. 1983. First record of Double-crested Cormorant nesting on Eastern Lake Erie. Ontario Birds 1983: 66-68.

Condit, J.M. 1964. The growth and development of the Common Tern, *Sterna hirundo*. M.Sc. thesis, The Ohio State University, Columbus.

Courntey, P.A. 1977. Selected aspects of Common Tern reproductive biology. M.Sc. thesis. Brock University, St.Catharines, Ontario.

Several factors influencing reproductive success were investigated at a Common Tern Colony at Port Colborne, Ontario in 1976. In general three egg clutches hatched better than two egg clutches and early started clutches hatched eggs and fledged chicks better than late clutches; the fledging success of two and three egg clutches was similar. Early clutches took longer to hatch and hatched more synchronously than did late clutches. While hatching success differed with nesting substrate used fledging success did not. No relationship was found between either incubation attentiveness and reproductive success or between incubation attentiveness and clutch size. At no time did food availability appear to be a factor limiting successful upbringing of two chick broods. While 'C' chicks (i.e. chicks hatching from the last laid eggs of three egg clutches) generally survived and grew poorly relative to their brood mates they grew best when they originated from clutches that hatched relatively asynchronously.

Courtney, P.A. 1979. Seasonal variation in intra-clutch hatching intervals among Common Terns *Sterna hirundo*. Ibis 121: 206-211.

Courtney, P.A., and H. Blokpoel. 1980. Food and indicators of food availability for Common Terns on the lower Great Lakes. Canadian Journal of Zoology 58: 1318-1323.

The food of Common Terns (*Sterna hirundo*) nesting on the lower Great Lakes was studied in 1979. In western Lake Ontario 90% of the diet comprised alewife and smelt. In the Niagara River the principal food items were smelt, emerald shiner, common shiner, and bluntnose minnow and in eastern Lake Erie the principal items were smelt, emerald shiner, and trout–perch. Nonfish material was rarely observed. Methods for studying the diets of Common Terns on the Great Lakes are examined.

Three indicators of food availability were examined in 1979 at the Eastern Headland in western Lake Ontario: (1) percentage fish accepted by chicks, (2) foraging time, and (3) chick growth. More food was presented to the chicks than they could eat. Food acceptance levels increased with chick age and brood size and ranged from 43.5 to 91.5%. Foraging trip times were 17.2 min on average and, depending on brood size, tern pairs spent an estimated 45–64% of daylight hours foraging for food for their chicks. Weights of 15–day–old chicks in three–chick broods were higher than those reported for other parts of the breeding range.

Courtney, P.A., and H. Blokpoel. 1983. Distribution and numbers of Common Terns on the lower Great

Lakes during 1900-1980: A review. Colonial Waterbirds 6: 107-120.

In the lower Great Lakes area at least 58 Common Tern (*Sterna hirundo*) colonies, each containing 50 or more nests, have existed during 1900–1980 or were still active in 1980. Estimated nest numbers increased from 4,000–7,000 (during 1900–1920) to a peak of 16,000 in the early 1960s and then declined to 5,000 in the late 1970s. These population changes were greatly influenced by the rise and decline of the ternery at Gull Island. Presqui'ile Provincial Park.

Historical data show a shift from western Lake Erie and eastern Lake Ontario as a major breeding area to eastern Lake Erie and western Lake Ontario and the Niagara River. A shift towards the use of man– made sites for nesting has occurred and in 1980 about 70% of all Common Terns nested on seven man–made sites.

Permanent desertion by Common Terns of their colonies has resulted from (1) encroachment by vegetation and/or nesting gulls (Ring–billed Gulls *Larus delawarensis* and Herring Gulls *L. argentatus*), and (2) recreational and/or industrial activities by man. The following factors have affected reproductive success: predation by birds and mammals, human disturbance and pollution of the terns' aquatic environment.

The Great Lakes Common Tern population appears to be fairly discrete with little emigration or immigration taking place. Recently, the weighted mean fledging success for different colonies and different years was 0.89 chicks fledged per nest (virtually the same as the published figure for Massachusetts terneries).

Curnow, R.D., and R.D. Hoffman. 1974. Mercury and organochlorine compounds in Lake Erie herons. Proceedings of the 35th Midwest Fish and Wildlife Conference, St. Louis, Missouri.

Great Blue Herons (*Ardea herodias*), Black–crowned Night-herons (*Nycticorax nycticorax*) and American Egrets (*Camerodias albus*) of the southwestern Lake Erie region were collected and assayed for tissue concentrations of mercury, polychlorinated biphenyls, DDT residues, and dieldrin.

Mean mercury concentrations in soft tissues were greatest in Black–crowned Night-herons (0.61 ppm in muscle to 3.04 ppm in liver) and were least in Great Blue Herons (0.23 ppm in brain to 1.79 ppm in liver). Mercury concentrations consistently were greatest in feathers (3.57 ppm in Great Blue Herons to 8.32 ppm in night herons) and were least in brain tissue (0.23 ppm in Great Blue Herons to 0.61 ppm in night herons). Generally, mercury levels increased from brain to muscle, to liver and feathers.

Organochlorine compounds in liver and brain tissues were most highly concentrated in livers of night-herons and least concentrated in brain tissue of egrets. Adult herons consistently contained higher residue levels than did nestlings. Mean DDT (total) residue levels in liver tissue ranged fro 35.0 ppm in night-herons to 1.60 ppm in egrets. Residues in brain tissue ranged from 13.8 ppm in night-herons to 0.55 ppm in egrets.

PCB and dieldrin concentrations in liver tissues reflected a similar pattern among heron species, with mean PCB concentrations ranging from 135.4 ppm in night-herons to 5.63 ppm in egrets, and dieldrin levels ranging from 0.61 ppm in night-herons to 0.03 ppm in egrets. Brain tissue contained PCB concentrations ranging from 52.4 ppm in night-herons to 2.19 ppm in egrets, and dieldrin levels ranging from 0.36 ppm in night-herons to 0.03 ppm in egrets.

Analytical results indicated concentration differences relating to heron species, age and location of collection. These factors and food chain relationships are discussed.

Custer, C.M., and T.W. Custer. 1993. Food habits of diving ducks in selected areas of the Great Lakes. Unpublished report to Canadian Wildlife Service, London, Ontario.

Dean, J. 1981. Breeding birds of the Bluff Point study area, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Dean, J. 1981. Breeding birds of the proposed Gravelly Bay walking trail, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Dennis, D.G., K.L. Fisher, and G.B. McCullough. (no date). Hunting club kill records as an indictor of the change in status of Mallards and Black ducks in southwestern Ontario. Unpublished Canadian Wildlife Service Report, London, Ontario.

Dennis, D.G. 1974. Breeding pair surveys for waterfowl in southern Ontario. In H. Boyd (ed.) Canadian Wildlife Service Waterfowl Studies in Eastern Canada, 1969-73. Canadian Wildlife Service Report Series Number 29.

Aerial transect surveys in 1970 in southern Ontario indicated that considerable numbers of waterfowl, especially Mallards, were present in southern Ontario during the spring nesting season. In an attempt to avoid some of the deficiencies associated with aerial transects, located along roads, ground crews surveyed a systematic sample of one–quarter–square–mile plots during breeding seasons of 1971 and 1972.

A comparison of waterfowl observed with Canada Land Inventory data showed some correlation in the first three waterfowl capability classes, but little correlation in the last four.

Sixteen species of waterfowl were considered to breed in the area surveyed and in 1971 we counted 3.94 pairs per square mile. Most breeding pairs in southern Ontario are the fertile beaver pond and moraine areas. Based on literature, waterfowl breeding density in southern Ontario is greater than in New Hampshire, New York and Wisconsin, but les than in Minnesota and parts of southern Manitoba and much less than in North Dakota.

Dennis, D.G., and R.E. Chandler. 1974. Waterfowl use of the Ontario shorelines of the southern Great Lakes during migration. In H. Boyd (ed.) Canadian Wildlife Service Waterfowl Studies in Eastern Canada, 1969-73. Canadian Wildlife Service Report Series Number 29.

Total waterfowl days and waterfowl days per acre for various sections of the southern Ontario Great Lakes shoreline were calculated for certain species and subgroups of waterfowl including Mallard (*Anas platyrhynchos*), Black Duck (*A. rubripes*), other dabbling ducks, Canvasback (*Aythya valisineria*) Redhead (*Aythya americana*), Greater and Lesser Scaups (*Aythya marila* and *A. affinis*), mergansers, sea ducks (including scoters, eiders and Oldsquaws (*Clangula hyemalis*), other diving ducks, and geese and swans.

The Canadian Wildlife Service obtained the data from aerial surveys during spring and autumn migration periods from 1968 to 1973. The effects of hunting pressure, artificial feeding areas, sanctuary areas and disturbance by power boats that modify waterfowl use of the various areas are discussed.

The marshes of Long Point, Lake St. Clair and the Detroit River are the most extensively and intensively used by waterfowl, and contain much valuable habitat that could be destroyed by people. The marshes of Prince Edward County, Rondeau Bay, The Grand River and Point Pelee vicinity are less important, but still valuable and subject to damage from human activities.

Dennis, D.G., G.B. McCullough, N.R. North, and R.K. Ross. 1984. An updated assessment of migrant

waterfowl use of the Ontario shorelines of the southern Great Lakes. In: S.G. Curtis, D.G. Dennis, and H. Boyd (eds.). Waterfowl studies in Ontario, 1973-81. Canadian Wildlife Service Occasional Paper No. 54. pp. 37-42.

Information from aerial surveys made between 1974 and 1981 to assess waterfowl staging areas along the southern Great Lakes is presented here as revisions and additions to earlier work done by the Canadian Wildlife Service. The results of these recent surveys show that the marshes of Long Point, Lake St. Clair, Prince Edward County, and the Detroit River continue to be the areas most extensively used by waterfowl, and that they contain much important and vulnerable habitat. The marshes of Rondeau Bay and the Grand River are less heavily used, but still merit some form of protection. Some other areas with little marsh habitat, such as the east and west ends of Lake Erie, Outer Long Point Bay, the Niagara River, and the Toronto waterfront, are frequented by large concentrations of waterfowl at certain times of the year. These areas must be closely monitored for environmental mishaps such as oil spills so that appropriate action to eliminate or alleviate damage can be taken.

Dennis, D.G., K.I. Fischer, and G.B. McCullough. 1984. The change in status of Mallards and Black Ducks in southwestern Ontario. In: S.G. Curtis, D.G. Dennis, and H. Boyd (eds.). Waterfowl studies in Ontario, 1973-81. Canadian Wildlife Service Occasional Paper No. 54.

Waterfowl hunting club data for southern Ontario for the period 1941 to 1973 were analysed to document the timing and the relative rates of change in the populations of Mallards and Black Ducks. In 1941, the proportion of Mallards killed per Black Duck was 0.5 or less throughout the hunting season; in 1973, in excess of four Mallards per Black Duck were taken early in the season and between two and three in the mid and late season. Annual variation may be a result of relative production of each species but long term trends may be related to increased areas of corn, harvesting techniques, and the establishment of field feeding traditions by the two species. Field feeding increases Mallard and Black Duck contacts during the time of pair formation and has resulted in hybridization of the two species and the subsequent loss of some Black Duck populations.

Dennis, D.G., G.B. McCullough, N.R. North, and B. Collins. 1989. Surveys of breeding waterfowl in southern Ontario, 1971-87. Canadian Wildlife Service Progress Note No. 180.

The Canadian Wildlife Service (CWS) began surveys of breeding waterfowl in southern Ontario in 1951. Early surveys (e g., Stirrett 1952) were largely exploratory and did not determine what was happening to duck populations or segments of duck populations. Those surveys, for the most part, covered wetland units rather than blocks of countryside. However, surveys that cover blocks of countryside are especially important in areas such as Ontario, because of varied habitat types and conditions across the province and because much of the population of many duck species is produced in beaver ponds, a transient but extremely important production habitat.

As reported in Dennis (1974), CWS began operational surveys in Ontario south of latitude 46°15' N in 1971. These were designed to yield a valid breeding–pair index for certain species, and thus provide a benchmark against which to measure trends in population. The purpose of this paper is to discuss these surveys and the trends in the populations of several species of waterfowl between 1971 and 1987.

Dewey, K. 1981. Fish inventory, hydrographic mapping, biolimnological sampling, bird, reptile, amphibian, and large mammal utilization of six island ponds in Gravelly Bay area of Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Dindal, D.L. 1967. Kinetics of Cl-36 DDT in wild waterfowl. Ph.D. Dissertation, The Ohio State University, Columbus, Ohio.

Dow, D.D. 1967. Aerial observations of large concentrations of diving ducks at Long Point, Ontario. Unpublished Report to University of Western Ontario, London, Ontario.

Dolbeer, R.A., G.E. Bernhardt. 1986. Early-winter population trends of gulls on western Lake Erie, 1950-1984. American Birds 40(4): 1097-1102.

Dolbeer, R.A., P.P. Woronecki, T.W. Seamans, B.N. Buckingham, and E.C. Cleary. 1990. Herring Gulls, *Larus argentatus*, nesting on Sandusky Bay, Lake Erie, 1989. Ohio Journal of Science 90(3): 87-89.

One of the largest Herring Gull (*Larus argentatus*) nesting populations on the Great Lakes is located in an urban setting on Sandusky Bay in the Ohio portion of Lake Erie. The survey reported here, carried out in 1989, indicated a population of 4,250 nests. The population has expanded from a focal point on Turning Point Island to coal piles at the Lower Lake Dock Company, rooftops in downtown Sandusky and breakwalls near Cedar Point. Comparison with data from a survey performed in 1976 indicates the population has grown at an average annual rate of 11.9% during the past 13 years. The population may now be expanding into suboptimal nesting areas.

Dufour, K.W., and C.D. Ankney. (submitted). Hunting vulnerability of Mallards in relation to diurnal activity, flocking behavior, and individual condition. Wildlife Biology.

We assessed diurnal variation in the number of Mallards shot by hunters at Long Point, Ontario, during the 1989 hunting season to determine peak periods of Mallard activity and to test the prediction that ducks shot during non–peak periods would be in poor relative condition. We also sought to determine whether lone Mallards are disproportionately vulnerable to hunting and whether ducks that are shot as singles are in poor condition relative to those shot from flocks. Diurnal variation in size of the harvest was pronounced, with peak harvest occurring during the first third of the day. Relatively few ducks were shot at mid–day, suggesting that Mallards were largely inactive at this time. Analysis of abdominal fat masses, however, revealed no relation between individual condition and time shot. Single Mallards were apparently more vulnerable to hunting than were those occurring in flocks, as the hunter–shot sample contained a high proportion of lone birds relative to an expected frequency based on observational data. However, we found no evidence of a relation between individual condition and status (i.e., alone vs. in a flock) at the time of harvest. Our results suggest that both diurnal activity and flocking behaviour may influence hunting vulnerability among Mallards and furthermore that these relations can occur independently of individual condition.

Dunn, E.H. 1979. Nesting biology and development of young in Ontario Black Terns. Canadian Field-Naturalist 93(3): 276-281.

Habitat, nesting substrate, egg characteristics, and growth are described for Black Terns (*Childonias niger*) nesting on Lake Erie. Black Terns prefer moderate density of emergent vegetation (mainly Typha) in about 1 m of water, adjacent to open water, and return to the same nest site or area as long as it is suitable. Egg and growth characteristics are similar to those for other temperate–nesting tern species. Minnows form a good portion of the biomass consumed by chicks in this area.

Dunn, E.H., J. Siderius, and D.J.T. Hussell. 1981. A census of Great Blue Herons in Ontario: 1980 and 1981. Unpublished Report to Canadian Wildlife Service, London, Ontario.

A census of Great Blue Heron colonies in Ontario was undertaken in 1980 and 1981 in order to 1) determine population size of Great Blue Herons in selected sample areas and 2) develop methods and experience in the utilization of volunteers in wide–scale censussing of nesting birds. The Long Point Bird Observatory co–ordinated the volunteer census, with support from the Ontario Ministry of

Natural Resources and the Ontario Region of the Canadian Wildlife Service.

Three sample areas were chosen, which currently contain 83 active colonies. Of these, 84% were censussed and 98% were either censussed or had an estimate of size made by a visitor to the site. The sample areas are thought to support 4,583 nesting pairs, or 35% of the estimated total population in the province. The sample areas are considered suitable for future censussing in order to detect long–term trends in the population size of Great Blue Herons.

Volunteers made 73% of all censussing trips. Most were enthusiastic and reliable, and there is no evidence that herons were disturbed by the censussing method. Difficulties arise in determining the degree of counting error, and further research on this is recommended. The volunteer census is considered preferable, however, both to censussing with paid staff and to censussing from airplanes. The method should be useful for other conspicuous species which would not be disturbed by a short visit to the nesting site.

Eadie, J.M., T.D. Nudds, and C.D. Ankney. 1979. Quantifying interspecific variation in foraging behavior of syntopic *Anas* (Anatidae). Canadian Journal of Zoology 57: 412-415.

Foraging behaviour of six *Anas* species was studied during autumn at Long Point Bay, southwestern Ontario. Data were collected using Cody's technique, but statistical analyses identified significant differences among species that could not be discerned from qualitative examination of foraging– behaviour curves alone. A relationship between similarity in body size and dissimilarity of foraging behaviour was observed.

Ellenton, J.A., and M.F. McPherson. 1983. Mutagenicity studies on Herring Gulls from different locations on the Great Lakes. I. Sister chromatid exchange rates in Herring-Gull embryos. Journal of Toxicology and Environmental Health 12: 317-324.

Unincubated Herring Gull (*Larus argentatus*) eggs were collected from five colonies on the Great Lakes Basin and from one relatively pollutant–clean colony on the Atlantic coast. Eggs were incubated at 38°C with 55% relative humidity, and sister chromatid exchange (SCE) levels were measured in 7–d embryos. For all the colonies, the average SCE/chromosome frequency ranged from 0.069 to 0.101; however, no significant differences were found. Organochlorine analysis was carried out on egg homogenates for each colony, to determine the levels of several contaminants. There were no relationships found between any of the contaminant levels and the SCE frequencies. The study indicates that either the contaminants present in the Herring Gull eggs are not having any genetic effects on the embryos or, alternatively, that there may be genetic damage that measurement of SCEs in the 7–d embryo is unable to detect.

Ellenton, J.A., and M.F. McPherson. 1983. Mutagenicity studies on Herring Gulls from different locations on the Great Lakes. II Mutagenic evaluation of extracts of Herring Gull eggs in a battery of *in vitro* mammalian and microbial tests. Journal of Toxicology and Environmental Health 12: 325-336.

Herring Gull (*Larus argentatus*) eggs were collected from five locations on the Great Lakes and from one colony on the Atlantic coast for organochlorine analysis and mutagenesis testing. The Great Lakes colonies were chosen for their different contaminant levels, while the Atlantic coast colony was used as a relatively clean control. The eggs were homogenized and extracted, and the extracts were tested in the Salmonella/mammalian microsome assay for induction of point mutations and in Chinese hamster ovary (CHO) cells for the induction of sister chromated exchanges (SCEs) and chromosome aberrations. None of the extracts was mutagenic in Salmonella, either in the presence or absence of metabolic activation. However, all of the extracts, including the clean control, caused significant increases in both the SCE rate and in the number of chromosome aberrations in the CHO cells. There was no apparent relationship between contaminant levels and the magnitude of these responses or the doses at which they occurred,

although the chemical analysis indicated a wide range in the concentrations of the different organochlorides present.

Ellenton, J.A., L.J. Brownlee, and B.R. Hollerbone. 1985. Aryl hydrocarbon hydroxylase levels in Herring Gull embryos from different locations on the Great Lakes. Environmental Toxicology and Chemistry 4: 615-622.

Aryl hydrocarbon hydroxylase (AHH levels were measured in the livers of Herring Gull (*Larus argentatus*) embryos to determine if monooxygenase activity in this species could be used as a "bioeffects" monitor of environmental contamination. Herring Gull eggs were collected in 1981 from five locations on the Great Lakes Basin and from one clean colony on the Atlantic coast. Microsomal protein determinations and AHH assays were conducted on livers from the embryos at 20 and 25 d of incubation. Organochlorines (DDE, DDT, tetrachlorobenzene, pentachlorobenzene, hexachlorobenzene, heptachlor eopxide, chlordane, dieldrin, mirex, photomirex, polychlorinated biphenyls and 2,3,7,8–tetrachlorodibenzo–p–dioxin) were also measured in egg homogenates from each colony. The 25–d embryos were found to be the most suitable for AHH analysis, since they had a higher baseline level and a greater response than did the 20–d embryos. Specimens from two of the Great Lakes colonies had significantly higher AHH activities than was found for the Atlantic coast colony. These levels of AHH activity closely paralleled the concentrations of 2,3,7,8–tetrachlorodibenzo–p–dioxin present in eggs gathered from the colonies in 1980. Further work regarding monooxygenase levels in Herring Gull embryos is discussed.

Enright, L., and R.W. Knapton. 1993. Are there too many Mute Swans? Long Point Bird Observatory Newsletter 25: 1.

Enright, L.., and R.W. Knapton. (submitted). Genetics and relative frequency of the White-morph in a feral breeding population of Mute Swans at Long Point, Lake Erie, Ontario. Wilson Bulletin.

Ewins, P.J., and B. Hennessey. 1992. Great Blue Herons, *Ardea herodias* , feeding at a fishing vessel offshore in Lake Erie. Candian Field-Naturalist 106(4): 521-522.

The Great Blue Herons were seen feeding on fish 15 km from the shoreline of Lake Erie, in the vicinity of a fishing vessel hauling its nets. These birds swooped down and picked up fish from near the water surface, in a manner described previously for some heron species as "dipping". Our observations constitute the first published account for the species of this foraging method and foraging in association with a fishing vessel in open water.

Ewins, P.J., D.V. Weseloh, J.H. Groom, R.Z. Dobos, and P. Mineau. 1994. The diet of Herring Gulls (*Larus argentatus*) during winter and early spring on the Lower Great Lakes. Hydrobiologica 279/280: 39-55.

In the Great Lakes, the Herring Gull (*Larus argentatus*) is a prominent member of the aquatic bird community, and has been used to monitor spatial and temporal trends in contaminant levels. To understand more fully contaminant loading outside the breeding season, we analyzed the contents of 1298 freshly regurgitated pellets and 179 fresh faeces, collected in March and early April 1978–83, and between late December and late February 1990–91, from the vicinity of breeding colonies in Lakes Ontario and Erie, the Niagara River, Detroit River, and south–eastern parts of Lake Huron. Most adult Herring Gulls from the Great Lakes population winter in these areas, but there is no published account of their food habits other than during the breeding season. Most pellets from colonies close to large urban centres contained remains of garbage, as well as various fish species. Small mammals, notably Deer Mice (*Peromyscus maniculatus*) dominated the early spring diet at Lake Huron colonies near agricultural areas. At all other sites fish predominated in pellets and faeces, but garbage items were also recorded regularly. The species of fish consumed varied regionally, probably reflecting local availability. In Lake Ontario, rainbow smelt (*Osmerus*

mordax) and alewife (*Alosa pseudoharengus*) occurred most frequently in samples, whereas freshwater drum (*Aplodinotus grunniens*) was the main fish prey in Lake Erie and the Detroit River. Dietary differences were apparent between years, within seasons, and amongst areas. While these may have reflected some real differences in food availability, interpretation of these results was confounded by various biases inherent in the sampling of pellets and faeces to determine diet in such an opportunistic species. Therefore, it would be unwise to draw rigid conclusions as to regional or seasonal differences in the diets of piscivorous birds, based upon analyses of diet from only a small sample of sites or years. Herring Gulls appear to feed mainly on fish and garbage in winter and early spring on the lower Great Lakes (much as during the breeding season), but any locally abundant food source is probably exploited opportunistically.

Ewins, P.J. D. Best, M. Candel, and M. Shieldcastle. (in prep). Population trends, reproduction and diet of colonial fish-eating birds breeding in Canadian and U.S. waters of Lake Erie in 1994. Technical Report, Canadian Wildlife Service, Ontario Region.

Fetterolf, P.M., H. Blokpoel, P. Mineau, and G. Tessier. 1984. Incidence, clustering, and egg fertility of larger than normal clutches in Great Lakes Ring-billed Gulls. Journal of Field Ornithology 55(1): 81-88.

Field, M.H. 1966. Banding of Blue-winged Teal at Long Point, Ontario, 1963. Ontario Bird Banding 1(1): 45-51.

Fitzpatrick, M.D. 1979. Marsh Hawk drowns Common Gallinule. American Birds 33(6).

Foley, R.E., and G.R. Batcheller. 1988. Organochlorine contaminants in Common Goldeneye wintering on the Niagara River. Journal of Wildlife Management 52(3): 441-445.

We collected adult male Common Goldeneye (*Bucephala clangula*) near their time of arrival on wintering grounds (Nov–Dec) (n = 26) and just prior to spring migration (Feb–Mar) (n = 24) from the Upper Niagara River (UNR), New York, to identify and measure organochlorine contaminants in fat tissues. Detectable concentrations of polychlorinated biphenyl (PCB), dichlorodiphenyldichloroethylene (DDE), dieldrin, hexachlorobenzene (HCB), oxychlordane, and heptachlor epoxide (HE) were found in all adult birds. Polychlorinated biphenyl, dieldrin, HCB, and HE increased ($P < 0.05$) in adults between the 2 sample periods. In a group of hatching–year (HY) birds sampled in November–December (n = 27), organochlorine residues were less than those of adults from the same period ($P < 0.00$)1 Contaminants known to occur in prey items (e.g., crustaceans, gastropods, insects, pelecypods, fish, and annelids) are probably the major source of exposure for common goldeneye on the Niagara River.

Forsyth, D.S., and W.D. Marshall. 1986. Ionic alkylleads in Herring Gulls from the Great Lakes region. Environmental Science and Technology 20: 1033-1038.

Herring Gull (*Larus argentatus*) tissues, collected from various breeding colonies in the Great Lakes, were examined to determine alkyllead levels and possible alkyllead sources into the Great Lakes region. Ionic trialkyl– and dialkyllead species ($R3Pb+$,$R2Pb2+$; R = Me, Et) were quantitated by gas chromatography–atomic absorption spectrometry. The extraction procedure was tested at trace levels (3–4 ppb as Pb) with four Domestic Chicken (*Gallus domesticus*) tissues. Trimethyllead was found in two avian species and all examined tissues. Methyllead levels frequently exceeded ethyllead levels with no direct automotive source. Correlation between alkyllead levels in Herring Gull tissue and lake sediment lead levels suggests possible methylation but not ethylation of inorganic lead. The methyllead concentration trend in gull tissues, Lake Ontario > Lake Huron = Lake Erie > Lake Superior, was opposite to the ethyllead concentration trend, Lake Superior > Lake Huron > Lake Erie = Lake Ontario.

Fox, G.A. 1993. What have biomarkers told us about the effects of contaminants on the health of fish-eating birds in the Great Lakes? The theory and a literature review. Journal of Great Lakes Research 19(4): 722-736.

The molecular, biochemical, and cellular precursors to disease are common to wildlife and humans. Colonial fish–eating birds have been used as convenient sentinel biological systems for detection and monitoring of the effects of chronic exposure to complex mixtures of persistent toxic environmental contaminants within the Great Lakes ecosystem. Studies of impairments to health using such biomarkers as induction of mixed function oxidases, alterations in heme biosynthesis, retinol homeostasis, thyroid function and DNA integrity and various manifestation of reproductive and development toxicity in these birds suggests the severity varies with time and location and generally decreased between the early 1970s and late 1980s. However, these studies confirm the continued presence of sufficient amounts of PCBs and related persistent halogenated aromatic hydrocarbons in forage fish to cause physiological impairments in these birds over much of the Great Lakes basin. The elimination of such impairments will be a measures our success in remediation of Areas of Concern and "virtual elimination" of persistent polyhalogenated aromatic hydrocarbon contaminants from the Great Lakes ecosystem.

Fox, G.A., and R.D. Moccia. (no date). Thyroid funtion in Great Lakes Herring Gulls. Unpublished report to Canadian Wildlife Service, Ottawa, Ontario.

Fox, G.A., A.P. Gilman, D.J. Hallett, R.J. Norstrom, F.I. Onuska, and D.B. Peakall. 1975. Herring Gull productivity and toxic chemicals in the Great Lakes in 1975. Canadian Wildlife Service Manuscript Report, Ottawa, Ontario.

The Herring Gull is a long–lived predator with catholic feeding habits. As such it reflects the health of the whole lake ecosystem to a greater degree than species lower in the food chain. Our studies in 1975 revealed almost total reproductive failure in Lake Ontario in contrast to normal reproductive success in the other Canadian Great Lakes. Sixteen organochlorine compounds (including seven not previously reported) and fourteen polynuclear aromatic compounds (including several known carcinogens) were identified in the tissues of Herring Gulls. The levels of several organochlorines were quantified in eggs from eight colonies throughout the Canadian Great Lakes.

Within the vertebrates, the basic metabolic pathways and their controlling substances are remarkably similar. The existance of pollutant levels in Herring Gulls causing both embryotoxic and behavioural alterations sufficient to cause almost total reproductive failure is a matter of concern. Future work will be directed towards identifying the compound(s) causing these effects and quantifying them in the Lake ecosystem.

Fox, G.A., and D.V. Weseloh. 1987. Colonial waterbirds as bio-indicators of environmental contaminants in the Great Lakes. International Council for Bird Protection. Technical Publication No.6, 209-216.

We have found the eggs of colonial waterbirds to be a convenient medium in which to monitor temporal and spatial trends in environmental contaminant levels in the Great Lakes. A monitoring programme, using Herring Gull (*Larus argentatus*) eggs, was established in 1973 to support the Canada–United States Agreement on Great Lakes Water Quality. This programme has allowed managers to assess the effects of remedial measures and has been responsible for the identification of dioxins and many other important microcontaminants within the Great Lakes ecosystem.

Since fish–eating birds and man share a common food resource, environmental factors affecting the welfare of populations of these birds have the potential for impacts on the welfare of man. We have used these colonial birds as convenient model populations in which to study the impact of chronic exposure to complex mixtures of persistent lipophilic environmental contaminants. We

have studied eggshell thinning, embryotoxicity, teratogenicity, genotoxicity, behavioural toxicity and demography in one or more species in the Great Lakes basin. We believe such manifestation of target organ toxicity as thyroid hyperplasia, hepatic porphyria, and mixed function oxidase induction show promise as health effects monitors for the Great Lakes ecosystem.

Fox, G.A., S.W. Kennedy, R.J. Norstrom, and D.C. Wigfield. 1988. Porphyria in Herring Gulls: A biochemical response to chemical contaminants of Great Lakes food chains. Environmental Toxicology and Chemistry 7: 831-839.

Concentrations of highly carboxylated porphyrins (HCPs) in the livers of adult Herring Gulls (*Larus argentatus*) from colonies throughout the Great Lakes were found to be markedly elevated in comparison with those gulls from coastal areas and in seven other species of birds consuming diets uncontaminated with polyhalogenated aromatic hydrocarbons (PHAHs). The highest levels were found in gulls from lower Green Bay (Lake Michigan), Saginaw Bay (Lake Huron) and Lake Ontario. We suggest that the high levels of HCPs reflect PHAH–induced derangement of heme biosynthesis. Determination of HCPs offers promise as a specific and sensitive biological marker of PHAH–induced toxicity and as a measure of the toxicological significance of the chemical burden in gulls, terminal members of Great Lakes food chains.

Fox, G.A., L.J. Allan, D.V. Weseloh, and P. Mineau. 1990. The diet of Herring Gulls during the nesting period in Canadian waters of the Great Lakes. Canadian Journal of Zoology 68: 1075-1085.

We report the content of 132 boli and 2000 pellets regurgitated by adults and 1749 boli regurgitated for or by chicks in 25 Herring Gull (*Larus argentatus*) colonies in Lakes Ontario, Erie, Huron and Superior, between mid–April and mid–July, 1977–1983. Fish were the predominant food in all four lakes. Although 11 families of fish and a minimum of 16 species were identified, 80% of the fish were of two exotic species, the alewife (*Alosa pseudoharengus*) and the rainbow smelt (*Osmerus mordax*). The dietary importance of these two fish species reflected their relative abundance within a lake. In addition, representatives of eight orders of insects and 11 families of birds were identified. In one colony where diets of birds of known sex were quantified, male and female gulls fed on different proportions of alewife and smelt, suggesting the sexes have different foraging strategies. Although some food was scavenged, most was obtained alive. Dietary differences existed between colonies and between lakes, both within and between years. We suggest that diet, contaminant burden, and population size of Great Lakes Herring Gulls will be affected by fisheries policies which alter the predator–prey dynamics of this exotic–dominated ecosystem.

Fox, G.A., B. Collins, E. Hayakawa, D.V. Weseloh, J.P. Ludwig, T.J. Kubiak, and T.C. Erdman. 1991. Reproductive outcomes in colonial fish-eating birds: A biomarker for developmental toxicants in the Great Lakes food chains. II. Spatial variation in the occurrence and prevalence of bill defects in young Double-crested Cormorants in the Great Lakes, 1979-1987. Journal of Great Lakes Research 17(2): 158-167.

Congenital malformations are relatively uncommon in most wild bird populations. Here we document the occurrence of bill malformations in Double–crested Cormorant (*Phalacrocorax auritus*) chicks from colonies in Green Bay and elsewhere in the Great Lakes and in reference areas off the Great Lakes, in the years 1979 through 1987. In the Great Lakes, 31,168 cormorant chicks were examined during 14 visits to 42 colonies. Seventy of these chicks had crossed or deflected bills or bills in which the mandibles differed in length. Only two of the 20,962 chicks examined during 82 visits to 35 colonies in reference areas located in the prairies and northwestern Ontario had bill defects. The probability of observing a malformed chick on a visit to a colony in Green Bay was 10 to 32 times greater than on a visit to a colony in the reference areas. Bill defects were observed at only two (6%) of the colonies in the reference areas. This proportion was exceeded in six of eight geographic regions within the Great Lakes and was highest (73%) in Green

Bay colonies. The prevalence of malformed chicks in Green Bay (52.1 per 10,000) was markedly greater than in all other regions during this period. These bill defects are an example of development asymmetry and are an indicator of developmental stability within local populations. Other investigations in Lake Michigan suggest that chemicals such as polyhalogenated aromatic hydrocarbons (e.g., PCBs) that induce aryl hydrocarbon hydroxylase are responsible for the observed defects.

Fox, G.A., D.V. Weseloh, T.J. Kubiak, and T.C. Erdman. 1991. Reproductive outcomes in colonial fish-eating birds: A biomarker for developmental toxicants in Great Lakes food chains. I. Historical and ecotoxicological perspectives. Journal of Great Lakes Research 17(2): 153-157.

Colonial fish–eating birds have been used as convenient model populations in which to study the impact of chronic exposure to complex mixtures of persistent lipophilic environmental contaminants within the Great Lakes ecosystem. To date, published reports of contaminant–induced adverse reproductive outcomes exist for six species. We briefly review the studies of the Herring Gull (*Larus argentatus*), Forster's Tern (*Sterna forsteri*), and the Double–crested Cormorant (*Phalacrocorax auritus*) to illustrate the use of reproductive outcomes in fish–eating birds as a biomarker for developmental toxicants in Great Lakes food chains. We discuss the management implications of using various species for such purposes. We recommend that cormorants be used more extensively in biomonitoring programs to measure exposure and effects of polyhalogenated aromatic hydrocarbons and other contaminants in aquatic food chains in the Great Lakes.

Fox, G.A., M. Gilbertson, A.P. Gilman, T.J. Kubiak. 1991. A rationale for the use of colonial fish-eating birds to monitor the presence of developmental toxicants in Great Lakes fish. Journal of Great Lakes Research 17(2): 151-152.

Fox, G.A., B. Collins, T.J. Kubiak, J.P. Ludwig, D.V. Weseloh, and T.C. Erdman. (in prep). Bill defects in young Double-crested Cormorants in the Great Lakes. I: Historical background and occurrence, 1979-1987.

Fox, W.H. 1968. Blue-winged Teal banding and recovery: Long Point Provincial Park. Ontario Bird Banding 4: 42-49.

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. Archives of Environmental Contamination and Toxicology 25: 234-243.

Organochlorine analysis was performed on adult and juvenile farm–raised Mallards (*Anas platyrhynchos*) released and collected at three experimental sites in southern Ontario: Hamilton Harbour Confined Disposal Facility (CDF); Winona Sewage Lagoons (SL); and Big Creek Marsh, Canada. Collections were scheduled at 10, 30, and 70 days after release. Hamilton Harbour CDF and Winona SL are known to be contaminated whereas Big Creek Marsh is a relatively clean, natural site. All sites are important resting and feeding areas for migratory and resident waterfowl. Breast muscle concentrations of polychlorobiphenyls (PCBs) in ducks collected 10 days after release (160.8 ug/kg, wet wt) at Hamilton Harbour CDF were more than 5300 times greater than day "0" birds (0.03 ug/kg). All ducks collected from Hamilton Harbour CDF had PCB concentrations exceeding Health and Welfare Canada and United States Food and Drug Administration (FDA) guidelines for edible poultry. Concentrations of DDE (216.9 ug/kg), hexachlorobenzene (0.9 ug/kg), dieldrin (1.9 ug/kg), and 1,2,4,5,–tetrachlorobenzene (24.9 ug/kg) were significantly elevated in ducks utilizing Winona SL. Concentrations of 1,2,3,4–tetrachlorobenzene, mirex, and photomirex were elevated at one or more of the sites. Ducks from Big Creek Marsh had lower contaminant concentrations than ducks from the other study sites. It is not clear whether bioaccumulation of organochlorines at these sites would pose a potential hazard to migratory and resident Mallards; however, other duck species such as diving

ducks that have more contact with sediments and sediment–derived foods would probably be at much higher risk.

Gilbertson, M. 1974. Pollutants in breeding Herring Gulls in the Lower Great Lakes. The Canadian Field-Naturalist. 88: 273-280.

Severe reproductive failures have occurred in Lake Ontario colonies of Herring Gulls. The reproductive failures were characterized by poor hatchability of the eggshell breakages and flaking. Eggs which were analyzed for organochlorine substances showed severe contaminantion with DDE and PCB. Eggshell thinning was found in all the colonies studied in the lower Great Lakes but was greatest in Lake Ontario and was correlated with the content of DDE in the eggs.

Gilbertson, M. 1975. A Great Lakes tragedy. Nature Canada 4(1): 22-25.

Gilbertson, M. 1983. Etiology of chick edema disease in Herring Gulls in the Lower Great Lakes. Chemosphere 12(3) 357-370.

Severe reproductive failure among fish–feeding birds on the lower Great Lakes was investigated in the early 1970s. Examination of Lake Ontario and Lake Erie Herring Gull chicks at hatching showed signs consistent with chick edema disease and thus with the presence of a chick edema factor. Subsequent microcontaminant analysis of stored eggs revealed the presence of 2,3,7,8–TCDD at concentrations that could account for the poor reproductive success and the signs of chick edema disease.

Gilbertson, M. 1988. Epidemics in birds and mammals caused by chemicals in the Great Lakes. In: Toxic Contaminants and Ecosystem Health: A Great Lakes focus. M.S. Evans (Ed.).

Gilbertson, M. 1988. Restoring the Great Lakes - Means And Ends. Canadian Field-Naturalist 102(3): 555-557.

Gilbertson, M., R.D. Morris, and R.A. Hunter. 1976. Abnormal chicks and PCB residue levels in eggs of colonial birds on the lower Great Lakes (1971-73). Auk 93: 434-442.

Gilbertson, M., and G.A. Fox. 1977. Pollutant-associated embryonic mortality of Great Lakes Herring Gulls. Environmental Pollution 12: 211-216.

Many embryos in recent nestings of Herring Gulls on Lake Ontario died prior to hatching. Signs associated with this embryonic mortality include enlarged livers, reduced embryo size, prophyria and accumulations of a subcutaneous muco–serous field in some embryos. These signs may be related to the widespread organochlorine pollutants DDE, dieldrin, hexachlorobenzene and PCBs.

Gilbertson, M., T. Kubiak, J. Ludwig, and G. Fox. 1991. Great Lakes embryo mortality, edema, and deformities syndrome (GLEMEDS) in colonial fish-eating birds: Similarity to chick-edema disease. Journal of Environmental Health 33: 455-520.

Several species of colonial, fish–eating birds nesting in the Great Lakes basin, including Herring Gulls, Common Terns and Double–crested Cormorants, have exhibited chronic impairment of reproduction. In addition to eggshell thinning caused by high levels of DDT and metabolites, the reproductive impairment is characterized by high embryonic and chick mortality, edema, growth retardation and deformities, hence the name Great Lakes embryo mortality, edema and deformities syndrome (GLEMEDS). The hypothesis has been advanced that GLEMEDS in colonial, fish–eating birds resembles chick–edema disease and has been caused by exposure to chick–edema active compounds that have a common mode of action through the cytochrome P448 system.

Detailed evidence has been collected from the following three groups of studies on: Herring Gulls in the lower Great Lakes during the early 1970s; Forster's Terns in Green Bay, Wisconsin in 1983; and Double–crested Cormorants and Caspian Terns in various locations in the upper Great Lakes from 1986 onwards.

It has proved difficult to establish not only the onset of the disease in the various species at various locations but also the period in which chick–edema active compounds were released. Anecdotal evidence suggested that serious egg mortality in Lake Ontario Herring Gulls first occurred in 1966, though the signs of chick–edema disease were not looked for until 1974. Only indirect evidence is available on the date of the release of the presumed causal agent, 2,3,7,8–tetrachlorodibenzo–p–dioxin, but highest levels may have occurred in the early to mid 1960s. More reliable data shows that the onset of the improvement of reproduction of Lake Ontario Herring Gulls coincided with the declines in organochlorine compounds and particularly 2,3,7,8–TCDD and PCB. Similarly, information on the onset of the disease and exposures in the Forster's Tern and Double–crested Cormorants in Green Bay is uncertain but bird banders did not observe deformities until the 1970s which corresponds with the onset of high levels of PCB. If the disappearance of the Caspian Tern from Saginaw Bay in the mid 1960s corresponds with the onset of GLEMEDS at that location, then there is a close temporal relationship to the onset of high PCB levels.

Chick–edema disease is difficult to diagnose because there is no specific lesion, but rather there is a suite of lesions. GLEMEDS is characterized by an elevated incidence of embryonic and chick mortality, growth retardation and development abnormalities including bill deformities, club feet, missing eyes and defective featherinig, and there is also subcutaneous, pericardial and peritoneal edema, liver enlargement, liver necrosis and porphyria. These signs conform to the known symptoms of chick– edema disease. A variety of chick–edema active compounds including non–ortho substituted PCBs and dibenzo–p–dioxins and furans substituted at the lateral positions, produce chick–edema disease. The active compounds have specific conformational requirements.

In considering evidence on the strength of association, the embryos and chicks of herring gulls from Lake Ontario and Forster's terns from Green Bay had a significant increase in the incidence of the lesions compared to the reference colonies. Similarly, the incidence of bill abnormalities was significantly elevated in Great Lakes colonies of Double–crested Cormorants particularly for Green Bay, Wisconsin. There was a significant dose–response relationship between the incidence of embryonic mortality in cormorant eggs and the presence of chick–edema active compounds expressed in 2,3,7,8– TCDD equivalences.

There is a high degree of consistency on replication. The disease has been found in a variety of species in a variety of locations, by different observers using different study designs. Outbreaks of the disease have occurred at different times and seem only to be related to exposures of developing embryos to high levels of chick–edema active compounds.

The new facts, that embryos and chicks of colonial, fish–eating birds can exhibit chick–edema disease when exposed to chick–edema active compounds, cohere with existing biological theory, experience and experimentation. There are plausible routes of exposure and sources of these compounds to the Great Lakes and statistically significant dose–response relationships have been demonstrated.

Gilman, A.P., G.A. Fox, D.B. Peakall, S.M. Teeple, T.R. Carroll, and G.T. Haymes. 1977. Reproductive parameters and egg contaminant levels of Great Lakes Herring Gulls. Journal of Wildlife Management 41(3): 458-468.

Poor reproductive success and declines in colony size of Herring Gulls (*Larus argentatus*) have occured in Lake Ontario at a time that dramatic increases of this species have been reported on the

Atlantic seaboard. In 1975 Herring Gull productivity on Scotch Bonnet Island, Lake Ontario, was 0.15 chicks per pair of adults, one–tenth the productivity of colonies studied on Lake Erie, Huron and Superior. Reduced nest site defense and decreases in eggs found, egg hatchability and chick survival were observed in the Lake Ontario colony. The major causes of egg failure were disappearance and embryonic death. Hatching success of Lake Ontario eggs by artificial incubation was 23–26 percent compared to 53–79 percent for eggs from other areas. Analyses of eggs from 9 gull colonies for organochlorine contaminants indicated that the pattern of relative contamination was Lakes Ontario > Michigan > Superior > Huron > Erie. Mirex levels were nearly 10 times higher in Lake Ontario than in the other lakes. Movements of Herring Gulls within the Great Lakes basin are offered as an explanation of variation in individual egg residues in each colony and the moderately high levels of chemical residues in some Lake Superior eggs.

Gilman, A.P., D.B. Peakall, D.J. Hallett, G.A. Fox, and R.J. Norstrom. 1979. Herring Gulls (*Larus argenta tus*) as monitors of contaminants in the Great Lakes. Animals as Monitors of Environmental Pollution pp 280-289.

The Herring Gull (*Larus argentatus*) is at the top of several food chains. Adults of this species are essentially year–round residents of the Great Lakes. The levels of contaminants found in them are higher than those in other Laridae in the Great Lakes. Their ability to bioaccumulate high loads of persistent contaminants allows investigators to identify compounds that would be difficult to determine in lower trophic levels. Since there are high levels of many contaminants in this species, it is likely that detrimental biological effects will also be found, although the possibility that other species will be more sensitive should be borne in mind.

Chlorinated bydrocarbons and other persistent pollutants accumulate to high levels in gull tissues and are deposited into the eggs. Egg contaminant levels reflect the levels of lake contamination. High levels of PCB's, DDE, and mirex in Lake Ontario Herring Gulls and their association with early embryonic mortality, chick deformity, and aberrant adult behaviour were examined. In an attempt to establish cause–and–effect relationships, relatively uncontaminated gull eggs were injected with organochlorine compounds and incubated naturally. It appears that the major efffects of toxic chemicals or embryonic mortality may be manifested before the eggs are laid. The behavioural and reproductive anomalies described in this paper indicate that the environmental quality of Lake Ontario is unacceptable. We believe that these findings have direct implications for other species, including man.

Hamilton, D.J. 1992. The relationship between two predator groups, diving ducks and fish, and a novel prey item the Zebra Mussel (*Dreissena polymorpha*), in Lake Erie at Point Pelee, Ontario. M.Sc. thesis. The University of Western Ontario, London, Ontario.

Zebra Mussels (*Dreissena polymorpha*) have recently arrived in the Great Lakes of North America, providing a novel and superabundant food source for several species of diving ducks and fish. Ducks in Europe feed heavily on Zebra Mussels, in some cases helping to control mussel density. After Zebra Mussels enter an area, diving ducks alter their diets, making mussels their preferred, and sometimes only, food source. Fish also consume Zebra Mussels in Europe, but no evidence exists to suggest that fish predation reduces the mussel populations.

I examined the relationship betwen potential predators, ducks and fish, and Zebra Mussels in North America, and compared my findings to European studies. I erected predator exclusion cages in Lake Erie at Point Pelee, Ontario, and monitored the impact of predators on mussel populations between May 1991 and May 1992. I combined this with duck gizzard and fish gut contents analyses, duck behavioural observations, and information on recent duck population changes at Point Pelee, to determine whether Zebra Mussels have become an important food source in Lake Erie, and whether predation helps to control mussel populations.

None of the fish I examined contained Zebra Mussels, and fish had no impact on mussel populations. Ducks, however, fed on Zebra Mussels, reducing mussel biomass by 46%. Ducks are size selective predators and altered mussel population structure through predation. Ducks have also altered their migratory patterns, remaining in the Point Pelee area much longer than they did prior to the arrival of Zebra Mussels. I conclude that ducks are tracking the Zebra Mussel population in the Great Lakes, much as they have in Europe, and that in limited areas predators may help to reduce mussel populations. However, long term effective predator based control of Zebra Mussels throughout the Great Lakes is unlikely.

Hamilton, D.J., and C.D. Ankney. 1994. Consumption of Zebra Mussels *Dreissena polymorpha* by diving ducks in Lakes Erie and St.Clair. Wildfowl 45: 159-166.

Zebra Mussels are a novel and abundant prey item for diving ducks in the Laurentian Great Lakes region. We investigated use of Zebra Mussels as food by several species of diving ducks (Greater and Lesser Scaup, Common Goldeneye, Bufflehead, White–winged Scoter and Oldsquaw) in Lakes Erie and St. Clair in 1990 and 1991. We examined 135 gizzards from ducks shot by hunters (fall) and ducks drowned in fishing nets (spring). We noted presence or absence of Zebra Mussels, and estimated lengths of mussels consumed. Mussels were eaten by all species examined and were consumed by ducks at each location. Overall, 52% of gizzards contained Zebra Mussels, including all those from Point Pelee, Ontario. Larger duck species tended to consume larger mussels, but prey sizes taken varied widely among locations. Although diving ducks probably were size–selective predators, they ate mussels from a wide size range. This suggests that at most locations where Zebra Mussels occur, some mussels of an acceptable size will always be present for ducks.

Hamilton, D.J., C.D. Ankney, and R.C. Bailey. 1994. Predation of Zebra Mussels by diving ducks: An enclosure study. Ecology 75(2): 521-531.

Zebra Mussels (*Dreissena polymorpha*) are a novel and abundant potential food source for several species of diving ducks in the Great Lakes region. Using predator exclusion cages, behavioural observations, and analyses of duck gizzard contents, we examined the predator–prey relationship between Zebra Mussels and their duck predators during the fall migratory period in Lake Erie at Point Pelee, Ontario. Diving Ducks feeding on Zebra Mussels in the area reduced mussel biomass by 57% during the period of heaviest feeding, but had no measurable impact on mussel numbers. Birds were size–selective predators, preferentially taking medium and large mussels over the more common small ones, thereby altering the size structure of the mussel population. Ducks were abundant at Point Pelee only during late fall, and differences between cages and control areas had disappeared by the following spring. Overall, ducks had little lasting impact on mussel populations, but mussel abundance may have determined duck concentration in the area. Duck staging populations were higher in 1990, when mussels were more abundant, than in 1991, when mussels were much scarcer. Efffective predator control of Zebra Mussels in the portion of the Great Lakes region that freezes over winter is unlikely becaue diving ducks are unable to overwinter in the area. However, mussels have become an important food source for diving ducks, and temporary reductions of mussel density through predation are likely in areas where ducks feed during migratory period. Similarly, in regions where ducks are resident through winter, greater and longer lasting effects may be observed.

Hanson, A.R. 1987. Lipid dynamics and diets of Black Ducks and Mallards during autumn. M.Sc. thesis. University of Western Ontario, London, Ontario.

A comparison of the diet and lipid dynamics of American Black Ducks (*Anas rubripes*) and Mallards (*A. platyrhynchos*) during autumn was undertaken to provide insight into the reasons for the recent contemporaneous decline of the Black Duck and increase in the Mallard populations of eastern North America.

Data were collected on 350 Black Ducks and 1744 Mallards shot by hunters in southwestern Ontario during the 1986 hunting season (September 24–December 20). Date shot and fresh body weight were recorded, and the head, wing, foot, and viscera were removed and frozen.

Body weight and lipid deposits (weight of mesenteric plus abdominal fat) were compared between the two species. Principal component analysis based on 9 morphometric measurements was used to create PCI, which summarized variation in body size. PCI was used to correct for differences in body weight and lipid depots due to differences in structural size.

I found that adult male and juvenile female Black Ducks had less lipid reserves (body weight, lipid depots) than their Mallard counterparts. I suggest that differences in lipid reserves between Black Ducks and Mallards may be a proximal reason for the lower survival of adult male and juvenile female Black Ducks when compared to their Mallard counterparts and may influence intraspecific and interspecific pair formation.

Diet analyses, based on gizzard contents, suggest that differences in lipid dynamics between the two species were not due to differences in the utilization of grain, vegetation, non–agricultural seeds, or animal matter.

Hanson, A.R., C.D. Ankney, and D.G. Dennis. 1990. Body weight and lipid reserves of American Black Ducks and Mallards during autumn. Canadian Journal of Zoology 68: 2098-2104.

A comparison of body weight and lipid reserves (weights of mesenteric and abdominal fat) of American Black Ducks (*Anas rubripes*) and Mallards (*Anas platyrhynchos*) during autumn was done to provide insight regarding the recent contemporaneous decline in Black Duck and increase in Mallard populations of eastern North America. Data were collected on 350 Black Ducks and 1477 Mallards shot by hunters in southwestern Ontario from September 24 to December 20, 1986. Date shot and fresh body weight were recorded, and the head, a wing, a foot, and the viscera were removed and frozen. Body weight and lipid deposits (weight of mesenteric and abdominal fat) were compared between the two species. The first principal component from an analysis of nine morphometric measurements was used as a covariate in subsequent analysis to remove variation in body weight and lipid deposits caused by differences in structural size. Although all age–sex classes of Mallards and Black Ducks stored lipids during the autumn, adult male and juvenile female Black Ducks stored less lipids than did their Mallard counterparts ($P \leq 0.01$). Differences in lipid reserves during fall migration may be a proximal reason for the lower survival of adult male and juvenile Black Ducks compared with Mallards and may also influence the timing of intraspecific, and the rate of interspecific, pair formation.

Hanson, A.R., and C.D. Ankney. (in press). Morphometric similarity of Mallards and American Black Ducks. Canadian Journal of Zoology.

Morphometric data were collected from 347 American Black Ducks (*Anas rubripes*), and 1466 Mallards (*Anas platyrhynchos*), taken by hunters in the Lake St. Clair and Lake Erie regions of southwestern Ontario during autumn, 1986 and from 511 American Black Ducks shot throughout the province of New Brunswick during the 1988 and 1989 hunting seasons. Discriminant function analyses (DFAs) based on eight external morphometric variables (wing chord, tarsus length, middle toe length, hind toe length, culmen, head length, naris width, and bill width) did not accurately distinguish Black Ducks from Mallards. DFAs had correct classification rates that, averaged over the four age–sex classes, were: 61% for Mallards and 71% for Black Ducks. The highest classification rates were from DFAs of Ontario Black Ducks and New Brunswick Black Ducks that, averaged over the four age–sex classes, were: 74% of Ontario Black Ducks and 80% for New Brunswick Black Ducks. Although our morphometric analyses did not incorporate all morphometric characteristics of Black Ducks and Mallards, they do show that Black Ducks and Mallards are morphometrically very similar.

Hanson, C.H. 1960. A study of the factors influencing nest site selection in Mallard ducks. M.Sc. thesis, The Ohio State University, Columbus, Ohio.

Harvey, G.F. 1904. A visit to the Lake Erie terns. Bird Lore 6(4): 122-129.

Haymes, G.T. 1977. Selected aspects of the breeding biology of two Lake Erie Herring Gull colonies. M.Sc. thesis. Brock University, St.Catharines, Ontario.

Aspects of the breeding biology of two Lake Erie Herring Gull colonies were studied in 1975 and 1976. In 1976 the incubation attention given 2–egg and 3–egg clutches initiated early and late in the season was measured. Brood size at one colony was artificially increased or decreased by addition of chicks shortly after hatching.

Hatching success was not consistently related to clutch size but early nesters were more successful than late nesters. Differences in hatching success between 2–egg and 3–egg clutches were a function of the time of clutch initiation with the clutch size having the greater proportion of its nests initiated early in the season being more successful.

The incubation attentiveness of parents of 2–egg and 3–egg, and early and late clutches was similar. Most nests were incubated greater than 95% of the time although their hatching success was similar to those incubated less than 75% of the time.

Fledging success, chick growth and weight at fledging were similar among broods of one, two and three chicks and artificially increased broods of four and five chicks. Fledging success was highest for one chick broods reduced from two and three chick broods.

Haymes, G.T., and R.D. Morris. 1977. Brood size manipulations in Herring Gulls. Canadian Journal of Zoology. 55: 1762-1766.

Herring Gull broods were artificially increased to four and five chicks while others were reduced to one chick. The growth rates of chicks and chick weights at fledging were similar among all control and experimental broods. The experimentally increased brood sizes had a slightly higher fledging success than control broods, and the fledging success of one–chick experimental broods was higher than that of one–chick control broods. Thus, chick survival was not reduced in larger brood sizes and the number of young fledged per pair of adults increased with brood size. Further, chicks in large broods were at no weight (or viability) disadvantage despite the presence of a larger number of brood mates. We conclude that food was not limiting either the growth rate or fledging success of chicks from broods larger than the modal clutch size, and suggest that parents used local, abundant, artificial food sources in addition to their natural food supply.

Haymes, G.T., and H. Blokpoel. 1978. Seasonal distribution and site tenacity of the Great Lakes Common Terns. Bird-banding 49(2): 142-151.

Banding records were used to study seasonal distribution, emigration from and immigration into the Great Lakes, and intercolony shifts of Great Lakes Common Terns. Adult Common Terns wintered primarily on the mainland of Central and South America whereas juveniles were frequently recovered in Florida and on the Caribbean Islands. Many terns returned to the Great Lakes probably to breed at two years of age and a small number returned the first year after hatching. Common Terns banded as breeding adults were most likely to be found in the same colony in subsequent breeding seasons, whereas those banded in their hatching year were most likely to be found breeding in a different colony. Exchange of breeding birds between colonies on the Atlantic coast and the Great Lakes is rare but exchange among the Great Lakes' colonies is frequent and normally limited to colonies on the same or adjacent lakes. Because of the lack of immigration into

the Great Lakes, loss of habitat and low reproductive success may seriously reduce the numbers of Common Terns on the Great Lakes.

Hebert, C.E., C.A. Bishop, and D.V. Weseloh. 1993. Evaluation of wetland biomonitors for the Great Lakes: A review of contaminant levels and effects in five vertebrate classes. Canadian Wildlife Service Technical Report No. 182, Ontario Region.

The purpose of this review was to identify species which could be used as indicators of wetland contamination. Five vertebrate classes; Osteichthyes (bony fishes), Amphibia (amphibians), Reptilia (reptiles), Aves (birds) and Mammalia (mammals) were included in the review. Within each class, species were compared using seven criteria. These criteria were based upon the characteristics for biomonitors suggested by the International Joint Commission's Ecosystem Objectives Subcommittee. The first four criteria examined our understanding of the biology of the species. No detailed literature review was conducted for these criteria. However, an attempt was made to evaluate them to provide an overall assessment of the species as wetland biomonitors. The remaining three criteria were used to evaluate the availability of information regarding contaminant levels and effects on wetland species. This review focused on the published literature pertinent to these three criteria.

A score was calculated for each species using the seven criteria. Within each class, the species scores were tabulated and the species were ranked. These rankings reflected the relative merits of the individual species as wetland biomonitors. Within the constraints imposed by field studies, i.e. local species availability, the highest scoring species should be the most useful in evaluating contaminant levels and effects in wetlands. These results are summarized at the end of each chapter.

These scores can be used when selecting species to evaluate wetland contamination but they should not be used exclusively. It is unlikely that one species will be able to meet the data requirements of all studies. It is incumbent upon the researcher to choose those species best suited to accomplishing the goals of the study. For example, if the purpose of the research is to examine the extent of sediment contamination in a wetland, then those species associated with benthic food–webs should be selected, regardless of whether other species scored higher in this review. Alternatively, if the intent of the study is to examine the implications of wetland contamination to humans consuming wildlife, then selection of a game species might be warranted. These considerations are endless, thereby precluding any attempt to suggest one species as the "best" wetland biomonitoring species. It is anticipated, however, that this review will provide a rational framework for selecting species as wetland biomonitors and draw attention to some of the work which has already been completed.

Hebert, C.E., R.J. Norstrom, M. Simon, B.M. Braune, D.V. Weseloh, and C.R. Macdonald. 1994. Tempor al trends and sources of PCDDs and PCDFs in the Great Lakes: Herring Gull egg monitoring, 1981-1991. Environmental Science and Technology 28: 1268-1277.

Levels of individual polychlorinated dibenzodioxin (PCDD) congeners were measured in pooled Herring Gull eggs collected from colonies in the Great Lakes and the St. Lawrence River between 1981 and 1991. Polychlorinated dibenzofurans (PCDFs) were quantified from 1984 to 1991. 2,3,7,8–TCDD, 1,2,3,7,8–PnCDD, 1,2,3,6,7,8–HxCDD, and 2,3,4,7,8–PnCDF were detectable in all samples; 1,2,3,4,6,7,8–HpCDD, OCDD, 2,3,7,8–TCDF, 1,2,3,4,7,8–HxDF, and 1,2,3,6,7,8–HxDF were frequently detected. Eggs from Saginaw Bay, Lake Huron, had the highest PCDD/PCDF levels. Levels of TCDD, PnCDD, and HxCDD declined in most colonies between 1981 and 1984. There were no obvious temporal trends after 1984. Using multivariate analyses, colonies were separated into two classes based upon differences in egg bioaccumulation patterns. PCDD and PCDF pattterns in a variety of potential sources were compared to these two Herring Gull classes. Patterns of PCDD accumulation were similar in herring gull eggs, lake trout, and

walleye emphasizing the similarity of these species as regional indicators of PCDD/PCDF contamination.

Herdendorf, C.E., S. Hartley, and M. Barnes. 1981. A summary of knowledge of the fish and wildlife resources of the coastal wetlands of the U.S. Great Lakes. Center for Lake Erie Area Research. Ohio State University, Columbus, Ohio.

Hildebrandt, T.D., and L.D. Fay. 1977. Chemical residues in Herring Gull eggs from the Great Lakes. Michigan Department of Natural Resources, Wildlife Division, Report 2766.

Hince, G.T. 1986. Point Pelee National Park Ontario, Canada. American Birds 40(1): 26-31.

Hoffman, R.D. 1974. Mercury in herons, egrets and their nesting environment. M.Sc. thesis. The Ohio State University, Columbus, Ohio.

Mercury concentration levels generally were higher in herons and egrets nesting on West Sister Island than those nesting in a mainland heronry. Primary feathers contained the highest concentrations of mercury followed by liver, breast muscle and brain tissues. These differences among the tissues were due to the physiological functions of these birds as they relate to mercury uptake from the environment. Highly significant correlations ($P < 0.05$) between adult breast muscle, liver and brain tissues make possible prediction of approximate mercury levels in any one of the tissues when the concentration in one of the tissues is known. The lack of a correlation between primary wing feathers and other tissues could reflect the possibility that these feathers represent previous "body burdens" of mercury. Mercury concentration levels increased with age in all four populations. Generally, female herons and egrets had higher mercury residue levels than males. Birds collected during the post–hatching period had higher mercury levels than those collected during pre–hatching and post–juvenile flight periods. This was thought to relate to the rate of activity and energy requirements of adults during this period.

Hoffman, R.D. 1976. Mercury levels in a 21-year-old Black-crowned Night-heron (*Nycticorax nycticorax*). Ohio Journal of Science 76(1): 18.

Hoffman, R.D. 1978. The diets of herons and egrets in Southwestern Lake Erie. Wading Birds 7: 365-369.

Hoffman, R.D. 1980. Total mercury in heron and egret eggs and excreta. Ohio Journal of Science 80(1): 43-44.

Complete clutches of Great Blue Heron (*Ardea herodias*), Black–crowned Night-heron (*Nycticorax nycticorax*), and Great Egret *(Casmerodius albus*) eggs were collected along with excreta from nesting colonies in southwestern Lake Erie during the 1973 and 1974 breeding seasons and analyzed for total mercury content. Mercury levels in eggs ranged from 0.04 to 0.47 ppm. Mercury concentrations in excreta ranged from 0.09 to 0.48 ppm.

Hoffman, R.D. and R.D. Curnow. 1973. Toxic heavy metals in relation to Lake Erie herons. Proceedings of the 16th Conference on Great Lakes Research, Great Lakes Research Division, University of Michigan, Ann Arbor, Michigan.

Great Blue Herons (*Ardea herodias*), Black–crowned Night-herons (*Nycticorax nycticorax*) and American Egrets (*Casmerodius albus*) of the southwestern Lake Erie region were collected and assayed for toxic metals concentrations. During August and September 1972, eleven Great Blue Herons, eight Black–crowned Night-herons and six American Egrets were collected from island and mainland heronries and marshlands in Oak Harbour–Port Clinton, Ohio vicinity. Tissue samples from adult, juvenile and nestling birds include breast muscle, brain and liver. Primary

wing feathers were also collected from adult juvenile birds. Concentrations of mercury, cadmium and lead were determined by atomic absorption spectrophotometry. Mercury concentration levels differed between bird species, location of collection, and age.

Hoffman, R.D., and H.H. Prince. 1975. Vegetative structure and nest distribution in a Black-crowned Night-heron heronry. Jack-Pine Warbler 53(3): 95-99.

Box elder was the most important arborescent species of vegetation in a Black–crowned Night-heron heronry in southwestern Michigan. Nest trees contained from 1 to 5 nests. A correlation was observed between the nest tree height and nest height. Nests were composed primarily of box elder twigs.

Hoffman, R.D., and R.D. Curnow. 1977. Total mercury in Lake Erie herons and their foods. Proceedings of the Colonial Waterbird Group: 202.

Between March and September 1972–73, 42 Great Blue Herons (*Ardea herodias*), 44 Black–crowned Night-herons (*Nycticorax nycticorax*), and 44 Great Egrets (*Casmerodius albus*) were collected from island and mainland heronries and marshlands in the Oak Harbour–Port Clinton, Ohio vicinity.

Total mercury concentrations were measured by flameless atomic absorption spectrophotometry. Elevated mercury levels were found in primary wing feathers (0.54 to 28.24 ppm), breast muscle (0.08 to 2.36 ppm), brain (0.08 to 1.85 ppm), and liver (0.26 to 143.80 ppm). Great Blue Herons nesting in the island heronry yielded the highest levels followed by Black–crowned Night Herons, Great Egrets and mainland nesting Great Blue Herons. Birds collected in the island heronry had significantly ($P < 0.05$) higher mercury concentrations than those of the same species collected in the marshes.

Adult birds had significantly ($P < 0.01$) higher mercury levels than nestlings. Positive correlations of mercury levels were found between tissues within each population. Bird populations with higher mercury levels fed more frequently on perch (*Perca flavescens*), which contained higher mercury levels (0.04 to 0.81 ppm) than most organisms in their diet. Results suggested dietary differences and feeding locations may have been responsible for differences in mercury levels among bird populations.

Hoffman, R.D., and R.D. Curnow. 1979. Mercury in herons, egrets, and their foods. Journal of Wildlife Management 43(1): 85-93.

Mercury concentration levels were measured in herons and egrets and their foods collected in the southwestern Lake Erie region. We analyzed primary wing feathers, breast muscle, liver, and brain tissues from 42 Great Blue Herons (*Ardea herodias*), 44 Black–crowned Night-herons (*Nycticorax nycticorax*), and 43 Great Egrets (*Casmerodius albus*). Concentrations were higher in island nesting birds than birds collected at the Winous Point Shooting Club, with primary wing feathers the highest, followed by liver, breast muscle, and brain tissues. Mercury levels in breast muscle, liver, and brain tissue of adult birds correlated ($P < 0.01$) within each population. Tissues of adult birds exhibited higher ($P < 0.05$) mercury concentrations than did tissues from nestlings of the same population. An importance index for each population of birds showing the significance of individual food items as sources of mercury indicated that birds nesting on West Sister Island acquired mercury from fish species found more frequently in Lake Erie than in marshes. Mercury concentration factors of the Lake Erie marsh ecosystem show a relationship between trophic levels and mercury concentration levels.

Hoffman, R.D., and T.A. Bookhout. 1984. Metabolized energy of seeds consumed by ducks in Lake Erie marshes. Transactions of the North American Wildlife and Natural Resources Conference 50:

557-565.

Hunter, R.A. 1976. A study of selected factors influencing the reproductive performance of the Common Tern (*Sterna hirundo*) at Port Colborne, Ontario in 1973 and 1974. M.Sc. thesis. Brock University, St.Catharines, Ontario.

Several study areas were investigated at two Port Colborne terneries during the summers of 1973 and 1974 in an attempt to determine the influence of clutch size, time of clutch initiation, position in the colony, proximity to Ring–billed Gulls, vegetation and nesting substrate on the reproductive performance of the Common Tern. Hatching success and reproductive success (the number of chicks fledged per egg laid) were generally higher for 3–egg than 2–egg clutches but fledging (the number of chicks fledged per egg hatched) success was usually independent of clutch size. Hatching, fledging and reproductive success declined as a function of time of clutch initiation. Mean clutch sizes also generally declined as a function of time. Nests located in the center of the colony exhibited higher fledging success than those on the periphery. Rock–based clutches had a lower hatching success than clutches initiated on sand or dried vegetation. Reproductive performance did not appear to be related to proximity to Ring–billed Gulls or vegetation within the study area.

Hunter, R.A., and R.D. Morris. 1976. Nocturnal predation by a Black-crowned Night-heron at a Common Tern colony. Auk 93: 629-633.

Hunter, R.A., H.A. Ross, and A.J.S. Ball. 1976. A laboratory simulation of predator-induced incubation interruption using Ring-billed Gull eggs. Canadian Journal of Zoology 54: 628-633.

Field observations have shown that nocturnal predation may cause nest desertion by adult larids. Such desertion was simulated by exposing laboratory–incubated Ring–billed Gull eggs to 10°C at either early, intermediate, or late periods of incubation. Hatchability was not significantly reduced by exposure. However, when eggs classed as 'non–viable at collection time' were eliminated, an increase in embryonic mortality was found to occur in late samples. The mean incubation time of all experimental eggs was slightly increased and the variance of incubation time was significantly greater for groups of eggs that suffered longer exposures at middle and late points in incubation. It is suggested that predator–induced desertion in natural populations may increase embryonic mortality and chick age heterogeneity, which in turn may reduce chick survivial.

Hussell, D.J.T. 1965. Long Point Bird Observatory: 1962 & 1963 reports. Ontario Bird Banding 1(1): 1-44.

Hussell, D.J.T. 1967. Long Point Bird Observatory: 1965 report. Ontario Bird Banding 3: 30-78.

Jones, L. 1897. Brunnich's Murre on Lake Erie. Wilson Bulletin 9: 16.

Jones, L. 1901. Five days among the islands of Lake Erie. Wilson Bulletin 13: 70-71.

Jones, L. 1902. The summer birds of Lake Erie's islands. Ohio Naturalist 2(8): 281-284.

Jones, L. 1912. A study of the avifauna of the Lake Erie islands. Wilson Bulletin 24: 6-18.

Kehoe, F.P., and C.D. Ankney. 1985. Variation in digestive organ size among five species of diving ducks (*Aythaya* sp.). Canadian Journal of Zoology 63: 2339-2342.

Ceca length, small intestine length, and gizzard weight were measured for individuals of five species of diving ducks collected at Long Point Bay, Lake Erie, and Mitchell's Bay, Lake St. Clair, Ontario, in the falls of 1982 and 1983. The five species were Lesser Scaup (*Aythya affinis*, N = 84),

Ring–necked Duck (*Aythya collaris*, N = 57), Greater Scaup (*Aythya marila*, N = 54), Redhead (*Aythya americana*, N = 58), and Canvasback (*Aythya valisineria*, N = 112). The ducks of these species reportedly differ in diversity as well as in amount of fibre, and interspecific differences in gut morphology not explained by differences in body weight, were accounted for by general differences in diet. Canvasbacks, although the heaviest species, had the shortest ceca, short intestines and light gizzards, presumably because their diet contains the least fibre. Conversely, the relatively small–bodied scaup species had the longest small intestines, likely because of their diverse diets which include animal and plant material. Our results show that morphological differences in waterfowl guts reflect dietary diffferences at a particular time and location and also illustrate the importance of adjusting gut measurements to body weight before making interspecific comparisons.

Kelley, A.H. 1978. Birds of the Southeastern Michigan and Southwestern Ontario. Cranbrooke Institute of Science, Bloomfield Hills, Michigan.

Kennedy, S.W., and G.A. Fox. 1990. Highly carboxylated porphyrins as a biomarker of polyhalogenated aromatic hydrocarbon exposure in wildlife: confirmation of their presence in Great Lakes Herring Gulls in the early 1970s and important methodological details. Chemosphere 21(3)a: 407-415.

Porphyrin patterns were determined by high–performance liquid chromatography (HPLC) in archived Herring Gull, *Larus agentatus*, chick livers which were collected in 1973 and 1974 from two locations in the Great Lakes of North America (Port Colborne, at the eastern terminus of Lake Erie and Scotch Bonnet Island, in eastern Lake Ontario). The results show that highly carboxylated porphyrins (HCPs) were elevated in the livers of half of the chicks from Scotch Bonnet Island. The importance of measuring HCPs and not simply total prophyrins when using porphyria as a biochemical marker of wildlife exposure to polyhalogenated aromatic hydrocarbons (PHAHs) is shown.

Killoran, M.R. 1993. Seasonal variation in hatching pattern and chick survival in the Ring-billed Gull (*Larus delawarensis*). M.Sc. thesis. Brock University, St.Catharines, Ontario.

The general objective of my study was to monitor proximate causes and seasonal patterns of hatching asynchrony and chick survival in the Ring–billed Gull (*Larus delawarensis*). Two different plots were set up at a Ring–billed Gull colony near Port Colborne, Ontario in the summer of 1992. One group was from 'peak' nesting pairs (clutches initiated between 15 April and 1 May); a second group was from 'late' nesting pairs (clutches initiated between 9 – 22 May). Despite equal intra–clutch egg laying intervals between the peak and late periods, intra–clutch hatching intervals lengthened as the season progressed (ie. hatching became more asynchronous). Clutches from both periods were monitored for nocturnal attendance and brood patch development of parents was monitored during the egg laying period. Late nesters were characterized by an absence of nocturnal desertion, substantial brood patch defeatheration at clutch initiation and a reduction in the number of chicks fledged per pair. Chick survival to 25 days (taken as fledging) reflected patterns of chick mass at brood completion and five days post–brood completion, in peak clutches. In late clutches, survival was poor for all chicks and, was partially independent of hatching order, due in part to stochastic events such as Herring Gull predation and adverse weather. In both the peak and late periods, last–hatched C–chicks realized the poorest survival to fledging among brood mates.

An artificial hatching pattern (manipulated synchrony) and an artificial hatching order were created, in three–chick broods, through a series of egg exchanges. In peak and late clutches manipulated to hatch synchronously ($\leq$ 24 h): C–chick survival to fledging did not differ from the survival of A– and B– chicks, in the peak period. In the late period, the survival of C–chicks was significantly lower than that of A– chicks. In peak clutches manipulated such that chicks from last–laid eggs (C–chicks) hatched 24 h – 48h ahead of the A– and B– chicks, C–chick survival was greater than in

controls. Within those broods, C–chick survived better on average than both A– and B– chicks.

Knapton, R.W. 1992. The American Wigeon at Long Point: a species on the increase? Long Point Bird Observatory Newsletter 24: 15.

Knapton, R.W. 1993. Population status and reproductive biology of the Mute Swan at Long Point, Lake Erie, Ontario. Canadian Field-Naturalist 107: 354-356.

Knapton, R.W. 1994. Mass staging of Ruddy Ducks at Long Point. Long Point Bird Observatory Newslet ter 26: 10-11.

Knapton, R.W. (submitted). Occurrance of a novel and abundant prey item, the Zebra Mussel (*Dreissena polymorpha*), in diets of *Aythya* and *Bucephala* diving ducks at Long Point, Lake Erie, Ontario. Canadian Journal of Zoology.

Knapton, R.W., and K. Pauls. 1994. Fall food habits of American Wigeon at Long Point, Lake Erie, Ontario. Journal of Great Lakes Research 20(1): 271-276.

We studied food habits of an abundant migrant, the American Wigeon (*Anas americana*), staging during the 1991 fall migration at Long Point, a World Biosphere Reserve and a Ramsar site on the north shore of Lake Erie. Food samples from 149 wigeons were analyzed; stems and leaves of aquatic plants (predominantly submerged macrophytes) comprised over 92% aggregate dry mass of the diet, seeds made up 7.8%, and animal matter 0.6%. A diverse array of plant species was identified; however, results indicate that wigeons were showing selectivity in plant species consumed. Stems and leaves of muskgrass (*Chara* spp.), elodea (*Elodea canadensis*) and bushy pondweeds (*Najas flexilus* and *N. guadalupensis*) (aggregate percent dry mass 37%, 22%, and 18% for proventriculi, and 15%, 12% and 38% for gizzards, respectively) comprised the bulk of the diet, although neither bushy pondweed nor elodea wholly dominated submerged macrophyte communities. Several submerged macrophytes, such as coontail (*Ceratophyllum demersum*) and pondweeds (*Potamogeton* spp.) which are common and widespread at Long Point and reported frequently as important in the diet of American Wigeons elsewhere, were not found at all or only in trace amounts. Some sex, age, and seasonal differences in diet were detected; *Chara* spp. and tubers were eaten more frequently by adults than by immatures, *Elodea canadensis* was eaten in late fall by females but not by males, immatures ate *Myriophyllum spicatum* seeds more frequently than did adults, and *Najas* spp. was consumed more in late fall than in early fall.

Knapton, R.W., and M.L. Enright. 1994. Population status, reproductive biology, and occurrence of the "Polish" morph in a feral population of Mute Swans (*Cygnus olor*) at Long Point, Lake Erie, Ontario in 1993. Unpublished Report to Ontario Ministry of Natural Resources, Simcoe, Ontario.

Koster, M.D., J. Struger, D.V. Weseloh, and D.P. Ryckman. (submitted). Mercury levels in Great Lakes Herring Gull eggs, 1972-1992. Environmental Pollution.

Since 1971, the Herring Gull (*Larus argentatus*) has been used as a sentinel species for monitoring the levels of persistent contaminants in the Great Lakes ecosystem. From 10 complete clutches per colony, a fresh egg was collected for the analysis of total mercury concentration. In total, 22 colonies were visited in the five Great Lakes and their connecting channels, during the years 1972–76 and 1980– 85 and 1992. Total mercury levels of these egg–contents ranged from 0.124–0.877 mg/kg wet weight, from Channel/Shelter Island, Lake Huron (1985) and Pigeon Island, Lake Ontario (1982) respectively. Lake Ontario samples contained, on average, the highest levels of mercury (0.53 mg/kg), followed by the Lake Superior samples, with 0.35 mg/kg. Lake Erie eggs had the lowest average levels (0.21 mg/kg). Eggs taken in 1982 often had the highest levels of mercury. Although absolute mercury levels have gone down over the past two decades; the

declines were significant at only two colonies. Compared to levels in the early 1970s, the average levels per lake have declined by around 15 %, with the exception of Lake Ontario (3.7 % decline). The highest mercury levels found in the early '70s were within the range found which potentially reduced hatchability in other fish–eating species. Recent levels in Herring Gull eggs were near or below 0.5 mg/kg, the level generally associated with reproductive effects in birds.

Kress, S.W., E.H. Weinstein, and I.C.T. Nisbet. 1983. The status of tern populations in Northeastern United States and adjacent Canada. Colonial Waterbirds 6: 84-106.

This is a report of a workshop on tern populations in northeastern North America. Eighteen regional reports summarize data on numbers, trends, and productivity of 10 species of terns in the Great Lakes, the Gulf of St. Lawrence, and the Atlantic coast from Newfoundland south to Virginia. Although census techniques have varied in accuracy and comprehensiveness, the data permit the following estimates of tern populations in this area: Gull–billed Tern (*Sterna nilotica*), less than 1000 pairs; Caspian Tern (*S. caspia*), 4250 pairs; Royal Tern (*S. maxima*), 3000–4000 pairs; Sandwich Tern (*S. sandvicensis*), less than 20 pairs; Roseate Tern (*S. dougallii*), 3100 pairs; Common Tern (*S. hirundo*), 70–75,000 pairs; Arctic Tern (*S. paradisaea*), 5–6000 pairs (excluding Newfoundland); Forster's Tern (*S. forsteri*), 3100 pairs; Least Tern (*S. antillarum*), 7000–7500 pairs; Black Tern (*Chlidonias niger*), no estimate possible. Recently, Arctic and Gull–billed Terns have decreased, whereas Caspian, Forster's, Roseate, and (at least locally) Common, and Least Terns have increased. Data on breeding success are available for six species. Adverse factors include occupation of nesting habitat by gulls, human disturbance and development, predation, and flooding. Loss of nesting habitat due to these factors has left sub–optimal or man–made habitat such as salt marshes, dredged spoil islands, structures, and roofs of buildings. For several species, a large fraction of the population now nests on sites that are publicly owned, managed, or protected. Despite some recent population increases, most species still remain far below numbers of 40 years ago. Continued management and protection will be necessary to maintain suitable sites for current populations.

L'Arrivee, L., and H. Blokpoel. 1988. Seasonal distribution and site fidelity in Great Lakes Caspian Terns. Colonial Waterbirds 11(2): 202-214.

We analysed 1,126 recoveries of Caspian Terns (*Sterna caspia*) from 1 January 1962 to 30 June 1986. Birds had been banded in their hatching year at colonies in the Great Lakes from 1959 to 1982. Adults (age $\geq$ 2.5 years) summer on the Great Lakes in June and July, winter in the southern Atlantic and Gulf Coast states and the Caribbean Basin from November to March, and migrate between their summer and winter ranges in April–May and August–October. Juveniles (ages 0–6 months) use the same migration routes as adults, i.e. the American Atlantic Coast and possibly the Mississippi Flyway, and winter in the same areas as adults. Immatures (age 6–18 months) apparently spend all four seasons on the adult winter range. Recoveries of sub–adults (age 18–30 months) during June and July included both the Great Lakes and the adult winter range while recoveries in other seasons were similar to those of adults but also included areas not normally associated with Great Lakes' Caspian Terns. We suggest that sub–adults have a greater tendency to wander than the three other age groups.

We analyzed interchanges of adults among the Great Lakes region and the two other major banding regions (> 5000 chicks banded) in North America as well as interchanges of adults among individual lakes of the Great Lakes among 10' x 10' blocks where birds had been banded. Great Lakes' birds showed a high degree of site fidelity. However, there was some exchange of adults between colonies in Washington and California. Although most Great Lakes terns return to the lake where they were born, more than 55% of adult recoveries occurred beyong the natal 10' x 10' block in June and July.

L'Arrivee, L.P., and H. Blokpoel. 1990. Seasonal distribution and site tenacity of Black–crowned Night–

herons, *Nycticorax nycticorax*, banded in Canada. Canadian Field-Naturalist 104(4): 534-539.

We analyzed 99 recoveries of Black–crowned Night–herons (*Nycticorax nycticorax*) banded in Canada during 1942–1986 (97 banded as chicks, one banded as an after–hatching year bird, one banded at an unknown age). Birds banded in Ontario and Quebec migrated south during September and October, wintered on the islands of Cuba, Jamaica, Hispaniola, and the Bahamas during November through March, and most were found in their natal province during April through August. Birds banded in the Prairie Provinces (Manitoba, Saskatchewan, and Alberta) and were recovered as far south as Oklahoma during September–October, and occurred in South Carolina, Cuba, and Mexico during November through March, while only one recovery of an adult in North Dakota occurred during the April through August period. For Black–crowned Night–Herons banded in Canada, the majority of adults and yearlings were recovered within 250 km of their original banding locations during April through August, a few even with the same 10' latitude x 10' longitude block. This suggests strong tenacity to natal area and possibly to the natal colony sites.

Lagerquist, B.A., and C.D. Ankney. 1989. Interspecific differences in bill and tongue morphology among diving ducks (*Aythya* spp., *Oxyura jamaicensis*). Canadian Journal of Zoology 67: 2694-2699.

Twelve morphological characters of the bill and tongue were measured in six species of diving ducks (*Aythya* and *Oxyura* spp.). We used multivariate analyses to describe interspecific differences in morphology and related these differences to published information about food habits and feeding behaviour of the six species. Canvasbacks (*Aythya valisineria*) have long, narrow, deep bills that are well suited to probing and grasping plant tubers from the substrate. Greater (*A. marila*) and Lesser Scaup (*A. affinis*) and Ruddy Ducks (*Oxyura jamaicensis*) have short, wide, shallow bills suited to straining food items. Lesser Scaup and Ruddy Ducks have the greatest lamellar density and this enables them to strain very small plant and animal material. Redheads (*A. americana*) and Ring-necked Ducks (*A. collaris*) have bills of intermediate size and shape that are suited to straining seeds and grazing leafy parts of plants. Lesser and Greater Scaup, on the basis of bill morphology, are more similar to Ruddy Ducks than they are to other *Aythya* species. Overall, bill size and shape were more important in distinguishing the six species than were lamellar density or tongue characteristics.

Lambert, A. 1981. 1981 annual report of the Great Lakes beached bird survey. Unpublished report to Long Point Bird Observatory, Port Rowan, Ontario.

Participants in the Great Lakes Beached Bird Survey conducted beached bird surveys at 74 sites in 1981, covering 223 km (138 miles) of shoreline. In total, 942 beached birds of 79 species were found. The average number of birds found per km surveyed was 0.67, compared with a mean of 0.87 birds per km in the survey's first three years. Ring–billed Gulls and Herring Gulls comprised 36% and 18% of beached birds respectively. The next most numerous species were Oldsquaw, Common Loon, and Mallard. Among gulls that were aged, hatching year birds comprised 43% of Ring–billed Gulls and 33% of Herring Gulls. Beached Herring Gulls again showed an imbalance in favour of males: of 44 birds for which sex was determined, 65% were sexed as male and 35% as female. Exceptional numbers of beached Ring–billed Gulls were found in August at Presqu'ile, Ontario (eastern Lake Ontario). This location is near a large gull colony at Bluff Island (Gull Island) which has undergone a rapid population increase in recent years. Cause of death was recorded for 26% of beached birds; the most important causes were starvation/disease, gunshot wounds, predation, and entanglements with fishing lines and commercial fishing nets. Seasonal patterns of beached bird numbers varied among different groups of birds. Waterfowl numbers peaked in spring (especially March and May) and in October; landbirds showed a single high peak in the spring; and gull numbers were highest in August, with smaller peaks in May and November.

Live waterbird counts conducted during beached bird surveys provided year–round data on the

numbers and distribution of waterbirds. Mean values from live waterbird counts can also facilitate comparison of beaching rates between different species and lakes. Relative to numbers of live birds seen on counts, the beaching rate of Herring Gulls was twice as high as that of Ring–billed Gulls. More exceptional were the very high beaching rates of Oldsquaw, Common Loon, and especially White–winged Scoters in proportion to their numbers as live birds. When inter–lake differences were examined, the beaching rate in relation to live bird numbers was found to be very high for Ring–billed Gulls and waterfowl on Lake Michigan. Likewise, the beaching rate for these species plus Herring Gulls was high for Lake Ontario in comparison with Lake Erie.

Langlois, T.H. 1950. Crow Ducks on Little Chicken Island. Ohio Conservation Bulletin. 14(10): 14.

Ligas, F.J. 1951. Island nesting eagles. Ohio Conservation Bulletin 15(9): 11.

Ligas, F.J. 1952. Migration, nesting and food studies of the piscivorous birds of the island region of Lake Erie. M.Sc. Thesis, Ohio State University, Columbus, Ohio.

Locke, A. 1986. Log-linear modelling of Herring Gull eggshell thinning in Canadian Great Lakes colonies, 1974 to 1983. Unpublished manuscript to Canadian Wildlife Service, Burlington, Ontario.

Eggshell thickness data of Herring Gull eggs from eight breeding colonies in the Canadian Great Lakes from 1974 to 1983 were studied. Five log–linear models were fitted using three different contingency tables, in order to test whether eggshell thickness varied with time and/or geographic location. No models were significant at the 90% level, and significance decreased with increasing complexity of the model. Interactions betwen eggshell thinning and lakes were significant at the 90% level. Statistical and biological explanations are given for the poor fit of the models to the data.

Lovvorn, J.R. 1990. Courtship and aggression in Canvasbacks: influence of sex and pair-bonding. Condor 92: 369-378.

Time– activity budgets, courtship, and aggression of paired and unpaired Canvasbacks (*Aythya valisineria*) were studied on the upper Mississippi River and on Long Point Bay, Lake Erie, during spring migration. Of Canvasbacks present, 25–28% were female of which 17–27% were paired. Paired Canvasbacks spent more time in foraging aggression and initiated and won more encounters than did unpaired individuals. Paired females engaged in more courtship–related threats, chases, and neck– stretches than did unpaired females. Paired females exceeded paired males in foraging aggression and in courtship behaviours such as neck–stretches and chases, with the trend in all chases reversing just before or upon arrival at nesting sites. Thus in the early stages of pairing, females rather than males appeared to assume the primary role of foraging aggression and repelling courtship advances of other males.

Ludwig, F.E. 1943. Ring-billed Gulls of the Great Lakes. Wilson Bulletin 55(4): 234-244.

After an interval of some 20 years, the Ring–billed Gull was again reported nesting in the Great Lakes region about 1926. Between 1926 and 1941, at least twenty–nine thousand Ring–billed Gulls were banded in the region. The data indicate that from the earliest of these recent colonies, St. Martins Shoals, the Ring–billed Gulls scattered throughout upper Lake Michigan, upper Lake Huron, and Georgian Bay; they have been found nesting on at least 26 islands in the region. The colonies do not always remain stationery, but sometimes shift from island to island. A colony on Scarecrow Island, Alpena County, Michigan, has become the largest single colony in the Middle West. Winter returns from banded Ring–billed Gulls extend the known winter range northward; summer returns indicate that some of these gulls spend all their first year in the south. Four returns from North Carolina, made during the breeding season of the third year after banding, point to the possibility of a nesting colony of Ring–billed Gulls on the North Carolina coast. Fall and spring

returns indicate migration routes along the upper Ohio River and the Mississippi, and along the St. Lawrence waterway and Hudson River. Returns indicate that mortality is highest in the first six months of life, followed closely by mortality in the first calendar year after banding. The oldest Ring–billed Gull we have yet recorded was ten years old.

Ludwig, J.P. 1968. Dynamics of Ring-billed Gull and Caspian Tern populations in the Great Lakes. Ph.D. thesis, University of Michigan, Ann Arbor, Michigan.

Ludwig, J.P. 1974. Recent changes in the Ring-billed Gull population and biology in the Laurentian Great Lakes. Auk 91(3): 575-594.

Ludwig, J.P. 1984. Decline, resurgence and population dynamics of Michigan and Great Lakes Double-crested Cormorants. Jack-Pine Warbler 62: 90-102.

Madenjian, C.P., and S.W. Gabrey. 1995. Waterbird predation on fish in Western Lake Erie: A bioenergetics model application. Condor 97: 141-153.

A bioenergetics model was applied to the nesting populations of colonial waterbirds in western Lake Erie to determine their total fish consumption. The important nesting species included the Herring Gull (*Larus argentatus*), Ring–billed Gull (*L. delawarensis*), Double–crested Cormorant (*Phalacrocorax auritus*), Great Blue Heron (*Ardea herodias*), Black–crowned Night–heron (*Nycticorax nycticorax*), and Great Egret (*Casmerodius albus*). The impact of migratory waterbirds, including the Red–breasted Merganser (*Mergus serrator*), on western Lake Erie fish biomass was also considered in the analysis. According to the model application, birds consumed approximately 11,400 tonnes of fish from western Lake Erie each year. This tonnage was equivalent to just 13% of the prey fish biomass needed to support the walleye (*Stizostedion vitreum*) population in western Lake Erie during a single growing season. Thus, the bird predation effect on fish in western Lake Erie was relatively modest.

Madore, P. 1981. Management report: Big Creek National Wildlife Area -- Hahn Unit. Wood Duck nest boxes survey, 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Marshall, N. 1942. Night desertion by nesting Common Terns. Wilson Bulletin 54(1): 25-31.

Night desertion of their nests, a behaviour frequently initiated by a distinctive group flight at twilight and lasting till dawn, has been observed on the part of the Common Terns comprising the breeding colony at Starve Island in western Lake Erie. The underlying causes for this lapse in attentiveness, which has been studied during the past three breeding seasons, are as yet unknown. Accompanying it there have been repeated, complete nesting failures, contrasting with reports of past successes.

Marshall, N. 1943. Factors in the incubation behaviour of the Common Tern. Auk 60: 574-588.

Reduction of or addition to the number of eggs existing in a Common Tern nest does not alter the normal attendance of the adults, if at least one egg remains.

Some Common Terns will roll eggs into their nests when the latter are empty. Some will roll their own eggs into their nests even if a normal complement of substitute eggs has been placed there; moreover, terns are known to roll additional eggs into their nests even if their own eggs are in normal position. Great variation exists in egg–rolling performances. Possible causes for such variation are mentioned; however, these appear complex and have not been fully analyzed.

The tendency to roll displaced eggs is strongest when all the eggs have been removed from the nest.

The nest site, rather than the nest itself or the eggs, exerts the initial attraction to the broody Common Tern as it alights in the colony.

Responses of the Common Tern show that it either fails to recognize its own eggs or acts indifferently to such recognition. The total appearance of the locale is used by an approaching tern in finding its eggs. The eggs, the nest, and the immediate and the more distant landmarks are the constituents of this landscape, and it is merely as such constituents that each serves in 'nest recognition'.

Masden, C.R., T.J. Seldrake, and J.T. Leach. 1982. Bald Eagle production in the Great Lakes states, 1973-1981. U.S. Fish and Wildlife Service, Twin Cities, Minnesota.

Mayfield, H.F. 1987. Changes in bird life at the western end of Lake Erie: Part I of III. American Birds 42(3): 393-406.

Mayfield, H.F. 1988. Changes in bird life at the western end of Lake Erie: Part II of III. American Birds 442(5): 1259-1264.

Mayfield, H.F. 1989. Changes in bird life at the western end of Lake Erie: Part III of III. American Birds 43(1): 46-49.

McCracken, J.D. 1978. The breeding birds of the Big Creek National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

McCracken, J.D. 1979. The breeding birds of the Big Creek National Wildlife Area. 1978-1979 Studies. Unpublished Report to Canadian Wildlife Service, London, Ontario.

McCracken, J.D. 1980. Avifaunal surveys at the Big Creek National Wildlife Area in 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

McCracken, J.D. 1981. Avifaunal surveys in the cattail marshes at Long Point. Unpublished Long Point Bird Observatory Report to Canadian Wildlife Service, London, Ontario.

McCracken, J.D. 1981. Avifaunal surveys in cattail marshes at Long Point. Unpublished Report to Canadian Wildlife Service, London, Ontario.

McCracken, J.D. 1982. Bird studies of certain wetlands at Long Point. Unpublished Report to Canadian Wildlife Service, London, Ontario.

McCracken, J.D. 1989. Post-dyking assessment of the breeding birds of Big Creek National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Breeding birds and habitat were surveyed in two 10–ha transects in the Big Creek National Wildlife Area marsh in 1989. Both transects had received previous study in 1978–79. One transect (experimental) was located within an area that had recently undergone extensive artificial habitat modification due to dyking, channelization and island creation. The other tansect (control) was located in an area that had undergone natural habitat change. The aim of the study was to assess the impact of the dyking scheme on habitats and breeding bird communities, relative to the natural area and relative to results obtained during the pre–dyking phase.

The control area was much drier in 1989 than in 1979; open water cover fell from 35% to about 10% during that time. Loss of water cover advanced community succession and increased habitat homogeneity. Habitat changed from a wet grassy marsh stage to one with several features characteristic of a later, dense grassy marsh stage. Parallel changes were noted in the breeding

bird community. Passerines generally responded favourably to these changes, but waterbirds were nearly eliminated. Overall, breeding bird density increased by 40%, but species diversity declined by 39%.

In 1989, the water level in the dyked area was held at artificially high levels in an effort to approximate a 50:50 ratio of water to vegetation cover. Hence, water cover increased from 20% in 1978 to 44% in 1989. This change served to create a much more open marsh, effectively setting back succession to a slightly earlier stage. Breeding bird density increased by 53%, primarily due to increases of some passerine species. Although species diversity declined by 24%, the decline was not as great as it was in the control area and species richness was essentially stable. There was no significant decline in the waterbird component. The dyking scheme retained several positive characteristics that were present in the area prior to development. Despite this, it was apparent that a 50:50 ratio of water to vegetation cover is not necessarily an optimal condition and management strategies should be adjusted acccordingly. An open water cover of about 30% seems to be a more ideal management target for maintenance of breeding bird diversity in these marshes. Further research is encouraged in order to verify this conclusion.

McCracken, J., M.S.W. Bradstreet, and G.L. Holroyd. 1981. Breeding birds of Long Point, Lake Erie: A study in community succession. Canadian Wildlife Service Report Series No. 44, London, Ontario.

One hundred and fifteen species of birds are believed to have nested on Long Point. Of these, 98 are confirmed on the basis of nests or flightless young; the rest are included on the basis of frequent sightings. These include two endangered species (Bald Eagle and Piping Plover) and such rare or potentially threatened species as King Rail, Little Gull, Forster's Tern, and Prothonotary Warbler. With the exception of marsh birds, the density of breeding birds is greater on the adjacent mainland than on the Point itself.

McCullough, G.B. 1981. Migrant waterfowl utilization of the Lake Erie shore, Ontario, near the Nanticoke industrial development. Journal of Great Lakes Research 7(2): 117-122.

In 1977 and 1978 a study was conducted to document the use by waterfowl of the north shore of Lake Erie, Ontario, near the Nanticoke Industrial Development. The data were collected to provide baseline information from which to measure changes in the use by waterfowl of a recently industrialized shoreline. Aerial and ground surveys were conducted along the Nanticoke shoreline during the autumn of 1977 and spring and autumn of 1978. The Nanticoke shoreline is a major fall staging area for Greater Scaup (*Aythya marila*) and Lesser Scaup (*A. affinis*), with a peak of almost 39,000 scaup and nearly 1,100,000 scaup–days observed during the fall of 1978. Major scaup concentration areas near the Nanticoke Industrial Development were mapped during the autumns of 1977 and 1978. Gizzards and esophagi taken from 18 scaup collected during the fall of 1978 indicated that gastropods were an important food source (100% occurrence), with *Goniobasis* sp. the most common organism. Continued use of the Nanticoke shoreline as a migration staging area may depend on maintaining an environment that will support large populations of the birds' major food items.

McCullough, G.B. 1984. Overwintering of waterfowl adjacent to the Nanticoke Generating Station, Lake Erie, Ontario, 1978 and 1979. In: S.G. Curtis, D.G. Dennis, and H. Boyd (eds.). Waterfowl studies in Ontario, 1973-81. Canadian Wildlife Service Occasional Paper No. 54, London, Ontario.

During the winters of 1978 and 1979 the Canadian Wildlife Service documented the waterfowl use of the recently created ice hole adjacent to the Ontario Hydro Nanticoke Generating Station, Lake Erie. Aerial surveys were conducted over the ice hole, and ground observations made at the intake and discharge channels. Eighteen species of waterfowl and three species of gulls were observed. The numbers of waterfowl utilizing the Nanticoke ice hole were estimated at 2000+ in 1978 and 3000+ in 1979. The development of an overwintering tradition for waterfowl in the industrial

environment of the Nanticoke ice hole could lead to ecological problems such as the outbreak of epizootic diseases, reduced breeding potential, or the death of birds from oil spills and starvation.

McDonnel, M.J. 1988. Landscapes, birds, and plants: Dispersal patterns and vegetation change. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 214-220. Ohio State University Press, Columbus, Ohio.

From this discussion it is apparent that the process of plant establishment, and consequently the pattern of vegetation change, is influenced by many events or mechanisms (e.g., dispersal, predation, herbivory, germination, etc.) which are functioning at many different organizational levels (e.g., population, community, ecosystem, etc.). Even though the process of plant establishment is extremely complex, the pattern of vegetation change is predictable if one knows the nature of the conditions present at a site which influence the probability certain events (e.g., dispersal, predation, etc.) will occur.

Similar patterns of vegetation change occur in time and space because the conditions present at a site, which affect the probability of events occurring, repeat in time and space. Conversely, different patterns of vegetation change come about because conditions exist which produce different probabilities events will occur. For example, the probability that wind–dispersed seeds will reach a recently disturbed site is directly related to the distance the site is from available seed sources. The probability bird–dispersed seeds will reach a recently disturbed site is related not only to the distance from the available seed source, but also to the attractiveness of the site (e.g., the existing structure and composition of the vegetation) to dispersal agents. Changes in the conditions which affect dispersal, influence the probability dispersal events will occur and thus effect the rate and direction of vegetation change.

McKeane, L., and D.V. Weseloh. 1993. Bringing the Bald Eagle back to Lake Erie. State of the Environment Fact Sheet, No. 93-3. Environment Canada , Ottawa, Ontario.

McKeating, G., and P. Prevett. 1983. Proposed introduction of eaglets to the Lake Erie Bald Eagle population. Unpublished Report to Canadian Wildlife Service, Ontario Ministry of Natural Resources proposal to Elsa Wild Animal Appeal of Canada, Aylmer, Ontario.

Melvin, G. 1979. Genetic variability in *Larus argentatus* and *Sterna hirundo*. M.Sc. thesis. Brock Universi ty, St.Catharines, Ontario.

Blood serum and egg–white protein samples from individuals representing seven colonies of *Larus argentatus*, and four colonies of *Sterna hirundo* were electrophoretically analysed to determine levels of genetic variability and to assess the utility of polymorphic loci as genetic markers. Variability occurred at five co–dominant autosomal loci. *S. hirundo* protein polymorphism occurred at the Est–5 and the Oest–1 loci, while nineteen loci were monomorphic. *L. argentatus* samples were monomorphic at seventeen loci and polymorphic at the Ldh–A and the Alb loci. Intergeneric differences existed at the Oalb and the Ldh–A loci. Although LDH–A^{100} from both species possessed identical electrophoretic mobilities, the intergeneric differences were expressed as a difference in enzyme thermostabilities.

Geographical distribution of alleles and genetic divergence estimates suggest *S. hirundo* population panmixis, at least at the sampled locations. The *L. argentatus* gene pool appears relatively heterogeneous with a discreet Atlantic Coast population and a Great Lakes demic population. These observed population structures may be maintained by the relative amount of gene flow occurring within and among populations. Mass ringing data coupled to reproductive success information and analysis of dispersal trends appear to validate this assumption. Similar results may be generated by either selection or both small organism and low locus sample sizes. To clarify these results and to detect the major factor(s) affecting the surveyed portions of the

genome, larger sample sizes in conjunction with precise eco–demographic data are required.

Metz, K.J., and C.D. Ankney. 1991. Are brightly coloured male ducks selectively shot by duck hunters? Canadian Journal of Zoology 69: 279-282.

In many species of ducks, males are harvested at higher rates than females. Several studies have suggested that particular aspects of the birds' biology may account for this difference, but few studies have attempted to determine the effect of hunter behaviour on the differential vulnerability. The objective of this study was to determine if the bright plumage of male ducks was related to greater hunting mortality. Ducks shot from pairs at Long Point Waterfowl Management Unit, Ontario, from September 25 to November 26, 1987, were examined, and questions were asked of hunters who brought the ducks into the Waterfowl Management Unit's check station. Sixty–one percent of ducks shot from pairs were Mallards, Green–winged Teal, or Ring–necked Ducks. A significant interaction occurred between the degree of dichromatism of plumage and which sex of duck was shot. Approximately equal numbers of males and females were shot when males resembled females. However, when males obtained their full, bright, alternate plumage, a signifiant greater proportion of males were shot regardless of which sex was leading. These data suggest that hunters select, consciously or unconsciously, the more distinctive male when he is accompanied by a female. Characteristics of hunters' behaviour while hunting are pertinent to assessing current waterfowl management programs.

Miller, G.W. 1977. The current status and breeding performance of the Long Point Piping Plovers - a survey of an endangered species population. Unpublished Report to Long Point Observatory, Port, Rowan, Ontario.

Censuses of the south shore of Long Point found a population of about 8 Piping Plovers distributed along a 7 km stretch of shoreline. In addition to one breeding pair were six male Piping Plovers that maintained territories but failed to attract mates. The nesting pair had a nest with a full clutch of four eggs by May 15. Gulls were observed mobbing the adults at the nest on May 19, and a protective wire mesh enclosure was placed over the nest to prevent gulls from destroying eggs. Despite the death of the breeding female sometime after May 28 the male continued incubating the eggs and two of them hatched on June 10. The chicks were not seen after June 11 and are not believed to have survived until fledging.

Miller, H.J., and S.C. Whitlock. 1948. Detroit River water-fowl mortality - winter 1948. Michigan Conservation 17(4): 11-15.

Miller, M.H. 1914. Wild fowl at Sandusky Bay in 1756. Bird Lore 16: 114-115.

Mineau, P. 1982. Levels of major organochlorine contaminants in sequentially-laid Herring Gull eggs. Chemosphere 11(7): 670-685.

Sequentially laid eggs of Herring Gulls in Lake Erie and the Detroit River (Ontario) were found to contain increasingly higher levels of organochlorine contaminants. The reason for this was not determined but a depletion of lipid pools during the egg laying period and a rapid equilibrium between body and egg burdens may explain the results. It is recommended that, for long term toxic residue monitoring, eggs at the same position in the order of laying be taken from all sampled clutches.

Mineau, P., D.J. Hallett, and D.V. Weseloh. (no date). Half-lives of organochlorine residues in Great Lakes' Herring Gulls. Unpublished manuscript to Canadian Wildlife Service, Burlington, Ontario.

Restrictions on the use of some organochlorine xenobiotics have led to their decline over the last decade in the Great Lakes. The Herring Gull, a top predator in the lakes' trophic web, has

exhibited first-order losses of these contaminants. Examining loss rates has provided a better understanding a pollutant dynamics in the Great Lakes.

Mineau, P. and R. Markel. 1981. The 1979 spring bird migration and other vertebrates at Middle Island, Lake Erie. Ontario Field Biologist 35(1): 13-21.

Middle Island, Canada's southernmost piece of land, was found to attract a large number of bird species (123) during 1979 spring migration. Eleven new breeders are reported from the island. Dates of arrival roughly correspond with those obtained on Point Pelee 29 km to the NNE. No mammals were encountered. The snake population is briefly discussed.

Mineau, P., and D.V.C. Weseloh. 1981. Low-disturbance monitoring of Herring Gull reproductive success on the Great Lakes. Colonial Waterbirds 4: 138-142.

A method by which the gross reproductive output of Herring Gull colonies can be assessed with a minimum of effort and disturbance is presented. Following the method, the number of chicks surviving to a median age of 21 days can be determined with a 95% confidence of $\pm$ 10%. A colony specific "chick condition" is also presented. Examples from the Great Lakes are used throughout.

Mineau, P., G. E. J. Smith, R. Markel, and C.S. Lam. 1982. Aging Herring Gulls from hatching to fledging. Journal of Field Ornithology 53(4): 394-402.

Formulae which make use of the logistic model are used to age Great Lakes Herring Gulls from birth to fledging through measurement of body parts. Whether using wing length alone or using wing length in combination with two other body measurements, over 80% of all sets of measurements give rise to an estimated age that is within $\pm$ 2 days of true age. Using three body measurements slightly decreases the number of "serious mistakes".

Mineau, P., G.A. Fox, R.J. Norstrom, D.V. Weseloh, D.J. Hallett, and J.A. Ellenton. 1984. Using the Herring Gull to monitor effects of organochlorine contaminants i n the Canadian Great Lakes. In J. O. Nriagu and M.S. Simmons (eds.). Toxic contaminants in the Great Lakes. John Wiley and Sons, Inc.

Mitchell, J. and R.W. Knapton. 1993. The effect staging and overwintering waterfowl on Zebra Mussel populations at Ontario Hydro's Nanticoke generating station. Ontario Ministry of Natural Resources, Maple, Ontario.

Moccia, R.D., G.A. Fox, and A. Britton. 1986. A quantitative assessment of thyroid histopathology of Herring Gulls (*Larus argentatus*) from the Great Lakes and a hypothesis on the causal role of environmental contaminants. Journal of Wildlife Diseases 22(1): 60-70.

Thyroids from 213 adult Herring Gulls of both sexes were collected during incubation from nine colonies in the Great Lakes basin of eastern North America between 1974 and 1983, and from a single colony in the Bay of Fundy from 1977 to 1982. Qualitative and quantitative histological assessment revealed that the majority of the gulls from the Great Lakes basin suffered from goiter. These thyroids had greater mass than those from the Bay of Fundy, and were microfollicular and frequently hyperplastic. The histopathology was similar to that previously observed in Pacific salmon from the Great Lakes. These findings are consistent with a forage fish–borne goitrogenic etiology other than, or in addition to, iodine deficiency. Temporal and spatial differences in the severity of the thyroid dysfunction are consistent with the hypothesis that polyhalogenated hydrocarbons are responsible for the goiter development and thyrotoxic effects observed in Herring Gulls from the Great Lakes area.

Moore, F.R. 1976. The dynamics of seasonal distribution of Great Lakes Herring Gulls. Bird-Banding 47:

141-159.

Morris, R.D. 1976. The breeding biology of Herring Gull (*Larus argentatus)* colonies at Port Colborne, Ontario. Canadian Wildlife Service Unpublished Report, Burlington, Ontario.

This report constitutes a section of the fourth progress statement on work initiated during the summer of 1972 on the breeding biology of colonial seabird species in the lower Great Lakes. Additional information on work completed during the summer of 1975 is available elsewhere (Morris, 1975; 1976). Field work in 1975 was designed to continue the assessment of various demographic aspects of the reproductive biology of the Herring Gull colonies at Port Colborne, Ontario and to determine the influence of brood size manipulation on the fledging rate of chicks from experimental nests. Field work was completed by Gerry Haynes and George Melvin, graduate students at Brock University, St. Catharines, Ontario.

Morris, R.D. 1977. Common Tern (*Sterna hirundo*). Position Paper. Ontario Technical Committee, Burlingtoin, Ontario..

The available long–term records suggest that numbers of Common Terns on the Great Lakes are declining substantially. Reproductive recruitment is currently below that of colonies on the east coast of North America. The causes for these declines are not always clear, however, immediate management procedures to reverse reductions (locally) are proposed. Solid conservation arguements can be made for the preservation and protection of Common Tern colonies on the Great Lakes.

Morris, R.D. 1979. Radiotelemetry and Herring Gull foraging patterns. Proceedings of the Colonial Waterbird Group: 259.

The movements of 4 brooding Hering Gull adults were followed for 25 days using commercially available telemetry equipment. Techniques to obtain precise information on distance, duration, and patterns of flight movements are described. Movement patterns of each bird were predictable and highly individualistic. Two individuals foraged at specific locations within 1 km of the colony while the other 2 took extended daily flights to destinations greater than 30 km away. The former individuals successfully raised young while the latter lost chicks early in the brooding period. Radio–telemetry has great potential for defining clear relationships between adult movement patterns and differential brood success among pairs.

Morris, R.D. 1986. Seasonal differences in courtship feeding rates of male Common Terns. Canadian Journal of Zoology 64: 501-507.

Courtship feeding rates by male Common Terns (*Sterna hirundo*) nesting late in the 1982 breeding season were markedly lower than those of peak nesters in that year. In 1983, however, there were no differences in courtship feeding rates between peak and late nesters. Both groups of males in 1983 fed females at similar rates before the first eggs were laid, and both rates declined after the second eggs were laid. Larger fish were fed to the females later in the season. Late nesting males adjusted their feeding rates to the size of fish delivered; males feeding larger fish fed them at a lower rate than males feeding smaller fish. There was no difference in the weights of three–egg clutches laid by peak and late nesting females, and there was no correlation between courtship feeding rate and clutch weight. As all females were apparently able to obtain sufficient nutrition to provision their eggs adequately, I suggest that 1983 was an unusually favourable food year at Port Colborne. This view accepts courtship feedings as an adaptation enabling the female to obtain sufficient nutrients before and during egg laying. Other functions of the behavior at other times during a breeding bout are not precluded.

Morris, R.D. 1987. Time-partitioning of clutch and brood care activities in Herring Gulls: a measure of

parental quality? Studies in Avian Biology 10: 68-74.

Thirty–one Herring Gull (*Larus argentatus*) pairs were observed during incubation and brood care over three breeding seasons at a colony near Port Colborne, Ontario (42°53'N, 79°16'W). Parents that successfully raised two or more chicks (n = 17) were normally both present with the clutch during incubation. In most of these pairs, timing of incubation was partitioned such that each partner incubated most frequently at predictable times of the day. Similar attendance synchrony was recorded during the first 10 days of brood care. In other successful, pairs, incubation and brood care were also partitioned equitably between partners. Conversely, in less successful pairs that raised at most one chick (n = 14), clutches and broods were frequently unattended by one or both parties. Synchronous or equitable partitioning of parental care activities were absent, with consequent egg and chick loss. Differential parental quality of pairs is inferred from these patterns.

Morris, R.D. 1988. Parent-offspring conflicts in Common Terns: the tactics of time-dependent winning. Proceedings of the 19th International Ornithological Congress 1260-1264.

The intraclutch hatching intervals of Common Terns (*Sterna hirundo*) lengthen during a breeding season despite equal egg–laying intervals. A testable hypothesis is that this pattern reflects adaptive advantage to the parents by permitting the potential for brood reduction in response to unpredictable food supply, especially late in a season. I measured rates of chick feeding and the reproductive success of two spatially separated groups of tern parents: (a) control pairs whose clutches were initiated during peak and late periods of egg laying; and (b) experimental pairs whose clutches were manipulated to hatch asynchronously (peak) and synchronously (late). For normal and poor food years, the hypothesis predicts (a) no difference in chick survival or parental reproductive success between control and experimental pairs (peak); and (b) reduced reproductive success or complete brood failure of experimental compared with control pairs (late). In the test year (1985), control and experimental pairs within each of the peak–and late–nesting groups realized similar reproductive success. Any disadvantage of late–hatched chicks or of chicks hatching asynchronously disappeared, suggesting high food availability throughout the season. I suggest that parents exert control over any parent–offspring conflict, at least until chicks become mobile. I also examine the extent and significance of adoption as a behavioural tactic of possibly disadvantaged chicks.

Morris, R.D., and R.A. Hunter. 1976. Factors influencing desertion of colony sites by Common Terns (*Sterna hirundo*). Canadian Field-Naturalist 90(2): 137-143.

During the years 1972 to 1974, factors affecting the breeding biology of Common Terns (*Sterna hirundo*) were studied at five colony locations in the lower Canadian Great Lakes. At three of these colonies, no terns returned to breed in 1974, but at two other locations numbers remained stable or increased. We consider availability of nesting substrate, reproductive failure, food supply, human disturbance, predation, and exploitation of Ring–billed Gulls as explanation for these observations. We conclude that whereas the most probable cause of desertion can be suggested for specific colonies, experimental work is required to identify the actual cause(s), which may be multiple.

Morris, R.D., and R.A. Hunter. 1976. Monitoring incubation attentiveness of ground-nesting colonial seabirds. Journal of Wildlife Management 40(2): 354-357.

Morris, R.D., Hunter, R.A., and J.F. McElman. 1976. Factors affecting the reproductive success of Common Tern (*Sterna hirundo*) colonies on the lower Great Lakes during the summer of 1972. Canadian Journal of Zoology 54: 1850-1862.

The breeding biology of five Common Tern (*Sterna hirundo*) colonies in the lower Great Lakes was studied between May and August 1972. Frequent visits were made to each colony and data collected on nests within large artificially enclosed areas. The objective was to identify factors that

influence the reproductive success of common tern colonies on the Great Lakes. Hatching success was significantly dependent on clutch size and time of clutch initiation, whereas fledging success was independent of clutch size. The most common category of egg failure was disappearance from the nest. One colony (Port Colborne) realized a significantly higher hatching and fledging success than the others, among which there were no significant differences in prehatch or posthatch success rates. Factors that contributed to differences in reproductive success are presented and their relative contributions to the reproductive success of the tern colonies are discussed. The factors include the relative proportion of three–egg clutches, incubation times as a measure of 'parent attentiveness', numerical size of the colony, predation, competition for nesting sites by gulls, food availability, flooding, and toxic chemicals. We conclude that no single factor can be readily correlated with reproductive success and suggest that caution should be exercised when considering the relationships between reproductive success and factors influencing it.

Morris, R.D., and G.T. Haymes. 1977. The breeding biology of two Lake Erie Herring Gull colonies. Canadian Journal of Zoology 55: 796-805.

The breeding biology of two Lake Erie Herring Gull colonies was studied from 1973 to 1976, emphasizing effects of clutch size and time of clutch initiation on reproductive success. In 1976, incubation attention of two–egg and three–egg clutches started early and late in the season was measured with a 20–pen event recorder. Chlorinated hydrocarbon residues in eggs were assessed in 2 years. Nest density was greater, clutch initiation more synchronized, and hatching success higher at one of the colonies. Hatching success and fledging success were independent of clutch size but early nesters were more successful than late nesters. Differences in hatching success between two–egg and three–egg clutches were a function of time of clutch initiation such that the clutch size with the greater proportion of its nests in the early period had a higher hatching success. The reproductive success of the Lake Erie colonies was intermediate among rates reported for other Great Lakes colonies but below those of most eastern North American or Eurpoean colonies. There were no significant differences in the incubation attention between two–egg clutches and three–egg clutches or between early and late three–egg clutches. Most clutches were incubated greater than 95% of the time although incubated less than 75% realized the same hatching success.

Morris, R.D., I.R. Kirkham, and J.W. Chardine. 1980. Management of a declining Common Tern colony. Journal of Wildlife Management 44(1): 241-245.

Morris, R.D., and J.E. Black. 1980. Radiotelemetry and Herring Gull foraging patterns. Journal of Field Ornithology 51(2): 110-118.

The movements of four brooding Herring Gull adults were followed for 25 days using commercially available telemetry equipment. Techniques to obtain precise information on distance, duration, and patterns of flight movements are described. Movement patterns of each bird were predictable and highly individualistic. Two individuals foraged at specific locations within 1 km of the colony whereas the other two took extended daily flights to destinations >30 km away. The former individuals successfully raised young whereas the latter lost chicks early in the brooding period. We suggest that radiotelemetry has great potential for defining clear relationships between adult movement patterns and differential brood success among pairs.

Morris, R.D., M.C. Benkel, A. Biernacki, and J.M. Ross. 1981. A new transmitter package assembly for adult Herring gulls. Journal of Field Ornithology 52(3): 242-243.

In 1978, commercially available transmitters were used to study movements of adult Herring Gulls (*Larus argentatus*) at a colony near Port Colborne, Ontario (Morris and Black, J. Field Ornithol. 51:110– 118, 1980). Two problems were identified with the procedures. First, some birds broke off

the whip antenna within a few days. This reduced signal range substantially. Second, as battery life is limited, adults recaptured in 1979 required a complete removal of the package and replacement with new equipment. To circumvent these problems, we designed a new transmitter package.

Morris, R.D., and M.J. Bidochka. 1982. Mate guarding in Herring Gulls. Colonial Waterbirds 5: 124-130.

The frequencies of aggressive acts towards intruders and of copulation bouts by partners in Herring Gull (*Larus argentatus*) pairs were determined for the time period from nest construction through hatching of first chicks. In each of 2 years (1980/81), males were consistently more aggressive than were females. Aggression by males was greatest during the copulation and egg–laying period, whereas aggression by females was relatively constant throughout. Male aggression was always highest when a mate was present. Aggressive acts by members of either sex prevent intrusion by conspecifics into territorial space. For males, aggressive acts also assure certainty of paternity by preventing access to their females by other males.

Morris, R.D., and J.W. Chardine. 1985. The effects of ice cover over the colony site on reproductive activities of Herring Gulls. Canadian Journal of Zoology 63: 607-611.

The substrate at a Herring Gull (*Larus argenatus*) colony on Lake Erie near Port Colborne, Ontario (Lighthouse), was completely covered by a thick layer of ice throughout April and early May 1982. Egg laying normally begins at this location in mid–April. An adjacent Herring Gull colony (Canada Furnace) was ice free. Herring Gull pairs at the Lighthouse colony defended territories on top of the ice but only 3 of about 90 pairs built nests on the ice. Birds neither deserted the colony nor moved within it to ice–free areas as these became available. The mean date of egg laying at the Lighthouse colony in 1982 was about 2 weeks later than in the previous year. At the adjacent Canada Furnace colony, there was no difference in the mean date of egg laying between the 2 years. There were no differences in the distribution of clutch sizes, mean clutch sizes, or hatching success of three–egg clutches laid within $\pm$ 1 SD of the mean date of egg laying at either colony in the 2 years. By these measures, the ice–induced delay in breeding chronology of birds at the Lighthouse colony in 1982 did not adversely effect reproductive performance in that year.

Morris, R.D., and D.A. Wiggins. 1986. Ruddy Turnstones, Great Horned Owls, and egg loss from Common Tern clutches. Wilson Bulletin 98(1): 101-109.

In two successive years, eggs of Common Terns (*Sterna hirundo*) disappeared or were found freshly perforated only from clutches initiated relatively early in the breeding season. Most of the losses were of single eggs from which an incubating adult was temporarily absent. Diurnal dreads of adult terns coincided with evidence of nocturnal predation by Great Horned Owls (*Bubo virginianus*). Ruddy Turnstones (*Arenaria interpres*) were observed breaking open and eating the contents of Common Tern eggs. We consider various explanations of the timing and pattern of egg loss. Circumstantial evidence supports the suggestion that nocturnal disturbance by owls at a time when Ruddy Turnstones are present at the colony may increase the risk of daytime predation by turnstones on tern eggs.

Morris, R.D., and J. Siderius. 1990. A treatment for prevention of hatching in field-incubated Ring-billed Gull eggs. Journal of Wildlife Management 54(1): 124-130.

Numbers of Ring–billed Gulls (*Larus delawarensis*) have increased on the Great Lakes and upper St. Lawrence River since 1974, and reduction in the size of some colonies may be justified for nuisance control or safety reasons. One management procedure is to prevent the hatching of eggs without desertion of clutch by adults. Our objective was to test the extent of hatching suppression induced by several chemical treatments on (1) fertile, domestic chicken eggs in laboratory incubators, and (2) Ring–billed Gull eggs in the field. Hatchability of chicken eggs was significantly

reduced ($P < 0.05$) by 2 applications of light–grade commercial petroleum oil and, in the field, hatchability of Ring–billed Gull eggs was reduced to zero by 2 applications of the oil irrespective of the stage of embryo development. Adults continued to incubate treated eggs for >6 weeks beyond the expected hatching time. Higher rates of preening and readjustment of nesting material were noted among adults incubating treated clutches compared to control adults. However, none of the experimental pairs deserted their clutches or renested in the breeding season of study.

Morris, R.D., M. Woulfe, and G.D. Wichert. 1991. Hatching asynchrony, chick care, and adoption in the Common Tern: can disadvantaged chicks win? Canadian Journal of Zoology 69: 661-668.

In 1987 and 1988, Common Tern (*Sterna hirundo*) chicks at a colony near Port Colborne, Ontario, were individually colour banded according to known hatch order. Intraclutch hatch intervals produced size disparities among chicks at brood completion; third–hatched chicks were significantly lighter and at a significant survival disadvantage compared with their earlier–hatched siblings. There were differences in feeding rates according to hatch order and many third–hatched chicks obtained fewer or no feedings during our periods of observation. Sixty–five chicks known to have abandoned their home broods gained acceptance into foreign broods. Chicks that remained in the foreign brood for more than 2 days (average residency 11.9 ± 5.3 days; $n = 26$) were fed and brooded by the foster parents, were on average older than the youngest resident chick, but were not always the last hatched in their home brood. Conversely, chicks that were in a foreign brood for less than 2 days were no different in age from the youngest resident chick. Survival and fledging success was highest for chicks accepted into two chick broods in which they were older than the resident second chick; in effect, the adoptee became the second chick. Parents that accepted a foreign chick for more than 2 days experienced a seasonal fitness loss compared with nonadopting parents. As the only viable option available to them, selection favours movement away from home broods by chicks that may be disadvantaged there.

Morris, R.D., and G.P. Burness. 1992. A new procedure for transmitter attachment: effects on brood attendance and chick feeding rates by male Common Terns. Condor 94: 239-243.

A transmitter crystal and battery were covered with epoxy and wired to a size 2 USFWS aluminium leg band. The male partners of 10 Common Tern (*Sterna hirundo*) pairs were captured during late incubation at a Port Colborne, Ontario tern colony and the transmitter units fixed to their legs. The total package weighed an average 1.08 g more than the usual mass of a single band. The brood attendance patterns and feeding frequency rates of transmittered–males and of their female partners were contrasted over a 20–day period with those of non–transmittered males and their partners. No differences were found. Advantages of the attachment procedure are speed of attachment, light mass, rapid loss of antennae following battery exhaustion, and lack of adverse effect on parental behaviour.

Morris, R.D., H. Blokpoel, and G.D. Tessier. 1992. Management efforts for the conservation of Common Tern *Sterna hirundo* colonies in the Great Lakes: Two case histories. Biological Conservation 60: 7-14.

Numbers of Common Tern *Sterna hirundo* colony sites have declined throughout the lower Great Lakes since the early 1970s. For the past 10–13 years, we have developed and tested management procedures to maintain numbers of breeding pairs. At an insular colony site near Port Colborne on Lake Erie, management procedures included protection from human disturbance, substrate rehabilitation, prevention of nesting on tern substrate by Ring–billed Gulls *Larus delawarensis* and control of egg/chick predation by Ring–billed and Herring *L. argentatus* Gulls. At the Eastern Headland in Lake Ontario, management efforts included vegetation control, monofilament lines to prevent nesting by gulls, control of human disturbance, and construction of new nesting habitat. Success in maintaining numbers of breeding pairs was high at Port Colborne but poor at the Eastern Headland. We discuss probable reasons for the differences in success at

the two colonies. As extirpation of a species from broad geographic areas may often begin with isolated local declines in numbers of breeding pairs, regular management procedures at local colonies are desirable.

Moseley, E.L. 1891. The White Headed Eagle in northern Ohio. American Naturalist 29: 168-170.

Moseley, E.L. 1900. Occasional abundance of certain birds on or near Lake Erie. Ohio Academy of Science, 8th Annual Report 1899: 12-15.

Moseley, E.L. 1901. Oldsquaw ducks (not "pintails") caught in deep water fish nets. Ohio Academy of Science, 9th Annual Report 1900: 19-20.

Moseley, E.L. 1930. Fluctuatations of bird life with changing water level. Wilson Bulletin 42(3): 191-193.

Moseley, E.L. 1931. The heronries of northern Ohio. Ohio Journal of Science 31(4): 270.

Munroe, P.L. 1964. Territory selection by ducks in Long Point Marsh. Seminar paper at University of Guelph, Guelph, Ontario.

Munroe, P.L. 1965. An ecological survey of Long Point marsh, with special reference to duck production. M.Sc. thesis. University of Guelph, Guelph, Ontario.

In this project two parts of the Marsh, Wood Duck Alley and the Pond-between-the-Ridges (see Map 2) were selected for intensive study. They were on the whole, representative of the more biologically productive parts of the study area. Both waters were more frequented by waterfowl than most other parts of the property. Finally, the two bodies, so different ecologically, brought into sharp focus a basic characteristic of the Marsh, its ecological complexity.

Nol, E. 1980. Factors affecting the nesting success of the Killdeer (*Chardrius vociferus*) on Long Point, Ontario. M.Sc. thesis. University of Guelph, Guelph, Ontario.

Three field experiments were conducted to investigate effects of predation and anti-predator behaviour of the Killdeer (*Charadrius vociferus*) on the nesting success of this species. Additionally, incubation behaviour was analyzed to determine the role of various behaviours on nesting success.

Norstom, R.J., T.P. Clark, J.P. Kearney, and A.P. Gilman. 1986. Herring Gull energy requirements and body constituents in the Great Lakes. Ardea 74: 1-23.

Page, G. 1967. Mist netting shorebirds at Long Point, Lake Erie. Ontario Bird Banding 3: 79-83.

Page, G. 1970. The relationship between fat deposition and migration in the Semipalmated Sandpiper. M.Sc. thesis. University of Guelph, Guelph, Ontario.

In order to clear up some of the confusion concerning the role of fat deposition in the migration of birds, the pattern of lipid depostion and migration was studied in the Semipalmated Sandpiper (*Ereunetes pusillus*). The Semipalmated Sandpiper was chosen because it is one of the commonest North American shorebirds with a long and easily definable migration. Shorebirds are ideally suited for field, migrational studies because they usually occur in restricted patches of shoreline habitat during migration whereas land birds are dispersed throughout a wide variety of terrestrial habitats.

Page, G., and M. Bradstreet. 1968. Size and composition of a fall population of Least and Semipalmated

Sandpipers at Long Point, Ontario. Ontario Bird Banding 4: 82-88.

The number of Least and Semipalmated Sandpipers occurring on the south beach of Long Point during the fall migration of 1967 was found to be slightly in excess of 1,000, which is considerably less than the figure obtained from summation of daily censuses. Changes in the composition of the fall population of Least and Semipalmated Sandpipers lends support to the hypothesis that much of the ability required to complete the fall migratory flight is innate.

Page, G., and A. Salvadori. 1969. Weight changes of Semipalmated and Least Sandpipers pausing during autumn migration. Ontario Bird Banding 5: 52-58.

Weight aspects of the Semipalmated and Least Sandpiper were examined during the autumn migratory pause at Long Point, Ontario. As a result of variations in their fat levels, these sandpipers exhibited a wide range of weights. The adults were on the average heavier than the juveniles. Weight changes during the migratory pause indicated that there is an increase in fat levels at a rate which is possibly greater for adults than juveniles. Although fat deposition was a very conspicuous aspect of the stop–over period there was only a slight indication that fat levels may influence the duration of the pause.

Palmer, R.S. 1964. Lake Erie niche for Ring-billed Gulls nesting on Mohawk Island. Natural History 73: 48-51.

Parris, R.W., and G.A. Grau. 1978. Feeding sites of Great Blue Herons in southwestern Lake Erie. Proceedings of the Colonial Waterbird Group: 110-113.

The major feeding areas of Great Blue Herons from one island and several mainland colonies were studied for two breeding seasons, 1977 and 1978, in northwestern Ohio. Observations of heron flight directions to and from colonies and feeding areas, and radio–telemetry were used to document major feeding areas. Flight directions from all colonies exhibited a nonrandom pattern, and major flight lines were constant over the season and between years. The mainland colonies, approximately 2200 breeding adults, were in close proximity to one another and overlapped in feeding areas. The island colony, approximately 2300 breeding adults, was located eight miles from the mainland and was 20 miles from the closest mainland colony. The mainland herons foraged within 6 miles of the colonies in 11,00 acres of wetland, and the island nesting herons foraged 8 to 18 miles from the colony in 12,000 acres of wetland. Feeding sites for these two groups overlapped on 900 acres. Although distances traveled to obtain food varied between the two nesting populations, the herons from each colony used the closest foraging areas to their respective colony. The two breeding populations also foraged in similar amounts of wetland habitat.

Pauls, K., and R. Knapton. 1993. Submerged macrophytes of Long Point's Inner Bay: their distribution and value for waterfowl. Technical Paper 1. In: J.G. Nelson and P. Lawrence (eds.). Long Point Environmental Folio Series, Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

This paper is divided into four sections: Study Area, Method, Results, and Discussion. First, a detailed description of the Inner Bay is provided to show abiotic factors which may influence macrophyte growth. Second, the steps and materials involved in the macrophyte survey of the Inner Bay as well as the steps and materials involved in diet analyses of waterfowl are outlined. Third, the 1992 distribution of the most frequently observed submerged macrophytes are presented and then are compared to findings of the 1991 survey and of Smith's 1976 survey. This section also outlines the dietary habits of nine different species of waterfowl (n=409) sampled at Long Point. Fourth, the discussion section interprets data, and discusses possible implications and limitations of these findings.

Peakall, D.B., G.A. Fox, A.P. Gilman, D.J. Hallett, and R.J. Norstrom. 1978. The Herring Gull as a monitor of Great Lakes contamination. Proceedings of the International Symposium on the analysis of hydrocarbons and halogenated hydrocarbons in the aquatic environment.

In our work on the Great Lakes we have used the Herring Gull as an indicator species. The Herring Gull eats a wide variety of food and is thus an indicator of overall pollution in the area. The adults of this species are essentially resident within the Great Lakes basin, although there is some movement from lake to lake. The Herring Gull nests colonially and thus the entire breeding population of large areas can be counted. Lastly the species is widely distributed throughout the holarctic enabling direct comparisons between work carried out in North America and Europe.

Peakall, D.B., and G.A. Fox. 1987. Toxicological investigations of pollutant-related effects in Great Lakes gulls. Environmental Health Perspectives 71: 187-193.

Reproductive failure of a number of fish–eating birds was observed on the Great Lakes in the mid–1960s to mid–1970s. The Herring Gull (*Larus argentatus*) has been used as the primary monitoring species. The low hatching success observed in this species on Lake Ontario in the mid–1970s was due to loss of eggs and failure of eggs to hatch. Egg exchange experiments demonstrated that this was due both to the incubation behaviour of adults and to direct embryotoxic effects. Decrease of nest attentiveness was demonstrated using telemetered eggs, but attempts to reproduce the embryonic effects by injection of pollutant mixtures into eggs were not successful.

Reproductive success improved rapidly during the late 1970s and was normal by the end of the decade. Recent studies have focused on cytogenetic and biochemical changes and detailed analytical chemistry of residues. No changes in the rate of sister chromatid exchange over values determined in coastal colonies were observed. Elevation of hepatic aryl hydrocarbon hydroxylase activity, levels of highly carboxylated porphyrins, and changes of thyroid function have been found. The geographic pattern of these changes indicates that they are caused by xenobiotics, but it has not been possible to relate the changes to a specific chemical.

Pettit, K.E., C.A. Bishop, D.V.C. Weseloh, and R.J. Norstrom. 1994. An atlas of contaminants in the eggs of fish-eating colonial birds of the Great Lakes (1989-1992). Volume 1; Accounts by location: Volume 2, Accounts by chemical. Technical report series Nos. 193&194. Canadian Wildlife Service, Ontario Region.

During 1989-1992, Canadian Wildlife Service (Ontario) collected a total of 1495 eggs from fish-eating colonial birds from 50 colonies throughout the Great Lakes to measure the levels of 86 chlorinated hydrocarbon compounds, and the lipid concentrations present. These data were generated as part of a monitoring program started in 1970 to understand the temporal and spatial trends in environmental contaminant levels in environmental contaminant levels in biota of the Great Lakes. During 1989-1992, the levels of chlorinated hydrocarbons in colonial waterbird eggs have remained relatively stable within colonies across the Great Lakes. This is consistent with trends occurring in the mid-1980s in fish-eating colonial bird eggs from the Great Lakes as reported in *An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988) Volume 1, Accounts by Species* and *An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988) Volume II, Accounts by Chemical* (Bishop *et al*., 1992a; 1992b).

The data from 1989-92 are summarized in two volumes. Volume I contains contaminant data summarized by location. Non-coplanar PCB cogener levels, patterns and interpretation of these patterns are also included in Volume I for Herring Gull eggs from 14 annual monitoring colonies. Volume II contains contaminant data summarized by compound analyzed. Both volumes contain sample locations and number of samples collected for each species each year, and pooled values or means and standard deviations for organochlorine pesticide, polychlorinated biphenyl, dioxin and furan concentrations.x

Planck, J.T. 1981. A brief preliminary report on waterfowl activity in southwestern Thoroughfare Point Unit, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Planck, J.T. 1982. Management implications of autumn waterfowl activity in the Throughfare Point Unit, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Postupalsky, S. 1976. Toxic chemicals and cormorant populations in the Great Lakes. Manuscript report No. 40. Wildlife Toxicology Division, Canadian Wildlife Service, Ottawa, Ontario.

This is a preliminary report of investigations into the changing population status of the Double–crested Cormorant (*Phalacrocorax auritus*) in the Great Lakes. A more detailed account including full documentation is in preparation and will be published elsewhere. The object of the present report is (1) to briefly review the historic status of the cormorant in the Great Lakes, (2) to compare it with results of recent field investigations, (3) to explore probable causes of the observed population changes, and (4) to examine the role of certain toxic pollutants in the observed population phenomena.

Prince, H.H., P.I Padding, and R.W. Knapton. 1992. Waterfowl use of the Laurentian Great Lakes. Journal of Great Lakes Research 18(4): 673-699.

Literature on habitat and limiting factors of waterfowl in Great Lakes wetlands and deep water habitats is reviewed; more than 30 species of waterfowl use coastal habitats at some time during the year. Waterfowl use of the Great Lakes has declined dramatically from presettlement times; the obvious cause is human encroachment on coastal wetlands and destruction of river delta and embayed wetland complexes. Loss of wetland habitats from diking and filling above the average water level constitutes a permanent habitat loss, especially during high water cycles. The greatest number of species and individuals use 15 concentration areas during the spring and fall migratory periods when use by diving ducks, sea and stiff tailed ducks, and swans and geese predominates. Lesser numbers of species use the coastal wetlands for breeding. Large concentrations of dabbling ducks, primarily Mallards (*Anas platyrhynchos*) and American Black Ducks (*A. rubripes*), and mergansers (*Mergus spp.*) are found on ice–free areas during winter. Wetland habitats have become more favourable, due to human modifications, to dabbling duck species found in the prairie habitats of North America. Mallards have become the most numerous species breeding in coastal wetlands along with a concomitant decline in Black Ducks, which may be a consequence of introgression. Habitat modifiations, degradation, and loss have great potential to affect existing waterfowl populations negatively and to point the way toward future research.

Puffer, D.A. 1979. The 1967-1977 Long Point wildlife management area waterfowl harvest as an indicator of kill and migration of common ducks in Ontario. B.Sc. thesis. The University of Western Ontario, London, Ontario.

A localized waterfowl harvest at Long Point, Ontario was compared with the provincial and regional harvest estimates compiled from the Canadian Wildlife Service Species Composition Survey for the years 1968 to 1977. Significant correlations were found between yearly totals from the two sources for only Canvasback, Lesser Scaup and Mallard. Thus, the Long Point kill showed little promise as an indicator of provincial and regional harvest estimates.

The Long Point duck kill for 10 years was used as an indicator of migration chronologies of 14 common duck species. These were compared to Canadian Wildlife Service aerial surveys of the same area. General agreement was found in the data for Ring–necked Duck, Canvasback, Blue–winged Teal and Redhead. Some differences were found in the data for Black Duck, Goldeneye, Green–winged Teal, Wigeon and Mallard. Major discrepancies were found in the data

for Bufflehead, Pintail, Gadwall, Greater and Lesser Scaup. Hunter–kill provided a more sensitive index to migration chronologies than aerial surveys but did not indicate waterfowl numbers. A combined application of both hunter–kill and aerial surveys was an effective indicator of migration behaviour and the responses by waterfowl to hunting pressure at Long Point.

Quinn, J.S., L.A. Whittingham, and R.D. Morris. 1994. Infanticide in skimmers and yerns: side effects of territorial attacks or inter-generational conflict? Animal Behaviour 47: 363-367

Chicks of colonial ground–nesting larids sometimes wander away from their home broods and are killed by neighbours, or occasionally adopted by foster parents. Hypotheses that explain infanticide in larids include selectively neutral infanticide during territory defence (selectively neutral territoriality) and prevention of misdirected parental care (inter–generational conflict). Some of the data from Black Skimmer, *Rynchops niger*, and Common Tern, *Sterna hirundo*, colonies are consistent with the inter–generational conflict hypothesis and inconsistent with the selectively neutral territoriality hypothesis.

Reed, L.W. 1971. Use of western Lake Erie by migrating and wintering waterfowl. M.Sc. thesis, Michigan State University, East Lansing, Michigan.

Ridout, R. 1994. Baseline assessment and monitoring of marsh bird and amphibian populations in Great Lakes areas of concern. Interim report to the Great Lakes Cleanup Fund and Environment Canada.

Richard, D.I. 1968. The movement patterns of populations of Red-winged Blackbirds, *Agelaius phoeniceus*, in the western Lake Erie basin. Ph.D. Dissertation, The Ohio State University, Columbus, Ohio.

Richards, M.H., and R.D. Morris. 1984. An experimental study of nest site selection in Common Terns. Journal of Field Ornithology 55(4): 457-466.

The Port Colborne Lighthouse–breakwall complex supports the second largest breeding colony of Common Terns (*Sterna hirundo*) on the Canadian Great Lakes. Birds nesting early in a breeding season tradionally occupy a preferred substrate area (logs, rocks, ground cover) at the western end of the linear colony site. Later nesting birds occupy remaining, open concrete substrate sites to the east. An experimental study area was established at the eastern end of the breakwall in late May 1982. The area contained 2 replicates each of 3 substrate types (control – bare concrete; enhanced – small rocks only; super–enhanced – small rocks, logs, plants). Late nesting terns which occupied the area preferred vegetated, high relief nesting substrate (super–enhanced) similar to that at the western end of the colony. Few terns nested on the control sites (bare concrete), the traditional nesting substrate of late breeders at this colony. Mean clutch size, hatching, and fledging success were all higher on the super– enhanced substrate. Eggs and chicks disappeared at higher rates on the enhanced than on the super– enhanced substrates. We suggest that a greater visibility of both eggs and chicks on the enhanced substrates (small rocks only) contributed to a greater loss rate due to predation than was the case on the super–enhanced substrates. Suitable substrate enhancement procedures, based on knowledge of preferrred substrates at a particular colony, is a valuable management tool for improving productivity of late nesting terns.

Richardson, M., and R.W. Knapton. 1993. Regional use, selection preferences and nesting success of Wood Ducks using large volume nest boxes in Ontario. Canadian Field-Naturalist 107: 293-304.

Roberts, J.O.L. 1966. Point Pelee bird banding station report for years 1959-1962. Ontario Bird Banding 2(1): 1-28.

Robinson, J.T., and J. Barbeau. 1982. Summary of breeding bird surveys for 1981 and 1982 in Gravelly Bay study corridor. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Robinson, J.T., and G. McCullough. 1988. Project summary report: Long Point National Wildlife Area Bald Eagle project. 1983-87. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Ross, R.K., D.G. Dennis, and G. Butler. 1984. Population trends of the five most common duck species breeding in southern Ontario, 1971-76. In: S.G. Curtis, D.G. Dennis, and H. Boyd (eds.). Waterfowl studies in Ontario, 1973-81. Canadian Wildlife Service Occasional Paper No. 54.

Trends in the populations of the five duck species breeding most abundantly in southern Ontario were examined for the period 1971–76 using systematic ground survey data from a maximum of 463 study plots, each of 64 ha. Total duck numbers increased because of increases of Mallards, Blue–winged Teal, and Wood Ducks. Those species were either responding positively to changes in the environment, e.g. increased beaver activity, or were expanding into previously unoccupied habitat. Black Ducks and Green–winged Teal appeared to be declining, although those trends could not be demonstrated statistically. The only species that showed a clear relationship between duck abundance and habitat change in the study plots was the Blue–winged Teal. Such a correlation also proved significant for total duck numbers, and points to the likelihood of population declines in the near future if there is net habitat deterioration. Monitoring of waterfowl populations in southern Ontario will continue at regular intervals and detailed habitat data will be collected to learn more about the requirements of each species and the impacts of habitat change.

Ruttan, N. and C.D. Ankney. 1976. Some aspects of the 1975 waterfowl migration at Long Point Bay, Ontario. B.Sc. thesis. The University of Western Ontario, London, Ontario.

During the fall of 1975, hunter kill was used to index migration of five species of diving ducks (*Aythya valisineria*, *Aythya americana*, *Aythya affinis*, *Aythya marilis* and *Aythya collaris*) and of Mallards (*Anas platyrhynchos*) into the Long Point, Ontario area. Although population levels of ducks in the area remained high, the hunter kill varied. It was thought than an increase in the kill of ducks by hunters resulted from an influx of ducks to the area, while a decrease in the kill of ducks was caused by an efflux of ducks, or alternatively by decreased vulnerability of ducks which stayed in the area but became wary and experienced.

From my observations it appears that adult Mallards, Canvasbacks, Redheads, Lesser Scaup and Greater Scaup were less vulnerable to hunting at Long Point in 1975 than they were at other areas in North America during 1966–1973 as calculated by Bellrose (1975). It is postulated that experienced adults can avoid hunters at Long Point by using the outer bay as a sanctuary during the day. Feeding flights to the inner bay are probably made nightly.

Adult male Mallards migrated later in the season than did all other classes. Migration of adult male Canvasbacks and Redheads took place before and after the main flow of migration. Adult male Lesser Scaup all migrated in the first of three peaks of Lesser Scaup migration. Male Greater Scaup made up a high proportion of hunter kill late in the season.

Female Lesser Scaup were killed in higher proportions than expected from known sex ratios of the species, perhaps because they were in the area in high proportions at a time of high hunting pressure. No clear difference was seen in weekly proportions of male and female Ring–necked Ducks. The difference in migration dates of adult male ducks of aforementioned species was believed to result from their geographic separation from all other age and sex classes prior to beginning migration.

Scharf, W.C. 1989. Coastal Great Blue Heron and Great Egret colonies of the Michigan Great Lakes. Jack Pine Warbler 67(2): 53-65.

Scharf, W.C., G.W. Shugart, and M.L. Chamberlain. 1978. Colonial birds nesting on manmade and natural sites in the U.S. Great Lakes. Technical Report D-78-10, No. FWS/OBS-78/15, U.S. Army Engineer Waterways Experient Station. Vicksburg, Michigan.

Schoen, R.B., and R.D. Morris. 1984. Nest spacing, colony location, and breeding success in Herring Gulls. The Wilson Bulletin 96(3): 483-488.

Shipman, C.M. 1927. Nesting of the Herring Gull and some other birds on Lake Erie islands. Auk 44: 242-243.

Shugart, G.W., and W.C. Scharf. 1981. Great Lakes Common Terns (*Sterna hirundo*): Status of Michigan colonies. Colonial Waterbirds 4: 201.

We examined published 1962, 1976 and 1977 census data to identify trends and problems associated with the decline in Common Terns nesting at colonies along 2000 km of Michigan shoreline (approx. 20% of the total Great Lakes shoreline). In 1962, 2885 pairs nested at 12 colonies. Nesting pairs declined to 1426 at 14 colonies in 1976. Only three of the 1962 sites were used in 1976, the remainder were new. Two new sites were added in 1977, but only 794 pairs nested. The reduction in the number of pairs nesting and increased number of colonies reflects the loss of established nesting sites due to human activities, inundation by cyclic high water during the late 1960s and 1970s, and predation at newly established sites.

To determine if the trend evident from the literature was continuing, we collected comparative data in 1980. We counted 1496 nests at 15 colonies. The apparent recovery from 1977 resulted primarily from the growth of two colonies at man–made sites where 62% of the pairs nested in 1980. Our 1980 census data indicate that recovery to 1962 levels may be hindered by a lack of suitable colony sites.

Smith, D.W. 1979. Ecological isolation between *Aythya* species at Long Point Bay, Ontario. M.Sc. thesis. The University of Western Ontario, London, Ontario.

Ecological isolation between fall migrating diving ducks, Canvasback (*Aythya valisineria*), Redhead (*A. americana*),Lesser Scaup (*A. affinis*), Greater Scaup (*A. marila*) and Ring–necked Duck (*A. collaris*) was investigated at Long Point Bay, Ontario, during 1975 and 1976. Ring–necked Ducks used a different habitat (marsh ponds) than the other 4 species. Canvasbacks and Redheads used a different part of the open water habitat in the Bay than did Lesser and Greater Scaup. Canvasbacks and Redheads as well as Lesser and Greater Scaup were ecologically isolated from each other by having different diets.

It is suggested that the different means of ecological isolation between the ducks are adaptive, allowing the ducks to occur together without competition for the food resources of Long Point Bay.

Length and width of bill, gizzard weight, small intestine (gut) and total cecum lengths were measured for each duck species. A relationship was found between diet of each species and bill shape and digestive organ sizes. Redheads had the highest fiber diet and the heaviest gizzard and longest ceca. Lesser Scaup had the most diverse diet and the longest gut.

Smith, D.W. 1995. Synchronous response of hydrophobic chemicals in Herring Gull eggs from the Great Lakes. Environmental Science and Technology 29: 740-750.

Herring Gull eggs from Great Lakes nesting sites exhibit short-term changes in hydrophobic chemical concentrations that are synchronized within and between Great Lakes. At one Lake Ontario site, for example, short-term trends for PCBs, DDE, mirex, hexachlorobenzene, and dieldrin in gull eggs tend to correlate significantly with each other, with these chemicals at another

site in Lake Ontario, and with gull egg chemicals from Lakes Superior, Huron, and Erie. Similar comparisons made for other Great Lakes are also significantly nonrandom. This synchrony indicates that some large-scale force - here proposed to be weather patterns - controls short-term patterns of hydrophobic chemical concentrations in gull eggs across the Great Lakes. Among eight alternative hypotheses considered, the data are least inconsistent with the following mechanism: warm spring weather conducive to phytoplankton growth produces relatively uncontaminated phytoplankton, which in turn produce less contaminated food for the gulls during the critical period of egg yolk formation (and vica versa for cold spring weather).

Smith, V.E., J.M. Spurr, J.C. Filkins, and J.J. Jones. 1985. Organochlorine contaminants of wintering ducks foraging on Detroit River sediments. Journal of Great Lakes Research 11(3): 231-246.

Organochlorine analysis was performed on carcasses of 13 diving ducks from a 1981 wintering population that foraged on contaminated sediments in the lower Detroit River. Mean total PCB concentrations were 10 mg/kg for seven Lesser Scaups (*Aythya affinis*), 11 mg/kg for three Greater Scaups (*A. marila*), and 7.6 mg/kg for three Goldeneyes (*Bucephala clangula*). Highest mean levels of other residues were measured for hexachlorobenzene (1.7 mg/kg) in Goldeneyes, and trans–nonachlor (0.33 mg/kg) and 4,4'–DDE (1.3 mg/kg) in Greater Scaup. Quantitative analysis of 72 PCB congeners also was applied to water, seston, sediment, benthic oligochaetes, and carp from the same site. Principal congeners in most of the samples included some of the more toxic and persistent PCBs. Results of a multivariate analysis indicated that ratios of more conservative to less conservative PCBs did not vary significantly among ducks (a = .05), but differed from those in carp, oligochaetes, and sediment. For the February through March period of fat mobilization, concentrations of total PCB in lipid were inversely correlated with percent lipid (r = 0.76) in ducks. The percentage of conservative PCBs increased slightly. The distribution and partitioning of organochlorines, including toxic PCB congeners, varied considerably within this water column–sediment–fauna ecosystem. Estimates of toxic exposure based on total PCB values may be unreliable.

Snyder, L.L. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. I General introduction. Transactions of the Royal Canadian Institute 18(39): 117-125.

Snyder, L.L. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. III The birds of Long Point and vicinity. Transactions of the Royal Canadian Institute 18(39): 139-229.

Soares, M.G. 1986. Long Point Bird Observatory, Ontario. American Birds 40(1): 21-25.

Southern, W.E. 1974. Seasonal distribution of Great Lake region Ring-billed Gulls. Jack-Pine Warbler 52(4): 153-179.

Over 18,000 Ring–billed Gull band encounters were analyzed by aid of a computer program that sorted data into 12 different categories, plotted encounter locations as a map overlay, and performed various calculations.

The breeding status of this species has changed significantly on the Great Lakes since the early 1900's. The primary breeding range is between 42° and 47°N latitude and 71° and 87°W longitude. Adults begin arriving in the nesting colonies in late March, and by May 74% of the band encounters are from the Great Lakes. Departure of juveniles and adults from colonies begins in late July and terminates in early August.

The present postbreeding range is similar to that described for the early 1900's, although population density may be significantly greater at some localities. During August and September dispersal is widespread but there is an increasing tendency to accumulate in the lower Great Lakes Region. During October, southward migration is more apparent. Large concentrations develop on

Lake Erie during November and December and this may represent a staging area for continued migration. Encounters increase in Florida and other southern areas during November and December, reaching a peak in January and February. During these months over 50% of the encounters are from Florida. Other areas having a significant number of encounters include the Carolina–Georgia Coast, Chesapeake Bay, the Gulf coast and the lower Great Lakes. Fewer recoveries were obtained from localities near inland waterways or from scattered regions apparently outside the primary postbreeding range (e.g. Cuba, Columbia).

Northward migration begins in late February and during March and early April most Ring–billed Gulls leave the southern extreme of their range. May encounters for Florida decrease to 3% whereas the Great Lakes proportion increases to 74%. A migratory corridor exists between the Great Lakes Region and the Atlantic coast near Chesapeake Bay. A significant number of encounters come from this area during spring and fall.

Spear, P.A., D.H. Bourbonnais, R.J. Norstrom, and T.W. Moon. 1990. Yolk retinoids (Vitamin A) in eggs of the Herring Gull and correlations with polychlorinated dibenzo-*p* - dioxins and dibenzofurans. Envionmental Toxicology and Chemistry 9: 1053-1061.

Little is known of the combined effects associated with chronic, low–level exposure of wildlife to the polyhalogenated dibenzo–p–dioxins, dibenzofurans, certain biphenyls and other related compounds. To examine possible effects upon egg yolk retinoids, Herring Gull (*Larus argentatus*) eggs were collected at early (i.e., days 2–12) and late (i.e., approximately day 20) phases of incubation. Analysis of egg yolks by reversed–phase high–performance liquid chromatography revealed compounds that comigrated with all–trans–retinol and all–trans–retinyl palmitate standards. The retinol concentration and the molar ratio of retinol to retinyl palmitate changed significantly between the early and late phases of incubation. Within the 2– to 12–d period of incubation, however, retinoid values were constant. Gull eggs were collected from two breeding colonies on the Great Lakes in 1986 and from five colonies in 1987. In 2– to 12–d eggs, retinol and retinyl palmitate concentrations were significantly different between gull colonies. The molar ratio of retinol to retinyl palmitate was significantly different between colonies and correlated with several indices of polychlorinated dibenzo–p–dioxin and dibenzofuran concentrations quantified in gull eggs from these collection sites. Significant correlations existed between the molar ratio of retinoids and (a) 2,3,7,8–TCDD concentration, (b) toxic equivalents of PCDDs and PCDFs and (c) the sum of PCDD and PCDF concentrations. These results are discussed in the context of sensitive, bioeffects monitoring.

Sprunt, A. IV, W.B. Robertson Jr, S. Postupalsky, R.J. Hensel, C.E. Knoder, and F.J. Ligas. 1973. Comparative productivity of six Bald Eagle populations. In: Transactions of the 38th North American Natural Resources Conference, Washington, DC, pp. 96-106.

Stock, L.J. 1956. Inventory of public hunting grounds and waterfowl refuges in Lake Erie district, 1956. Ontario Department of Lands and Forests, Simcoe, Ontario.

Stoll, R.J. 1969. A Pheasant population study on Kelleys Island, Ohio. M.Sc. thesis, The Ohio State University, Columbus, Ohio.

Struger, J., D.V. Weseloh, and T. Kubiak. Progress report on the occurence of congenital anomalies in Double-crested Cormorants and Herring Gulls in the Great Lakes area. Unpublished manuscript to Canadian Wildlife Service, Burlington, Ontario.

Struger, J., and D.V. Weseloh. 1985. Great Lakes Caspian Terns: Egg contaminants and biological implications. Colonial Waterbirds 8(2): 142-149.

Levels of contaminants and eggshell thickness were measured in eggs of Caspian Terns from

seven colonies in Lakes Michigan, Huron, and Ontario in 1980/1981. Levels of PCBs, DDE, mirex and hexachlorobenzene (HCB) ranged from 18.5–39.3 ppm (wet wt.), 3.3–8.8 ppm, 0.04–1.57 ppm and 0.03–0.06 ppm, respectively. Eggs from Lake Ontario (Pigeon Is.) had the greatest levels of PCBs, HCB and mirex. DDE levels were greatest in eggs from Lake Michigan (Gravelly Is.). Eggshell thinning ranged from 0 on Hat. Is. and Ile aux Galets (L. Michigan) to 7.4% on South Limestone Is. (L. Huron). Reproductive success on two Lake Michigan colonies was 1.2–1.3 young/pair. Most residue levels of DDE, PCBs, and mirex in eggs of Caspian Terns from the Great Lakes in 1980 and 1981 have decreased from past levels and do not appear to have had a serious effect on reproduction, eggshell thickness and past and present population size and growth. Camparisons with organochlorine residues in Herring Gulls indicated that generally similar bioaccumulation patterns of contaminants occurred in the two species.

Struger, J., D.V. Weseloh, D.J. Hallett, and P. Mineau. 1985. Organochlorine contaminants in Herring Gull eggs from the Detroit and Niagara Rivers and saginaw Bay (1978-1982): Contaminant discriminants. Journal of Great Lakes Research 11(3): 223-230.

The levels of organochlorine residues found in eggs of Herring Gulls are reported for the Detroit River, the Niagara River, and Saginaw Bay from 1978 to 1982. Levels were determined for DDT, DDE, PCBs, mirex, hexachlorobenzene, dieldrin, mercury, and seventeen other organochlorine compounds at various intervals during the study. The levels of PCBs and HCB in eggs from Fighting Island from the Detroit River are among the greatest of any found in more than 25 colonies surveyed since 1978. Organochlorine levels from these sites are compared with data from our Annual Monitor Colonies. Discriminant function analysis indicates that levels of Ocs found in eggs of herring gulls from these locations are statistically unique. These results indicate the Herring Gull has value as an indicator of regional chemical contamination in the Great Lakes.

Struger, J., J.E. Elliot, and D.V. Weseloh. 1987. Metals and essential elements in Herring Gulls from the Great Lakes, 1983. Journal of Great Lakes Research 13(1): 43–45.

Adults and prefledged Herring Gulls were collected from one location each in Lakes Ontario, Erie, Huron, and Superior. Composite samples of liver, kidney, and feather were analyzed for 24 element and composite samples of bone for 22 elements. After consideration of quality assurance results, concentrations of 16 elements (Al, Ca, Cd, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, P, Pb, Sr, Ti, Zn) in liver, kidney, and feather were accepted for presentation while 6 elements were accepted from bone (Ca, Cd, Hg, P, Pb, Zn). Only lead, cadmium, and mercury values were of toxicological interest. Data on other trace elements are presented as baseline values among locations for each tissue and age class. Concentrations of Cd, Pb, and Hg were higher in adults than in prefledged young. Metal levels varied among different tissues with Cd highest in kidney (2.16 ug/g; Hamilton Harbour, Lake Ontario), Pb highest in bone (30.0 ug/g; Double Island, Lake Huron), and Hg highest in feather (6.11 ug/g; Middle Island, Lake Erie). Lead levels in both age classes were generally higher in tissues from the two upper lakes colonies than in samples from the lower lakes. Cadmium and mercury levels did not vary greatly among locations. Levels fround are below those associated with metal toxicoses in laboratory studies with other avian species.

Swift, B.L., R.E. Foley, and G.R. Batcheller. 1993. Organochlorines in Common Goldeneyes wintering in New York. Wildlife Society Bulletin 21: 52-56.

Terrell, C.B. 1929. More ducks for Long Point, Norfolk County, Ontario - Report 1, October, 1929. Ontario Department of Lands and Forests, Simcoe, Ontario.

Terrell, C.B. 1929. Report 2 - Suggested solutions to some Long Point problems. Ontario Department of Lands and Forests, Simcoe, Ontario.

Thompson, D.W. 1964. A study of waterfowl nesting in the southwest Lake Erie region. M.Sc. thesis,

The Ohio State University, Columbus, Ohio.

Tillitt, D.E., G.T. Ankley, J.P. Giesy, J.P. Ludwig, H. Kurita-Matsuba, D.V. Weseloh, P.S. Ross, C.A. Bishop, L.Sileo, K.L.Stromborg, J. Larson, and T.J. Kubiak 1992. Polycholorinated biphenyl residues and egg mortality in Double-crested Cormorants from the Great Lakes. Environmental Toxicology and Chemistry 11: 1281-1288.

We evaluated the overall potency of polychlorinated biphenyl (PCB)–containing extracts from Double–crested Cormorant (*Phalacrocorax auritus*) eggs with an in vitro bioassay system, the H4IIE rat hepatoma cell bioassay. Results from the H4IIE bioassay were strongly correlated with the hatching success of eggs in the colonies, whereas conventional methods of PCB analysis correlated poorly with hatching success of eggs from the same colonies. These observations suggest that even though concentrations of total PCB residues have declined in almost compartments of the environment, their effects are still being observed. The significance of this observation is that the adverse symptoms presently observed in certain Great Lakes fish–eating waterbird populations do not appear to be caused by some as yet unidentified industrial chemical or chemicals and seem not to be the result of pesticides, but rather to the dioxin–like activity of PCBs. Evidence is presented to suggest that the relative enrichment of the potency of PCBs in the environment may play a role in the persistence of the observed adverse symptoms.

Todd, W.E.C. 1904. The birds of Erie and Presque Isle, Erie County, Pennsylvania. Annals of the Carnegie Museum 2: 481-596.

Tramer, E.J., and E.J. Durbin. 1982. Breeding birds of Ohio's Lake Erie marshes. Kirtlandia 37: 55-87.

The bird population of 24 of Ohio's Lake Erie marshes were surveyed during the period 1 June–12 August 1980. One hundred thirty–eight bird species were encountered, of which 26 are included on the Ohio Department of Natural Resources "Special Species" list. The Great Blue Heron occurred at the greatest number of sites, followed by the Red–winged Blackbird, Mallard, Tree Swallow, Barn Swallow, and Song Sparrow. Eleven wetlands were judged to be especially significant because of their large size and/or habitat quality. With the exception of Mentor Marsh in Lake County, all the highest quality wetlands were located between Toledo and Sandusky Bay. The text briefly describes each wetland and gives the distributional status of each bird species.

Tramer, E.J., and L.W. Campbell. 1986. Laughing Gull nesting attempt on Lake Erie. Wilson Bulletin 98(1): 170-171.

Tucker, P. 1980. Resident waterfowl survey for Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Turle, R., R.J. Norstrom, B. Collins. 1991. Comparison of PCB quantification methods: re-analysis of archived specimens of Herring Gull eggs from the Great Lakes. 22: 201-213.

Eggs have been collected from colonies of Herring Gulls (*Larus argentatus*) throughout the Great Lakes since 1970, and analyzed as a means of assessing trends in levels of organochlorine contaminants. PCBs were originally determined by packed–column GC–ECD as Aroclor 1254/1260 1:1 equivalents. Since 1986, forty–one individual congeners have been determined and summed to obtain EPCB. In order to relate the new and old data and remove discontinuities due to method improvements, representative samples of a pooled gulls eggs from the 1970s and 1980s were retrieved from a specimen bank and reanalysed for individual PCB congeners. Conversion factors from Aroclor 1254/1260 1:1 to EPCB were 0.450 for Lake Superior, 0.484 for Lake Huron, 0.444 for Lake Erie and 0.461 for Lake Ontario.

Umpherson, D.K. 1983. Waterfowl use of Duncan's Pond, Long Point National Wildlife Area, fall 1982.

Unpublished Report to Canadian Wildlife Service, London, Ontario.

Urban, D. 1970. Raccoon populations, movement patterns, and predation on a managed waterfowl marsh. Journal of Wildlife Management 34 (2): 372-382.

Populations, movement patterns and denning of Raccoons (*Procyon lotor*), and relationships between Raccoons and nesting waterfowl were studied on a managed waterfowl marsh on western Lake Erie. Density of raccoons per square mile was estimated to be 45.3. Nine raccoons were instrumented with radio transmitters to determine movements, home ranges, and denning habits. These animals were radio–tracked 87 nights during fall and spring. The average home range included 119.6 acres but varied greatly depending on sex and age–class. Eighty–seven percent of the average home range was marsh, 8 percent woodlot, 4 percent wet meadows, and 1 percent farmland. During nocturnal hours, raccoons spent more time in the marsh than in the vicinity of the dikes. Females frequented wooded areas more than males. Seventy–three percent of all raccoon activity occurred in shallow water areas. Raccoons did not change their movements during the waterfowl nesting season as compared to other times of the year. There was no evidence of an influx of raccoons into the marsh from surrounding areas during the waterfowl nesting season. Muskrat (*Ondatra zibethica*) houses were used extensively as dens by 89 percent of the radio–tagged raccoons. Of 64 waterfowl nests found on the dikes of the study area during the 1967 and 1968 nesting seasons, only one was successful. Raccoons terminated 39 percent of the dike nests.

Vermeer, K., and D.B. Peakall. 1977. Toxic chemicals in Canadian fish-eating birds. Marine Pollution Bulletin 8(9): 205-210.

Cross–country comparison of DDE and PCB residue levels in cormorant, gull and tern eggs in Canada reveal that bird populations at the Great Lakes are the most contaminated with those pollutants. DDE levels have been correlated with reproductive failure in Double–crested Cormorants in the Great Lakes with eggshell thinning as a major factor. Low reproductive success in Herring Gull colonies at Lake Ontario is associated with high chlorinated hydrocarbon levels in eggs. Fish–eating birds in the Wabigoon River system, northwestern Ontario, are among the most known mercury contaminated birds. It is suggested that the effects of mercury on the reproduction of fish–eating birds should be further examined there.

Fish–eating birds occupy the highest levels of the food web and magnification of toxic chemicals through prey organisms in this web makes those bird vulnerable to the effects of environmental contaminants. Since fish–eating birds are present everywhere in Canada's freshwater and marine habitats and occupy various niches there, they may serve as pollution indicators in various food chains of our aquatic environment. Colonial birds are especially valuable indicators as pollution effects on total bird populations can be studied. Baseline information on fish–eating bird populations should now be collected everywhere in Canada for measuring present and future effects of environmental pollutants, as well as other man–made disturbances on their populations.

Weekes, F. 1974. A survey of Bald Eagle nesting attempts in Southern Ontario, 1969-1973. Canadian Field-Naturalist 88: 415-419.

The Bald Eagle, *Haliaeetus leucocephalus*, was found on the verge of extinction in extreme southern Ontario, where breeding status during 1969–1973 was studied and compared with breeding status circa 1950 and earlier. Though formerly a common resident, the species has been subjected to too many adverse factors to maintain a steady breeding population. These adverse factors, any one of which might have been inadequate to destroy the total population, include general loss of habitat, nest destruction, shooting of individual birds, human disturbance during nesting attempts, and the probable contamination of their food by technologically–introduced toxicants.

Weekes, F.M. 1975. Bald Eagle nesting attempts in Southern Ontario in 1974. Canadian Field-Naturalist 89(4): 438-444.

My search for active nests of the Bald Eagle (*Haliaeetus leucocephalus*) in southern Ontario was continued in 1974, and nesting results were noted. Active nests in the southwestern sector showed reproductive success at three of six nests (average of one nest in two); this is a better success rate than five nests of 25 (average of one nest in five) during the five seasons 1969–1973. The southwestern sector near Lake Erie continued to show more active nests (six compared to one) and more successful fledgings (three compared to none) than the eastern sector. One successful 1974 nest had been inactive since the fledging of one young and the shooting of one adult in 1970; the surviving adult appeared to have mated in 1974 with the bird fledged from the nest in 1970. Another nest had its third successful fledging in 4 years after at least 11 (possibly 18) barren seasons. The question is raised as to a possible corrrelation between improved 1974 nesting success of the Bald Eagle in southwestern Ontario and the restrictions of DDT use in the province as of 1970. Some nest histories are included with the 1974 observations.

Weseloh, D.V. 1984. The origins of banded Herring Gulls recovered in the Great Lakes region. Journal of Field Ornithology 55(2): 190-195.

Nearly 15,000 band recoveries of Herring Gulls from 1933-1980 from within the Great Lakes area were examined. Over 99% of the recoveries were of birds banded within the Great Lakes. Most of the immigrant gulls came from areas to the east of the Great Lakes as birds of the year and died before reaching breeding age. The maximum recruitment rate of immigrant adult Herring Gulls into the Great Lakes population was in the range of .1–.2%. The presence of this miniscule percentage of immigrant Herring Gulls in the Great Lakes population does not appear, in any way, to jeopardize the use of this species as an indicator of toxic chemical contamination in the food web of the Great Lakes ecosystem.

Weseloh, D.V. 1991. Eagles could be Lakes' "canary in the coal mine." The Great Lakes Reporter 8(1):4.

Weseloh, D.V., P. Mineau, and D.J. Hallett. 1979. Organochlorine contaminants and trends in reproduction in Great Lakes Herring Gulls, 1974-1 978. Transac tions of the 44th North Americ an Wildlife and Natural Resources Conference. 543-55 6.

1. Herring Gull eggs were monitored for levels of the major organochlorine residues in two colonies from each of Lakes Ontario, Erie, Huron and Superior during 1974, 1975, 1977 and 1978. Colonies of Lake Ontario were the most contaminated followed by Lakes Huron and Superior with Lake Erie as the least contaminated. Since 1974 significant decreases were evident in levels of DDT, mirex and PCBs, at all colonies and most colonies showed similar decreases for dieldrin, DDE and HCB. One significant increase was noted for DDT for Granite Island (Lake Superior) between 1977 and 1978.

2. Half–lives for mirex (1.9 to 2.1 years) were calculated for the Snake and Mugg's Island colonies on Lake Ontario. These were taken from significant fits of mirex residue trends to a log–linear regression model. Other half–lives calculated in a similar fashion were 3.3 years for DDE on Mugg's Island (Lake Ontario) and 2.4 years for HCB on Mamainse Island (Lake Superior). Log– linear model decreases were also used to extrapolate years of non–detection for these residues. They were 1992 and 1994 for mirex on Mugg's and Snake Islands respectively, both on Lake Ontario, 2012 for DDE on Mugg's Island (Lake Ontario), 2037 for PCB on Granite Island (Lake Superior) and 1986 for HCB on Mamainse Island (Lake Superior).

3. Reproductive success of Herring Gulls was determined on all colonies in 1978 and on selected colonies prior to that. Reproductive success has shown a substantial improvement on Lakes Erie and Ontario. It was directly paralleled by a decline in the major organochlorine

residues. Reproductive success on Lake Huron and Lake Superior has remained relatively high.

4. Continued monitoring of residue levels and the reproductive success of Herrring Gulls will serve to indicate trends in contamination by persistent toxicants and in the overall health of the Great Lakes ecosystem. Trends from 1974 to 1978 show a general improvement.

Weseloh, D.V., and P. Mineau. 1982. Demography, productivity, and contaminant levels in Herring Gulls in Lake Erie. Colonial Waterbirds 5: 179.

Colony size and location, eggshell thickness, nest attentiveness, reproductive success, and egg residues (Ocs) were determined for Herring Gulls nesting in Lake Erie and the Detroit and Niagara Rivers in 1978 and 1979. The nesting gull population numbered approximately 6200 pairs, split 53% and 47% between Canadian and U.S. colonies, and centered in the Western Basin. From 1977 to 1979, available data show a 58% mean increase in four established colonies and 158% mean increase in three "new" colonies (man–made sites). The Lake Erie Herring Gull population ranks 4th largest among those of the Great Lakes and accounts for approximately 8.5% of their nesting numbers.

Nest atttentiveness (99%) and reproductive success (0.97–1.74 young/pr) were normal and showed no significant intercolony variation. Egg shell thickness was unchanged between 1978 and 1979, but mean values (0.350 mm) remain 6.7% thinner than pre–1947 values. Sandusky and Middle Island eggs had thicker shells and consistently lower residues than those from other colonies. Levels of DDE, HCB, and PCBs were greatest on the Detroit River. Mirex was greatest at Niagara Falls, and decreased westwardly. Between 1978 and 1979 several contaminants showed significant colony decreases while fewer showed similar increases.

Weseloh, D.V., R.B. Sutherland, and P. Mineau. 1983. Utilization of garbage dumps by Ring-billed and Herring Gulls on the lower Great Lakes. Colonial Waterbirds 6: 72.

Gull numbers were recorded at 22 sites in and near Toronto, Ontario in 1972–73 and at 36 sites around Lake Erie and Lake Ontario in 1979–80. Peak period of dumpsite use by Ring–billed Gulls *Larus delawarensis* occurred in July–August with a gradual decrease in numbers through the autumn. Herring Gull *L. argentatus* numbers were maximal in November with a sharp decline during December. Use of dumpsites was only light and sporadic from January to mid–April. Gulls did not use the dumps from mid–April to mid–July. In spring and autumn Herring Gull numbers far exceeded local population levels and probably reflect movements of other Great Lake gulls into the area. In winter, Herring Gulls appear to move away from shore–based sites to offshore ice edges.

Weseloh, D.V, S.M. Teeple, and H. Blokpoel. 1988. The distribution and status of colonial waterbirds nesting in Western Lake Erie. In: J.F. Downhower (ed.) The Biogeography of the Island Region of Western Lake Erie. Ohio State University. pp. 134-144. Ohio State University Press, Columbus, Ohio.

Weseloh, D.V., T.W. Custer, and B.M. Braune. 1989. Organochlorine contaminants in eggs of Common Terns from the Canadian Great Lakes, 1981. Environmental Pollution 59: 141-160.

To determine if contaminant levels in Common Terns had changed over the last decade, we collected and analyzed eggs from four nesting colonies on the three lower Great Lakes during 1981. DDE and PCBs were detected in every egg from the four colonies. Dieldrin, mirex and trans–nonachlor were detected in more than 45% of the eggs. Seven other organochlorine contaminants (DDD, DDT, hexachlorobenzene, oxychlordane, cis–chlordane, cis–nonachlor and toxaphene) were detected in less than 25% of the eggs. Eggs from the Lake Ontario colony were generally the most heavily contaminated. Comparisons of DDE and PCB data with earlier studies of Common Terns indicated that contaminant levels in eggs from the four sampled colonies, or

nearby sites, have decreased by up to 80–90% from 1969–73 to 1981. Interspecies comparisons showed that Common Tern eggs have lower organochlorine residue levels than eggs of Caspian Terns or Herring Gulls. Dietary variation and migratory status are possible explanations for the differences in residue levels among species. Eggshell thickness, log–PCBs, and log–DDE were not significantly intercorrelated. Elevated contaminant levels in the early 1970s might be at least partly responsible for the delcline of the Great Lakes Common Tern populations over the past decade. Stabilization of population numbers during the early 1980s suggests that organochlorine pollution levels have been reduced to a point where they are no longer an important factor in the population dynamics of this species on the Great Lakes.

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. The Science of the Total Environment 91: 141-159.

The distribution and size of colonies, residue levels of DDE, DDT, HCB, dieldrin, mirex and PCBs in eggs, productivity and eggshell thickness were determined for Herring Gulls at 14 sites in Lake Erie and connecting channels. The centre of distribution for breeding Herring Gulls was the Western Basin where approximately 90% of the 6200 nests in the study area were located. Seven of 22 colonies showed an average annual population increase of 48.3%. Most of the increase in breeding Herring Gulls on Lake Erie is directly associated with sites that have undergone habitat modification by man. Levels of PCBs and DDE ranged from 35 to 140 ppm (wet weight) and from 2.8 to 9.4 ppm, respectively; all other residues were < 0.49 ppm. Most organochlorine residue levels were highest in eggs from colonies in or near the Niagara or Detroit Rivers. Mirex residues were greatest in the Niagara River and decreased significantly to the west. PCB residues were greatest in the Detroit River and decreased significantly to the east. The lowest levels generally came from colonies in the Sandusky Basin and near Pelee Island in western Lake Erie. Discriminant function analysis of six organochlorine contaminants correctly classified 90% or more of the eggs from up to four colonies in one or more years. Levels of PCBs and HCB appeared to have the greatest discriminating power. Herring Gull productivity at all colonies (1–1.7 young gulls/pair) was normal and showed no significant geographical variation. Eggshell thickness was greatest in colonies in the Sandusky Basin and least in colonies in the Detroit River and extreme west end of the lake; mean eggshell thickness was 0.350 $\pm$ 0.02 mm (6.7% thinning), which was weakly, but significantly correlated to DDE concentration. The variation in contaminants in Herring Gull eggs on a Basin basis (i.e., Western, Eastern, Sandusky, etc.) paralleled those known for sediments, water and fish. Thus, we suggest that in addition to its role as an indicator of lake–wide contamination of the Great Lakes, the Herring Gull, under some circumstances, may function as an indicator of "regional" contamination. This is an important distinction as it improves the geographical specificity of the Herring Gull as an indicator species on the Great Lakes, where it is a non–migratory species.

Weseloh, D.V.C., J. Struger, and C. Hebert. 1994. White Pekin Ducks (*Anas platyrhynchos*) as monitors of organochlorine and metal contamination in the Great Lakes. Journal of Great Lakes Research 20(1): 277-288.

Utilizing domestic birds as biomonitors may provide vital information regarding the risk to migratory waterfowl posed by contaminated wetlands. Data collected from domestic waterfowl might also allow scientists to address the public health implications of feral waterfowl consumption by humans. In this study, the White Pekin Duck (*Anas platyrhynchos*) was evaluated as an indicator of environmental contamination in the Lower Great Lakes during 1986. These birds rapidly accumulated organochlorine and heavy metal contaminants, sometimes to high levels. Intersite differences in their contaminant burdens reflected known geographic differences in contaminant sources. There were, however, some difficulties associated with using White Pekin Ducks as biomonitors, most notably their high rate of disappearance after release. This reflected their vulnerability to predation and poaching but at one of the sites, Windermere Basin in Hamilton

Harbour, lead poisoning may also have been a factor contributing to their disappearance.

Wiggins, D.A. 1984. Parental care in the Common Tern (*Sterna hirundo*): sexual roles in a monogamous seabird. M.Sc. thesis. Brock Universi ty, St.Cath arines, Ontario.

The parental behaviour of male and female Common Terns (*Sterna hirundo*) was documented throughout two breeding seasons at a colony near Port Colborne, Ontario. Thirteen and fourteen pairs of terns were chosen for intensive study in 1982 and 1983, respectively. The delivery of fish by males to their mates ("courtship feeding") occurred prior–to, during, and following the egg–laying period. Following the laying of the second egg, courtship feeding rates declined significantly. There was a significant, positive correlation between courtship feeding rates and subsequent chick feeding rates by males.

The incubation rates of females were significantly higher than those of males, especially during the first ten days of incubation. Territorial attendance rates during the incubation stage were similar for males and females. During the chick stage, territorial attendance rates of females were significantly higher than those of males. The size of fish fed to chicks by males increased as the chicks grew older and chick feeding rates of males were approximately three times higher than female rates.

Based on these quantitative differences in parental care activities, the cumulative parental time investment by the two sexes was very similar. However, the energetic investment by males was likely greater than that by females, since male parental contributions (e.g. courtship feeding and chick feeding) often entailed extensive foraging behaviour.

Wiggins, D.A. 1989. Consequences of variation in brood size on the allocation of parental care in Common Terns (*Sterna hirundo*). Canadian Journal of Zoology 67: 2411-2413.

Data on the behaviour of Common Tern (*Sterna hirundo*) parents were analyzed to document shifts in parental care patterns with changes in brood size. The primary roles of the sexes, chick feeding by males, and brood attendance by females, did not change with shifts in brood size. Rather, parents simply altered the amount of care provided. One–chick broods received more parental attendance at the nest site than both two– and three–brood chick broods, likely as a result of the increased foraging effort of two– and three–chick parents. The number of chick feeds per hour increased significantly with each increase in brood size, but the number of feeds of each chick per hour did not. Thus, although parents increased their foraging effort with increasing brood size, the net effect was that chicks in all brood sizes were fed at similar rates.

Wiggins, D.A., R.D. Morris, I.C.T. Nisbet, and T.W. Custer. 1984. Occurrence and timing of second clutches in Common Terns. Auk 101: 281-287.

Eighteen pairs of Common Terns (*Sterna hirundo*) at three different colonies laid second clutches while still feeding young from their first broods. Seven clutches were laid before the chicks from the first brood feldged, and 11 were laid after the chicks from the first brood fledged. In each case, parents alternately fed chicks from the first brood and incubated the second clutch. Sixteen of the 18 clutches disappeared, were addled, or were deserted. Young hatched from the two other second clutches, but all chicks died or disappeared 2–4 days after hatching. We suggest that a second clutch, laid before chicks from the first brood fledged, probably results from a physiological miscue associated with chick loss from the first brood and stimulated by an unusual surplus of food. Conversely, when laid after chicks from the first brood fledge, a second clutch might function as insurance, permitting a pair to raise young late in the season if chicks from the first brood are lost. In either case, parents must partition care between eggs and chicks from the second clutch and fledged chicks from the first brood. Accordingly, the successful fledging of chicks from two broods in a single season is unlikely unless exceptionally favourable conditions occur.

Wiggins, D.A., and R.D. Morris. 1986. Criteria for female choice of mates: courtship feeding and paternal care in the Common Tern. American Naturalist 128(1): 126-129.

Wiggins, D.A., and R.D. Morris. 1987. Parental care of the Common Tern *Sterna hirundo*. Ibis 129: 533-540.

Parental care activities of male and female Common Terns *Sterna hirundo* were recorded over two breeding seasons. Males and females exhibited distinct parental roles throughout a breeding bout. Courtship feeding by males was extensive prior to and during egg–laying, but declined with the onset of incubation. Females performed significantly more incubation behaviour than males although both sexes spent equal time attending at the nest site. During the chick stage, females spent significantly more time on the territory than did males. Chick feeding was largely the responsibility of the male; males fed chicks at a rate approximately three times higher than that of females. In addition, whereas females showed no trend in the size of fish delivered to chicks relative to chick age, the size of fish delivered by males increased with chick age. Courtship feeding activities and extensive chick feeding contributions by male Common Terns appear to outweigh parental contributions by females, contrary to predictions for a monogamous species.

Wiggins, D.A., and R.D. Morris, 1988. Courtship feeding and copulatory behaviour in the Common Tern, *Sterna hirundo*. Ornis Scandinavica 19(2): 163-165.

We investigated the temporal associations between courtship feeding and copulatory behaviour prior to and during egg–laying stage of Common Terns *Sterna hirundo*. The occurrence of courtship feeding did not affect either the likelihood of successful cloacal–contact copulations or the number of cloacal– contacts per copulation bout. In addition, courtship feeding did not appear to induce mounting behaviour. However, this finding is largely dependent on the manipulation of data prior to statistical analysis. We suggest that such manipulations be standardized and explicitly defined in future studies.

Wilson, S.F., and C.D. Ankney. 1988. Variation in structural size and wing stripe of Lesser and Greater Scaup. Canadian Journal of Zoology 66: 2045-2048.

Heads, wings, and feet of Lesser Scaup (*Aythya affinis*) and Greater Scaup (*Aythya marila*) were obtained from 365 birds killed by hunters to investigate differences in structural size and in the intensity and extent of the white wing stripe. Twelve morphological measurements were taken on each bird and wing stripes were quantitatively scored using soil colour charts. Principal component analysis of the structural data separated the birds into two nonoverlapping size groups. We considered the group of large birds and the group of small birds to be Greater and Lesser Scaup, respectively. Variation in the wing stripe characters was extensive; 9% of the birds in our sample could not be correctly classified as Lesser or Greater Scaup on the basis of wing strip alone. However, most of the variation was due to sexual differences, i.e., female Greater Scaup with unusually dark wings and male Lesser Scaup with unusually white wings.

Wormington, A., and J.H. Leach. 1992. Concentrations of migrant diving ducks at Point Pelee National Park, Ontario, in response to invasion of Zebra Mussels, *Dreissena polymorpha*. Canadian Field-Naturalist 106(3): 376-380.

The European Zebra Mussel, *Dreissena polymorpha* (Pallas), has recently invaded North America and is now well established in Lake Erie. Since 1988, larger–than–usual flocks of eight species of diving ducks were observed at Point Pelee during autumn migration. Maximum one–day counts of the principal species, Lesser Scaup, *Aythya affinis*, were up to 90 times historical counts. The ducks also remained in the area for a longer–than–normal period. Examination of gizzard contents of eight specimens and observations of feeding behaviour indicated that the ducks actively feed on Zebra Mussels. The availability of a new food source has led to this recent change in autumn

migratory behaviour by several species of diving ducks. Distribution patterns of diving ducks in other areas of the Great Lakes may change as the Zebra Mussel expands its range.

Woulfe, M. 1989. Brood reduction and adoption in Ring-billed Gulls (*Larus delawarensis*): the potential for intergenerational conflict. M.Sc. thesis. Brock University, St.Catharines, Ontario.

Patterns of intra–clutch egg size variation and intra–clutch hatch intervals in the Ring–billed Gull (*Larus delawarensis*) were documented during the peak nesting period of two consecutive breeding seasons, at a colony near Port Colborne, Ontario. Egg size decreased with laying order; third laid eggs were significantly smaller than first laid eggs. Hatching of the third egg was delayed from that of first and second eggs. Intra–clutch egg size differences established initial size disparities among chicks at hatch. Hatch intervals further exaggerated size disparities during the early post brood completion period. Competitive asymmetries among chicks were associated with increased mortality rates among third hatched chicks despite the lack of evidence of a sibling feeding hierarchy. Fledging success in 1987 was greater than in 1988. A "brood reduction strategy" appears to have enabled parents in 1987, to obtain an extra unit of reproductive fitness, while in 1988 parents were often unable to raise the entire brood and third chicks likely represented insurance reproductive value.

Experimental broods (1988) were created in which hatch intervals were double those of natural intervals. The size disparities among chicks were significantly greater than in control broods, and the pattern of mortality among chicks suggested that first chicks benefited at a cost to second and third chicks. Parents of peak experimental broods achieved a fledging success rate similar to that of control broods.

Characteristics of chick adoptions were also recorded. In each study year, 9 chicks abandoned their natal territories, 6 of which were adopted. Chicks consistently established themselves into broods where they were older than resident chicks. No direct evidence of cost to foster parents, or benefits to adopted chicks was obtained, although fledging success of adopted chicks was high.

Young, M. 1980. Breeding birds in the Buttonbush Swamp - 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Breeding–bird censuses conducted by Long Point Bird Observatory workers have provided important information on the avifauna breeding in various habitats on Long Point. The following study rounds out the range of habitats sampled.

There is, however, another reason that this breeding bird census was undertaken in 1980. The buttonbush habitat sampled lies immediately behind an area where public use is permitted along the north beach. While the public is not allowed inland from the beach, we wished to consider the possibility that beach use might disturb bird species nesting in the buttonbush habitat, or might encroach on a habitat critical to rare or especially vulnerable species.

The following study found no rare or vulnerable bird species nesting in or regularly visiting the sampled area. Negative evidence does not rule out the posssibility that such species occur in this habitat, but does provide the reassuring information that many man–hours of observations revealed no reason for concern over public use impact on breeding birds of the buttonbush swamp.

Young, M. 1980. A survey of the faunal use of the south beach of Long Point. Unpublished Report to Canadian Wildlife Service, London, Ontario.

AMPHIBIANS AND REPTILES

Adams, M.S., and H.F. Clark. 1958. A herpetofaunal survey of Long Point, Ontario, Canada. Herpetologica 14: 8-10.

Ashendon, J.E. 1983. Movements of nesting Midland Painted Turtles and Blanding's Turtles at Long Point, Ontario. Unpublished Report, Department of Biology, Wilfred Laurier University, Waterloo, Ontario.

Ashley, P. 1994. Herpetofaunal road mortality on the Long Point Causeway. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Road mortality on a 3.6 km causeway on highway 59, Long Point Ontario was censused over a four year period, 1979–1980 and 1992–1993. Total road mortality exceeded 32000 individuals, the majority being young of the year Leopard Frogs. Ninety–six vertebrate species were recorded, 7 amphibian, 10 reptile, 21 mammal and 58 bird. Seasonal patterns of mortality were observed for most herpetofaunal species. Roadside habitat was significantly related with species–specific road mortality. Management options for reducing wildlife occurrence on the causeway and methods of influencing motor vehicle driver behaviour are discussed.

Bishop, C.A., R.L. Brooks, J.H. Carey, P. Ng, R.J. Norstrom, and D.R.S. Lean. 1991. The case for a cause-effect linkage between environmental contamination and development in eggs of the Common Snapping Turtle (*Chelydra serpentina serpentina*) from Ontario, Canada. Journal of Toxicology and Environmental Health 33: 521-547.

Bishop, C.A., and K.E. Pettit. 1992. Declines in Canadian amphibian populations: designing a national monitoring strategy. Occasional Paper No. 76. Canadian Wildlife Service, Burlington, Ontario.

Blanchard's Cricket Frog Recovery Team. 1994. Canadian Blanchard's cricket frog Recovery Plan.

Blanchard's Cricket Frog (*Acris crepitans blanchardi*) is a small, non–climbing tree frog in the family Hylidae. The subspecies is widely distributed in the southern and central United States but is known only from Pelee Island and Point Pelee in Canada. It is considered extirpated at Point Pelee since the last record was in 1920. Cricket frogs have only been recorded from one location on Pelee Island since 1977 and, despite considerable effort in 1992 and 1993, no sites with frogs were located. Unconfirmed reports were made in 1993. Blanchard's Cricket Frog was designated as 'endangered' by COSEWIC in 1990. Cricket frog populations have also declined in the northern tier of U.S. states and are designated as 'endangered' in Wisconsin and of 'special concern' in Minnesota.

Reasons for the decline in Blanchard's Cricket Frog are not known. Substantial habitat loss has occurred but apparently small pockets of suitable habitat remains on Pelee Island. Fluctuating water levels in Lake Erie and breeching of beach ponds during storms have been implicated in losses from some sites; agricultural use of pesticides may also be a factor. The last known site has high populations of bullfrogs, herons, and other predators which are thought to have contributed to probable extirpation.

The goal of the plan for this subspecies is to establish populations at four locations on Pelee Island and, after this is achieved, establish a population at one suitable location in Point Pelee National Park.

The plan is presented as a step–down process that follows a sequence of: protecting existing

habitat; determining whether cricket frogs are still present on Pelee Island, and if present initiating further protective measures; or if not present, working within biological and political considerations to repatriate the species.

The first priority of the plan is to confirm the presence or absence of the frog on Pelee Island, and to protect existing habitat. If no frogs are found during the two years of monitoring, repatriation will be considered. The Ontario Ministry of Natural Resources should be responsible for ensuring that monitoring is carried out. Because of the many political and biological uncertainties associated with repatriation, the step–down outline contains numerous 'decision' points where recovery efforts can be terminated if success seems unlikely. The cost for recovery is estimated to vary between $ 15 and $25,000 annually.

It is the Team's assessment that Blanchard's Cricket Frogs are very likely already extirpated from Canada and that recovery will only be possible through repatriation from U.S. sources.

Bogart, J.P. 1982. Ploidy and genetic diversity in Ontario salamanders of the *Ambystoma jeffersonianum* complex revealed through an electrophoretic examination of larvae. Canadian Journal of Zoology 60: 848-855.

Salamander larvae from 13 breeding ponds were subjected to chromosomal and electrophoretic analyses. Both triploid and diploid members of the *Ambystoma jeffersonianum* complex were polymorphic for a malate dehydrogenase locus (MDH–3) and a lactate dehydrogenase locus (LDH–2). Sympatric *A. maculatum* larvae were electrophoretically distinctive from *A. jeffersonianum* complex larvae at both loci. Two genetically distinctive triploid clones were fixed heterozygotes. Most diploid larvae were homozygous, but a few diploid heterozygotes were found for both polymorphic loci. All the offspring of a sperm–carrying single triploid female which produced eggs in the laboratory were genetically identical to each other and to the mother but the tadpoles from some naturally occurring egg masses from one pond contained both diploid and triploid individuals. Tadpoles from two different egg masses contained representatives of both triploid genetic clones. Two different triploid genotypes were found to occur in a pond in Parry Sound District. This provides evidence for a northern extention of the known range for Ontario triploids. The genetic information derived from *A. jeffersonianum* complex triploids suggests that there exists genetic interaction among certain members of this complex.

Bogart, J.P., L.E. Licht, M.J. Oldham, and S.J. Darbyshire. 1985. Electrophoretic identification of *Ambyst oma laterale* and *Ambystoma texanum* as well as their diploid and triploid interspecific hybrids (Amphibia: Caudata) on Pelee Island, Ontario. Canadian Journal of Zoology 63: 340-347.

Ambystoma Salamanders from Pelee Island, Ontario, were compared with mainland populations of *A. jeffersonianum*, *A. laterale*, and *A. texanum* using erythrocyte area measurements, chromosome counts, and electrophoretic analysis of proteins coded by 32 loci. The mainland species are characterized by relatively low heterozygosity (H = 0.053–0.11) and high Nei's genetic distances (D = 0.896–1.067). Nine diagnostic loci were found in *A. jeffersonianum* and five in each of *A. laterale* and *A. texanum*. Two loci (SOD–1 and GOT–1) diagnose all three mainland species and provide gene dosage for assessing genome contributions of *A. laterale* and *A. texanum* in Pelee Island Salamanders. Diploid and triploid female *A. texanum* x *A. laterale* hybrids as well as *A. laterale* and *A. texanum* occur on Pelee Island.

Bogart, J.P., and L.E. Licht. 1986. Reproduction and the origin of polypoids in hybrid salamanders of the genus *Ambystoma*. Canadian Journal of Genetics and Cytology 28: 605-617.

Eggs and larvae produced by diploid, triploid, and tetraploid females collected from breeding ponds on Pelee Island in Lake Erie were studied to examine the reproductive mechanism. No instance of

parthenogenesis was found as all examined females required sperm to produce viable progeny. Diploid females produced diploid and triploid larvae, triploid females produced triploid and tetraploid larvae, and tetraploid females produced triploid and tetraploid larvae. The majority of the eggs produced by hybrid females do not develop or do not complete embryogenesis. Electrophoretic examination of females and their offspring demonstrate that the male genome is being incorporated in reduced as well as unreduced eggs produced by all three ploidy classes of females. The elevation of ploidy among Pelee Island *Ambystoma* is attributed to sperm incorporation in unreduced eggs. Triploid as well as tetraploid individuals are constantly being produced. A critical examination of the literature on parthenogenetic or gynogenetic modes of reproduction in North America *Ambystoma* hybrids shows no conclusive evidence supporting these modes and it is suggested that the reproductive mechanism found among Pelee Island female hybrids may be more generally applied to other hybrid *Ambystoma* populations.

Bogart, J.P., and L.E. Licht. 1987. Evidence for the requirement of sperm in unisexual salamander hybrids (Genus *Ambystoma*). Canadian Field-Naturalist 101(3): 434-346.

A fast and easy method is described which can be used to detect insemination in hybrid female salamanders of the genus *Ambystoma.* Finding sperm in the cloacae of these females provides evidence of the presence of males, which are often rare. Of 70 females examined on Pelee Island, only those females which were found to be sperm positive gave rise to free–swimming larvae. It is suggested that true parthenogenesis does not occur in the sampled populations.

Bogart, J.P., L.A. Lowcock, C.W. Zeyl, and B.K. Mable. 1987. Genome constitution and reproductive biology of hybrid salamanders, genus *Ambystoma*, on Kelleys Island in Lake Erie. Canadian Journal of Zoology 65: 2188-2201.

On Kelleys Island, Ohio, in Lake Erie, are found bisexual *Ambystoma tigrinum* and *Ambystoma texanum* as well as five different combinations of diploid and polyploid hybrid female salamanders. Genome composition and ploidy of salamanders from five breeding sites on the island were examined using starch gel electrophoresis, erythrocyte area measurements, and chromosome counts. All of the hybrids contained at least one *Ambystoma laterale* genome, yet pure individuals of this species were not encountered. Embryonic mortality was severe among eggs deposited by 42 hybrid females. The few resulting offspring, when compared electrophoretically with their mothers, showed no evidence of being the product of parthenogenesis. Recently described *Ambystoma nothagenes* Kraus is not a valid species as this trihybrid is demonstrated to be genetically heterogeneous and independently derived from diploid *A. laterale* x *texanum* hybrids.

Calvert. E.W. 1920. Notes on the fauna and flora of East and Middle Sister and North Harbor Islands, Lake Erie. Canadian Field-Naturalist 34: 109-110.

Campbell, C.A. 1969. "Who cares for the Fowler's Toad?" Ontario Naturalist 4(69): 24-27.

This article runs through the results of a number of herpetological surveys performed in Southern Ontario in the summer of 1969. Highlighted are the Fowler's Toad, Hog-nosed Snake, Black Rat Snake, Queen Snake, and Timber Rattlesnake. Also include is a list of amphibians and reptiles of concern.

Camin, J.H., C.A. Triplehorn, and H.J. Walter. 1954. Some indications of survival value in the type "A" pattern of the island water snakes of Lake Erie. Natural History 131: 1-3.

Camin, J.H., and P.R. Ehrlich. 1958. Natural selection in Water Snakes (*Nerodia sipedon* L.) on islands in Lake Erie. Evolution 12: 504-511.

Data are presented indicating post–natal selection for pattern type in Water Snakes (*Natrix sipedon*) on the islands of Lake Erie. Strong selection, demonstrable without regard to selective agent, has produced a shift towards unbanded pattern types on the islands, while constant migration from the mainland has maintained "banded" genes in the island gene pools. These antagonistic pressures have produced a situation unusually amenable to analysis.

Cambell, C.A. 1975. Reproduction and ecology of turtles and other reptiles and amphibians of Lakes Erie and St.Clair in relation to toxic chemicals. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Campbell, C.A. 1977. Range, requirements and status of the Eastern Spiny Softshell. (*Trionyx spiniferus spiniferus*) in Canada. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Campbell, C.A. 1978. Reproduction and ecology of turtles and other reptiles and amphibians of Lakes Erie and St.Clair in relation to toxic chemicals. Part II: results, discussion, and conclusion. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Campbell, C.A. 1979. Preliminary herpetological survey and evaluation of proposed habitat alterations at Big Creek National Wildlife Area, Port Rowan, Ontario. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Cliburrn, J.W. 1961. The taxonomic position of *Natrix sipedon insularum* Conant and Clay. Herpetologica 17(3): 166-168.

Conant, R., and W.A. Clay. 1937. A new subspecies of Water Snake from the islands in Lake Erie. Occasional Paper to the Museum of Zoology, University of Michigan 346: 1-15.

Conant, R., and W. M. Clay. 1963. A reassessment of the taxonomic status of the Lake Erie Water Snake. Herpetologica 19(3): 179-184.

The subspecific status of the water snake indigenous to many of the Lake Erie islands and to which we applied the name *Natrix sipedon insularum* (Conant and Clay, 1937), has been challenged by Cliburn (1961). He concluded that insularum is not a valid form and that the insular population, at best, is only an incipient subspecies (p. 168). Although Cliburn offered no new evidence and based his conclusions solely upon previously published information, his action has prompted us to re–examine and reanalyse our data plus those published by Camin, Triplehorn, and Walter (1954), Camin and Ehrlich (1958), and Ehrlich and Camin (1960). We have also studied an additional series of 204 specimens upon which no report has previously been made. These latter include 185 newborn young from captive adult females collected on South Bass Island in 1939 by Robert H. Mattlin; this lot of 185 is now catalogued under one number at the American Museum of Natural History (AMNH 88103).

Cook, F.R. 1964. Rare or endangered Canadian amphibians and reptiles. Canadian Field-Naturalist 78(3): 201-202.

Of a total of 110 forms (included in 84 species) of amphibians and reptiles known to occur in Canada, at least 29 can be considered rare or endangered in this country, with respect to either their entire Canadian distribution or to certain, usually relict, populations of particular interest. None of these forms are restricted to Canada and most are widespread and abundant over the United States portions of their range. However, because these populations are able to survive at the Northern extremes of the tolerance for their species, and because they form part of the original fauna of Canada, they are of interest, and are worth preserving.

Destruction of habitat is perhaps the greatest danger of their continued survival. However,

collecting, except when it is scientifically useful and does not itself endanger the form, should be discouraged. No Canadian estimates exist for any of these species, and even recent records of some forms are few or non–existent.

Cook, F.R. 1964. Additonal specimens of the Small-mouthed Salamander from Pelee Island, Ontario. Canadian Field-Naturalist 78(3): 201-202.

Dance, K.W., and C.A. Campbell. 1981. General notes - Eastern Hognose Snake sighted at Point Pelee National Park, Ontario. Ontario Field-Biologist 35(1): 40-42.

The Eastern Hognose Snake, a species which is secretive and hence seldom observed, was thought to have been extirpated from Point Pelee and Rondeau. This paper reports the sighting of an eastern hognose snake at Point Pelee National Park in May of 1979. Sightings of this species at Rondeau Provincial Park since 1972 are also described.

Eastern Hognose Snakes (*Heterodon platyrhinos*) were thought to have been extirpated from Point Pelee National Park and Rondeau several years ago (Campbell 1969, Cook 1970, Froom 1972). Cook (1970) included the eastern hognose snake on his list of reptiles and amphibians which are rare or endangered in Canada.

This snake was included on a list of rare or extirpated snakes of Point Pelee National Park (Parks Canada 1973, Point Pelee National Park Atlas, Hough–Stansbury and Associates Limited 1975). It had occurred on Point Pelee about 1919 (Patch 1919) and in 1920 (Logier 1925). Campbell has a record of a dead–on–road specimen there 16 May 1938 (pers. comm., G.M. Stirrett 1971).

At Rondeau, an Eastern Hognose Snake was found just outside the provincial park laying eggs in 1972, a year after Campbell (1971, MS) questioned if it was extinct in this park (pers. comm. to Campbell from P.D. Pratt, Park Naturalist, 1973). The Rondeau Park Museum has a slide of one from the point dated "1968" (examined by Campbell). By 1973, five separate individuals were reported in Rondeau Park (op. cit., 1973 pers. comm.). None was reported in 1974 but five, eight, one and one individuals were reported in 1975, 1976, 1977 and 1978 respectively. No Hognose Snakes were sighted at the park during 1979, but in late April of 1980 a specimen was found along the Lakeshore Road and was placed on display in the interpretive centre (pers. comm. to Dance from A. Woodliffe, 1980).

This note was prompted by the sighting of an Eastern Hognose Snake at Point Pelee National Park. Campbell confirmed the identification (of the species) from photographs taken of the specimen. A single Eastern Hognose Snake was present on the west shore of the point, near the tip, on the morning of 12 May 1979 which was sunny and warm. The senior author watched it between 11 20 and 12 00 h, as it rested on sand

Dewey, K. 1981. Fish inventory, hydrographic mapping, biolimnological sampling, bird, reptile, amphibian, and large mammal utilization of six island ponds in Gravelly Bay area of Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Dewey, K. 1982. Road kills on a 1.55 km. section of the Causeway, Long Point, 1982. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Downs, F.L. 1978. Unisexual *Ambystoma* from the Bass Islands of Lake Erie. Occasional Paper. Museum of Zoology, University of Michigan. 685: 1-36.

Ehrlich, P.R., and J.H. Camin. 1960. Natural selection in Middle Island Water Snakes (*Natrix sipedon* L.). Evolution 14: 136.

Gibson, A.R., and G.B. Falls. 1975. Evidence for multiple insemination in the Common Garter Snake, *Thamnophis sirtalis*. Canadian Journal of Zoology 53: 1362-1368.

Morph frequencies in litters of naturally mated female *Thamnophis sirtalis* from populations containing a recessive allele for melanism were found to deviate significantly from simple Mendelian values. These deviations are attributed to multiple male parentage. It is argued that multiple insemination and the resultant sperm competition are viewed most profitably together with copulatory plugs, hemipenal morphology, and aspects of male and female reproductive behaviour as consequences of intense intrasexual selection among males.

Gibson, A.R., and J.B. Falls. 1979. Thermal biology of the Common Garter Snake *Thamnophis sirtalis* (L.): I. Temporal variation, environmental effects and sex differences. Oecologia 43: 79-97.

This paper describes the thermal biology of the Common Garter Snake, *Thamnophis sirtalis*, a diurnal, viviparous colubrid. The body temperatures of snakes caught in the field are cooler and more variable early and late in the day, and early and late in the active season. On sunny days in midsummer, females average about 1 C° warmer than males. The frequency distribution of body temperatures for females is skewed to the left, whereas that for males is nearly symmetrical. Under cloudy skies, body temperatures are lower and more variable than under sunny skies, and the difference between males and females disappears. This and related considerations suggest to us that males are less determined, or less precise, thermoregulators than are females. Air and ground–surface temperatures, and snout–vent length, are poor predictors of body temperature. In contrast with other studies, we found no indication that the body temperatures of gravid and nongravid females differ either in mean or variance. We discuss our conclusions in light of previus studies and identify in the latter, analytical shortcomings which we believe hinder interpretation and synthesis.

Gibson, A.R., and J.B. Falls. 1979. Thermal biology of the Common Garter Snake *Thamnophis sirtalis* (L.): II. The effects of melanism. Oecologia 43: 99-109.

The thermoregulatory significance of a striped–melanic colour polymorphism in the Common Garter Snake, *Thamnophis sirtalis*, was assessed through a combination of laboratory experimentation and field study. In experiments with living snakes the melanic morph maintained a higher body temperature than the striped morph, when exposed to natural insolation. Experiments with excised skin showed that this thermal advantage is attributable to some integumental difference between the two morphs. Body temperatures of snakes in the field revealed that, during the colder part of the active season, melanics were able to stay warmer than striped snakes by an amount (1.24C°) approximating the difference observed in the laboratory. Some evidence and argument is presented to suggest that melanism also may confer protection against overheating in warm periods.

Gibson, A.R., and J.B. Falls. 1985. Melanism in the Common Garter Snake: A Lake Erie phenomenon. Presented at 9th Biosciences Colloquium, Ohio.

Gibson, A.R., and J.B. Falls. 1988. Melanism in the Common Garter Snake: A Lake Erie phenomenon. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 233-245. Ohio State University Press, Columbus, Ohio.

Green, D.M. 1981. Theoretical analysis of hybrid zones derived from an examination of two dissimilar zones of hybridization in toads (Genus *Bufo*). Ph.D. thesis. University of Guelph, Guelph, Ontario.

A descriptive theory of hybrid zone types and their characteristics is developed based on the results of detailed analysis of two hybrid zones of the toad, *Bufo americanus* . Natural hybridization of *B.*

americanus with *B. hemiophrys* in southeastern Manitoba and with *B. fowleri* in southern Ontario was studied principally by means of isozyme electrophoresis, augmented by chromosome analysis and artificial hybridization.

Green, D.M. 1982. Mating call characteristics of hybrid toads (*Bufo americanus* X *B. fowleri*) at Long Point, Ontario. Canadian Journal of Zoology 60: 3293-3297.

The mating calls of toads *Bufo americanus, B. fowleri*, and their natural hybrids were recorded in May 1981 at Long Point, Ontario, on the northern shore of Lake Erie. The calls of the two species differed substantially in pulse rate and call duration but much less so in terms of dominant frequency. The numbers of pulses per call were not signifiantly different. Calls of hybrids were intermediate in character. Values for pulse rate, call duration, and dominant frequency agreed with those previously described. The relationship between pulse rate and call duration is hyperbolic as pulse number appears to be relatively constant. The differences in the calls of B. americanus and B. fowleri appear to be fundamentally due to mechanical properties of the pulse undulating apparatus of the larynx. The characteristics of the calls of the hybrids may be due to intermediate morphology of the laryngeal cartilages that modulate the pulses of a call.

Green, D.M. 1984. Sympatric hybridization and allozyme variation in toads *Bufo americanus* and *B. fowleri* in southern Ontario. Copeia 1984: 18-26.

Hybridization in the toads *Bufo americanus* and *B. fowleri* in Ontario was investigated by electrophoretic examination of allozyme variation of 26 gene loci. Both species of toads were highly polymorphic, in amounts consistent with previous reports. Heterozygosity averaged 0.114 in *B. americanus* and 0.072 in *B. fowleri.* Clines or other patterns of geographic divergence were not present or notable. Hybrid individuals were encountered at Long Point, Ontario, on Lake Erie in association with both species. Hybrids were intermediate in morphology and genotype and appeared to be first generation progeny with high individual heterozygosity ($x = 0.196$). There was no evidence of any substantial introgression between species. Hybridization between *B. americanus* and *B. fowleri* appears to be a widespread, but scattered, natural phenomenon that does not interfere with their maintenance of separate gene pools.

Green, D.M. 1989. Fowler's Toad, *Bufo woodhousii fowleri*, in Canada: biology and population status. Canadian Field-Naturalist 103(4): 486-496.

Fowler's Toad, *Bufo woodhousiifowleri*, is widespread throughout the eastern United States but is restricted to sandy or rocky points and sandy beaches along the northern shore of Lake Erie (Ontario) in Canada. Beetles and ants are its major food and garter snakes its major predator. Adults are primarily nocturnal and active at between 14° and 25°C. They breed from early May to mid–June in marshy shallows adjacent to sand dunes, savannah or open forest. Clutch size is 4000 to 10,000, Tadpoles transform by the end of July. Males first breed as two–year–olds at 50 mm snout–vent length, females are older and larger at first laying. Although the species has disappeared from at least two sites at the western end of Lake Erie within the last 30 to 40 years, and is discontinuously distributed, it appears to be stable at most recorded localities and abundant at Long Point. Hybridization with the American Toad, *B. americanus*, is recorded widely in the United States but confirmed only at Long Point in Canada, and introgression is insignificant there. Many areas where it occurs are within parks or other managed lands where there seem to be no immediate threats from industry or other development. However, it has disappeared from one intensively used park (Point Pelee) and an agricultural area with heavy chemical use (Pelee Island). This toad is classified as Rare in Canada because of its restricted distribution, which makes it vulnerable to further habitat loss.

Green, D.M. 1991. Fowler's Toad (*Bufo woodhousie fowleri*) at Long Point, Ontario: changing

abundance and implications for conservation. In: C.A. Bishop and K.E. Pettit (eds.). Declines in Canadian amphibian populations: designing and national monitoring strategy. Canadian Wildlife Service Occasional Paper No. 76.

Fowler's Toad (*Bufo woodhousei fowleri*) activity with abundance were surveyed during the four consecutive breeding seasons of 1988–91. Calling male abundance rose markedly from 11 toads in the survey area in 1988 to over 245 in 1991. Mark/recapture surveys of noncalling males, adult females, and juveniles showed a similar trend. The population density of toads along a 1–km stretch of Lake Erie beach at Thoroughfare Point was estimated at 1800 toads/km in 1991. The high water levels in Lake Erie in the mid–1980s that could have produced less favourable conditions for tadpole development and survivorship may have been responsible for the previous decline in toad abundance. The extent of human disturbance does not appear to have radically changed throughout the cycle of decline and recovery, but it is probable that the toads found at the western base of the point are migrants from a reservoir population farther to the east along the point. Although they have been intensively monitored for only four years, the Fowler's Toads at Long Point are one of the few Canadian amphibian populations for whom multiple–year censuses – critical data necessary for addressing concerns over apparently global declines in amphibian populations – are availble.

Green, D.M., C.W. Zeyl, and A. El Yassir. 1992. Spring emergence and abundance of Fowler's Toads, *Bufo woodhousei fowleri*, at Long Point, Ontario, in 1991: Implications for conservation. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Green, D.M., C.W. Zeyl, and A. El Yassir. 1993. Spring emergence, age structure, and abundance of Fowler's Toads, *Bufo woodhousii fowleri*, at Long Point, Ontario, in 1992. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Haggeman, J.G. 1981. Some characteristics of a population of Spotted Turtles and a population of Blanding's Turtles. Unpublished Report, Department of Zoology, University of Guelph, Ontario.

Spotted Turtles (*Clemmys guttata*), and Blandings Turtles (*Emydoidea blandingi*), were studied in a portion of Long Point Ontario. Estimates of the adult population were 80 for the Spotted Turtle and 30– 60 for the Blandings Turtle. Both species preferred the shallow grass–sedge marsh habitat. Significant differences between the sexes was noted for the ratio of carapace length to plastron length in both species and for the ratio of width of plastron at posterior suture to plastron length in the Spotted Turtle. Two deformed Spotted Turtles and 1 injured or deformed Blandings Turtles were recorded.

Hamilton, W.J. Jr. 1951. Notes on the food and reproduction of the Pelee Island Water Snake, *Natrix insularum* Conant and Clay. Canadian Field-Naturalist 65: 64-65.

Hebert, C.E., C.A. Bishop, and D.V. Weseloh. 1993. Evaluation of wetland biomonitors for the Great Lakes: A review of contaminant levels and effects in five vertebrate classes. Canadian Wildlife Service Technical Report No. 182, Ontario Region.

The purpose of this review was to identify species which could be used as indicators of wetland contamination. Five vertebrate classes; Osteichthyes (bony fishes), Amphibia (amphibians), Reptilia (reptiles), Aves (birds) and Mammalia (mammals) were included in the review. Within each class, species were compared using seven criteria. These criteria were based upon the characteristics for biomonitors suggested by the International Joint Commission's Ecosystem Objectives Subcommittee. The first four criteria examined our understanding of the biology of the species. No detailed literature review was conducted for these criteria. However, an attempt was made to evaluate them to provide an overall assessment of the species as wetland biomonitors. The remaining three criteria were used to evaluate the availability of information regarding

contaminant levels and effects on wetland species. This review focused on the published literature pertinent to these three criteria.

A score was calculated for each species using the seven criteria. Within each class, the species scores were tabulated and the species were ranked. These rankings reflected the relative merits of the individual species as wetland biomonitors. Within the constraints imposed by field studies, i.e. local species availability, the highest scoring species should be the most useful in evaluating contaminant levels and effects in wetlands. These results are summarized at the end of each chapter.

These scores can be used when selecting species to evaluate wetland contamination but they should not be used exclusively. It is unlikely that one species will be able to meet the data requirements of all studies. It is incumbent upon the researcher to choose those species best suited to accomplishing the goals of the study. For example, if the purpose of the research is to examine the extent of sediment contamination in a wetland, then those species associated with benthic food–webs should be selected, regardless of whether other species scored higher in this review. Alternatively, if the intent of the study is to examine the implications of wetland contamination to humans consuming wildlife, then selection of a game species might be warranted. These considerations are endless, thereby precluding any attempt to suggest one species as the "best" wetland biomonitoring species. It is anticipated, however, that this review will provide a rational framework for selecting species as wetland biomonitors and draw attention to some of the work which has already been completed.

Hecnar, S., R. Russell, R. M'Closkey, and D. Haffner. 1993. Contaminant analysis of amphibians from Point Pelee National Park 1993. Department of Biological Sciences and Great Lakes Institute, University of Windsor, Windsor, Ontario.

Herdendorf, C.E., S. Hartley, and M. Barnes. 1981. A summary of knowledge of the fish and wildlife resources of the coastal wetlands of the wetlands of the U.S. Great Lakes. Center for Lake Erie Area Research. Ohio State University, Columbus, Ohio.

Hubbs, F.T. 1979. Endemic herpetofaunal species and their distribution in Big Creek Marsh, Port Rowan, Ontario. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Humphreys, G.B., and F.F. Mallory. 1977. Colour preferences of the Pond Slider, *Chrysemys scripta elegans* (Schoepff), and the Spotted Turtle *Slemmys guttata* (Schneider). Ontario Field Biologist 31(2): 41-44.

King, R.B. 1986. Population ecology of the Lake Erie Water Snake. Copeia 1986(3): 757-772.

Population ecology of the Lake Erie Water Snake, *Nerodia sipedon insularum*, is described based on a 5 yr capture–mark–recapture study involving 1449 captures of 1247 individuals. Water Snakes are widespread in the island area of Lake Erie but have declined in numbers and have disappeared from one island within the last 50 yr. Population estimates for adult snakes range from 25 to about 500 individuals on seven islands. Snakes are active from late April until early October. Males are caught most often during the breeding season in May and June, while females are taken more often later in summer. Females appear to feed over a longer portion of the active season than males, grow at a faster rate (0.014 vs 0.012 cm/d mean growth rate) and attain a larger body size (82.1 vs 62.5 cm mean snout–vent length). Weight gain occurs throughout the active season in adult females but is restricted to mid–summer in adult males. Some females reproduce annually but smaller females may skip opportunities to reproduce. Number and size of offspring are positively correlated with female size. Comparisons with data from mainland populations elsewhere in the range of this species indicate that island water snakes differ in having larger adult body sizes (mean snout–vent length is 10–16 cm greater in males and 13–14 cm

greater in females), lower growth rates (maximum growth rate is 0.06 cm/d vs 0.13 cm/d in mainland populations) and shorter tails (by 2–5% in males, 1–3% in females). In addition, litter size is less strongly correlated with female body size in island populations (r^2 = 0.17 vs 0.34–0.72 elsewhere). Differences may also exist in size of newborns (mean newborn SVL of mainland population ranges from 12% shorter to 4% longer than that of island populations), diet (mainland populations typically consume more amphibians and fewer fish) and intensity of predation (frequency of stub tails is two times greater in mainland populations).

King, R.B. 1987. Reptile distributions on islands in Lake Erie. Journal of Herpetology 21(1): 65-67.

King, R.B. 1987. Color pattern polymorphism in the Lake Erie Water Snake, *Nerodia sipedon insularum*. Evolution 41(2): 241-255.

Populations of the Water Snake, *Nerodia sipedon*, on islands in western Lake Erie are polymorphic for color pattern. These populations include banded, intermediate, and unbanded morphs while surrounding mainland populations consist solely of the banded morph. The hypothesis that this polymorphism is maintained by strong selection and migration pressures is widely accepted. Unbanded morphs are apparently more cryptic along island shorelines while banded morphs are more cryptic on the mainland. Migration of banded morphs from the mainland explains their persistence in island populations.

Data collected in a capture–mark–recapture program on six islands provide no evidence of differential selection among morphs; morph frequencies do not differ among age classes, between once–captured and multiply–captured snakes, or between scarred and unscarred snakes. Furthermore, Herring Gulls, the most common snake predators in the island area, appear to detect banded and unbanded model snakes with equal ease. High site fidelity of water snakes and the distribution of morphs among islands suggest that migration from the mainland is not common. However, islands close to each other are similar in morph frequency, and water snakes have colonized islands elsewhere in the Great Lakes, indicating that some migration does occur. Recently, the frequency of banded morphs has increased in island populations while adult population sizes have declined. This increase in banded morphs is interpreted as reflecting an increased impact of migration from the mainland into these reduced populations.

One scenario for the evolution and maintenance of this polymorphism is that selection was important in establishing unbanded morphs in island populations as they became isolated from the mainland. As populations declined to their present size, the impact of migration from the mainland increase and is now swamping the effect of selection. Further declines in island population size may result in fixation of the banded morph.

King, R.B. 1988. Biogeography of reptiles of island in Lake Erie. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 125-133. Ohio State University Press, Columbus, Ohio.

King, R.B. 1988. Polymorphic populations of the Garter Snake *Thamnophis sirtalis* near Lake Erie. Herpetologica 44(4): 451-458.

Populations of the Garter Snake *Thamnophis sirtalis* in the Lake Erie area are polymorphic, consisting of striped and melanistic morphs. The frequency of melanistic morphs is similar between sexes but varies greatly among seven island and 15 mainland sites: from 0.00–0.59. Thermoregulatory differences thought to exist between morphs have not resulted in differences between morphs in frequency of reproduction by adult females or in snout–vent lengths of adults of either sex. Non–selective factors (genetic drift, founder effect) may influence morph frequencies but have not produced significantly greater variance in morph frequency among island sites than among mainland sites.

King, R.B. 1989. Body size variation among island and mainland snake populations. Herpetologica 45(1): 84-88.

Body size of adult Garter Snakes (*Thamnophis sirtalis*) and adult Water Snakes (*Nerodia sipedon*) varied significantly among eight island and three mainland sites in the Lake Erie area. Among the six sites at which both species were sampled, mean adult snout–vent length of garter snakes was positively correlated with that of water snakes for females but not for males. Explanations for geographic variation in body size and for parallel variation in body size between species include differences in individual growth rate and differences in population age–structure among sites.

King, R.B. 1993. Microgeographic, historical, and size-correlated varation in Water Snake diet composition. Journal of Herpeto logy 27(1): 90-94.

King, R.B. 1993. Determinants of offspring number and size in the Brown Snake, *Storeria dekayi.* Journal of Herpetology 27(2): 175-185.

Determinants of reproductive variables in the Brown Snake, *Storeria dekayi,* are examined using path analysis, a method which reveals both direct effects (e.g., of female size on offspring number) and indirect effects (e.g., of female size on offspring size through offspring number). In *S. dekayi,* there is a clear trade–off between offspring number and offspring size. Part of this trade–off is mediated through the timing of parturition suggesting that placental nourishment contributes to offspring development. However, placental nourishment is not sufficient to result in an uncoupling of offspring number and size. Another clear result is that female size and female condition at ovulation (a size–corrected measure of mass) both influence offspring number. As a result, female size and female condition have indirect effects on offspring size such that overall, larger females and females in better condition produce smaller offspring. Larger females also produce offspring in poorer condition. Additional reproductive mass (mass lost by females at parturition beyond that accounted for by offspring) is determined directly by offspring number suggesting it represents a per–offspring allocation of resources. Captivity has marked effects on reproduction; females held captive longer produced offspring which were smaller and in poorer condition. Comparisons among species reveals that female size consistently has positive effects on offspring number and offspring size in viviparous snakes but that the effect of offspring number on offspring size varies among species.

Langdon, M. 1969. Reptiles and amphibians of Norfolk County. Wood Duck 23: 17-21.

Langlois, T.H. 1951. Timber Rattlesnakes on the Erie Islands. Ohio Conservation Bulletin: 15(9): 14.

Langlois, T.H. 1953. Ringneck Snakes on South Bass Island. Inland Seas 9: 69.

Lannoo, M.J., L.Lowcock, and J.P. Bogart. 1988. Sibling cannibalism in noncannibal morph *Ambystoma tigrinum* larvae and its correlation with high growth rates and early metamorphosis. Canadian Journal of Zoology 67: 1911-1914.

We describe here, for the first time, the existence of an *Ambystoma tigrinum tigrinum* larval morph characterized by fast growth rates and early metamorphosis and triggered by cannibalism. This new morph does not have the anatomical specialization of true A. *tigrinum* cannibal morphs, i.e., enlarged vomerine teeth and a wider head described previously by several workers. Functionally, however, this new morph and true cannibal morphs achieve the same end; high growth rates and early metamorphosis may facilitate survival in individuals inhabiting temporary and unpredictable wetlands.

Laurin, G., and D.M. Green. 1990. Spring emergence and male breeding behaviour of Fowler's Toads at Long Point. Canadian Field-Naturalist 104(3): 429-434.

In 1988, emergence of Fowler's Toads (*Bufo woodhousiifowleri*) at Long Point, Ontario coincided with heavy thunder showers. The breeding populations was small; only 14 male *B. W.fowleri* were observed and tagged over a two–week breeding season. Male Fowler's Toads tended to alternate their calls with those of close neighbors and call from stationery positions, either in small groups or individually. Active searching behaviour was not observed. Individual males exhibited strong calling site fidelity over successive nights. Calling rate and body temperature were significantly correlated. The Fowler's Toads emerged relatively late compared to previous years and there was only a short period of overlapping breeding seasons with sympatric American Toads, *B. americanus*. The two species of toads maintained separate choruses.

Licht, L.E. 1976. Sexual selection in toads (*Bufo americanus*). Canadian Journal of Zoology 54: 1277-1 284.

The breeding behaviour of the American Toad, *Bufo americanus*, in southern Ontario, is described. The hypothesis is presented that the male vocalization, that call normally given by mature males at the spawning site, can function, not only as a premating isolating mechanism, but as a means for sexual selection by breeding toads. Descriptive and experimental evidence is given to support the hypothesis.

Licht, L.E., and J.P. Bogart. 1987. Ploidy and developmental rate in a salamander hybrid complex (Genus *Ambystoma*). Evolution 41(4): 918-920.

Licht, L.E., and J.P. Bogart. 1987. Comparative size of epidermal cell nuclei from shed skin of diploid, triploid and tetraploid salamanders (Genus *Ambystoma*). Copeia 1987(2): 284-290.

A comparison was made of the sizes of the nucleus within epidermal cells from the shed skin of six species of Mole Salamanders (genus *Ambystoma*), and three different hybrid complexes including diploid, triploid, and tetraploid animals. The shed skin cells of diploids have smaller nuclei than those of polyploid animals. Nuclei of tetraploid cells are largest but their dimensions overlap those of triploid cells. Nuclei of shed skin cells can be measured to accurately distinguish diploids from polyploids in mixed populations without injury of any kind to the animals.

Licht, L.E., and J.P. Bogart. 1988. Embryonic development and temperature tolerance in diploid and polyploid salamanders (Genus *Ambystoma*). American Midland Naturalist 122: 401-407.

The effects of polyploidy on embryonic developmental rate and temperature tolerance of salamanders in the *Ambystoma laterale – texanum* hybrid complex were examined. Neither initial size, genotype nor ploidy of eggs affected embryonic rates and tolerance limits. Larger eggs gave rise to larger hatchlings at cold temperatures only, and body size of hatchlings from large and small eggs was larger at cold temperatures than at warm temperatures. Although polyploidy does not affect embryonic development, one selective benefit of polyploidy is large egg size.

Licht, L.E., and J.P. Bogart. 1989. Growth and sexual maturation in diploid and polypoid salamanders (genus *Ambystoma*). Canadian Journal of Zoology 67(4): 812-818.

On Pelee Island, Ontario, Mole Salamanders, *Ambystoma laterale* and *Ambystoma texanum*, coexist with their diploid, triploid, and tetraploid hybrids. In an initial study, *A. laterale* and hybrid larvae were raised in groups, but from metamorphosis to 5 months postmetamorphosis, individuals were raised in isolation. In a second study, *A. texanum* and hybrids were raised as isolated individuals under uniform feeding and laboratory conditions from the egg stage to 22 months postmetamorphosis. The total length of larvae at 14 days posthatching was correlated with size of eggs. Tetraploids originated from larger eggs, were larger at 2 weeks posthatching, and maintained their larger size throughout larval development. Tetraploids metamorphosed later and

were heavier than all other genotypes. The heavier mass at metamorphosis was maintained and relatively increased so that by 22 months postmetamorphosis, when compared with other groups, tetraploids were heavier in mass, but not larger in snout–vent length. Bodies of tetraploids were more robust and tails, although not longer, were thicker. In contrast to *A. texanum* and diploid and triploid hybrids, among which 50% of individuals developed fully pigmented, yolk–filled ova by 22 months, no tetraploids showed such signs of sexual maturity. The growth and reproducitve patterns of diploids and polyploids are discussed.

Licht, L.E., and J.P. Bogart. 1990. Comparative rates of oxygen consumption and water loss in diploid and polyploid salamanders (genus *Ambystoma*). Comparative Biochemical Physiology A: Comparative Physiology A: Comparative Physiology 97(4): 569-572.

1. The Mole Salamanders *Ambystoma laterale* and *Ambystoma texanum* coexist with their fertile diploid and polyploid hybrids on Pelee Island, Ontario.

2. Rates of oxygen consumption and water loss of diploid *A. laterale* do not differ from those of diploid, triploid or tetraploid hybrids.

3. Potential benefits of polyploid may be from indirect effects of adult body size on rates of metabolism and water loss.

Licht, L.E., and J.P. Bogart. 1990. Courtship behaviour of *Ambystoma texanum* on Pelee Island, Ontario. Journal of Herpetology 24(4): 450-452.

Logier, E.B.S. 1925. Notes on the herpetology of Point Pelee, Ontario. Canadian Field-Naturalist 39(5): 91-95.

Logier, E.B.S. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. IV The amphibians and reptiles of Long Point. Transactions of the Royal Canadian Institute 18(39): 229-236.

Lovisek, J. 1983. Spotted Turtle research at the Thoroughfare Point Unit of the Long Point National Wildlife Area in 1982. Unpublished Progress Report to Canadian Wildlife Service, London, Ontario.

Lowcock, L.A. 1985. Genetics, zoogeography, and morphological aspects of peripheral populations of the *Ambystoma jerffersonianum* complex. M.Sc. thesis. University of Guelph, Guelph, Ontario.

This thesis examines aspects of the extent, nature and routes of dispersal of the *Ambystoma jeffersonianum* comples of salamanders across eastern North America. Diploid and triploid specimens of the comples from Ontario, Quebec, Nova Scotia, New Brunswick, Maine, Prince Edward Island and Long Island, N.Y. were compared electrophoretically and morphologically to determine inter- and intrapopulational differences between the bisexual diploids and their assumed unisexual triploid associates. Morphological comparisons were also made using available specimens from Labrador and Cape Breton Island. Routes of post-glacial dispersal into the region are hypothesized based on these data as well as geological and paleoclimatological evidence. Variation between diploids was relatively low while triploids often showed marked genetic affinity to their associated diploid populations. Some of the herterozygosity observerd in diploids can be accounted for by the presence of triploids in a population. This apparent lack of genetic isolation between diploids and triploids makes the myth of monoclonality and concomitant species status for the triploids completely unwarranted. Prince Edward Island samples, including larvae, showed evidence of insular giganticism and genetic bottlenecking.

Lowcock, L.A., and J.P. Bogart. 1992. Electrophoretic identification of the Marbled Salamander, *Ambyst oma opacum*, on Kelleys Island, Lake Erie. Canadian Field-Naturalist 106(2) 196-199.

Kelleys Island is the second largest island in the western Lake Erie archipelago, an enigmatic biogeographic area in which all previously known species of the salamander genus *Ambystoma* are involved in intraspecific unisexual hybrid complexes. This paper documents the occurrence of A. opacum on Kelleys Island. Identification was made through electrophoretic comparison of tissue homogenates from unidentified larvae with tissue extracts from individuals whose identity was known. This demonstrates the utility of molecular markers for rapid identification in biological surveys without the need (time and expense) of raising animals to metamorphosis. The occurrence of this species on Kelleys Island is of both biogeographic and ecological interest.

MacCulloch, R.D., and W.F. Weller. 1988. Some aspects of reproduction in the Lake Erie population of Blanding's Turtle, *Emydoidea blandingii.* Canadian Journal of Zoology 66: 2317-2319.

A Lake Erie population of *Emydoidea blandingii* produced clutches of slightly greater relative mass than those of other emydids. Regression analyses showed that both the clutch mass and relative clutch mass were significantly related to both female mass and female size, while clutch size was also related to female size. Mean egg mass was not related to either clutch size or female size.

McDermott, P.W. 1947. Snake stories of the Lake Erie Islands. Inland Seas 3(2): 83.

Patch, C.L. 1919. A rattlesnake, Melano Garter Snakes and other reptiles from Point Pelee, Ontario. Canadian Field-Naturalist 33(3): 60-61.

Pfingsten, R.A., and C.F. Walker. 1978. Some nearly all black populations of *Plethodon cinereus* (Amphibia, Urodela, Plethodontidae) in Northern Ohio. Journal of Herpetology 12(2): 163-167.

In Ohio, populations, each with at least 15 individuals, of *Plethodon cinereus* from 75 localities were examined. Some of these populations were originally sampled as long as 47 years ago. Six populations were found to have at least 70% of the individuals of the unstriped phase. These populations have probably arisen due to genetic drift as a result of isolation during the time of the Wisconsin glacial retreat. Stability of color phase frequency within a population seems to be dependent upon the amount of disturbance of the habitat.

Pfingsten, R.A., and F.L. Downs. 1989. Salamanders of Ohio. Bulletin of the Ohio Biological Survey 7(2).

Although the editors are the principal authors, 14 authors have contributed to this extensive treatment of the 25 species of salamanders recorded in Ohio. A dedication and preface are followed by an overview of salamander biology, a checklist, a chronology of earlier publications dealing with the State's salamanders, a section on education and conservation, and an explanation of the format of the species accounts. Subsequent introductory materials presented include summaries of Ohio's geology and physiography, a chapter on the often neglected larval stage, and, finally, identification keys for both adults and larvae.

The bulk of the book consists of the individual species accounts. Species are arranged by family. Each family is introduced by a brief commentary on its content, distribution, and its way of life. Each species account is headed by a black–and–white photograph, which is followed by a description, information on size and sexual dimorphism, and, when relevant, variation within Ohio. The distribution within Ohio, and the overall geographic range of the species, are described and illustrated by distribution maps. Each symbol on the Ohio maps represents a township with at least one known locality, and these townships are listed at the end of each account. The largest section of each account deals with the natural history of the species, and includes such topics as habitat, habits, diet, various aspects of reproductive biology, survivorship, and development to maturity.

Information gleaned from studies in Ohio is supplemented by that obtained from the herpetological literature to present as detailed a life history as is presently possible. Some accounts also have a section dealing with unique behaviours, and one noting special attributes, controversies, or gaps in our knowledge particular to that species.

There are 29 pages of color plates, some of which illustrate a variety of habitats occupied by salamanders, but most of which illustrate life history stages. The latter features paintings of the adult stage by David M. Dennis, and photographs of eggs, larvae, and juveniles.

The text concludes with a notation of species which have been reported erroneously in the state, and those which, although not yet recorded in Ohio, might some day be discovered. There is a glossary of unfamiliar terms, a bibliography with an excess of 500 entries, and three appendices which list regional herpetological societies within the state, the abbreviations of county names used in the listing of localities, and the codes used to identify the museums the collections of which house the specimens used to compile the locality data.

Planck, J.T. 1981. Amphibian and reptile distributions along a proposed Gravelly Bay walking trail, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Planck. J.T. 1981. Amphiblian and reptile distributions at Bluff Point, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Planck, J.T. 1983. Eastern Spiny Softshell nesting at Long Point National Wildlife Area: Management concerns at critical habitats. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Purves, S. 1980. Turtle studies in the Big Creek National Wildlife Area in 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Purves, S. 1980. Turtle studies in the Long Point National Wildlife Area in 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Ridout, R. 1994. Baseline assessment and monitoring of marsh bird and amphibian populations in Great Lakes areas of concern. Interim report to the Great Lakes Cleanup Fund and Environment Canada.

Robinson, J.T. 1984. Summary report of hoop netting in Bluff Point Long Point National Wildlife Area, 1984. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Saumure, R.A. 1992. A report on the pilot year of a mark-recapture study on four species of turtles inhabiting Big Creek Marsh National Wildlife Area, Long Point, Ontario. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Schueler, F.W. 1975. Notes on Garter Snake (*Thamnophis sirtalis*) spring mortality and behaviour at Long Point, Ontario. Ontario Field Biologist 29: 75.

Seburn, C.N.L. 1993. Spatial distribution and macrohabitat use in the Five-lined Skink (*Eumeces fasciatus*). Canadian Journal of Zoology 71: 455-450.

Patterns of spatial distribution and microhabitat use in *Eumeces fasciatus* were examined in a population at Point Pelee National Park, Canada. Each individual was uniquely marked and classified as adult male, adult female, yearling, or hatchling. In each census the location of individuals was recorded. At each microsite, I measured thickness and surface area of cover, degree of shading, and distance to nearest neighbouring microsite.

Significant aggregation was found among individuals within age and sex classes. Males and females associated significantly during the breeding season but not at other times. The number of captures made at a microsite was positively correlated with cover surface area and negatively correlated with cover thickness. Nest sites were the most used subset of all sites at which individuals were captured. Evidence was found to suggest that some females shift home range, once prior to oviposition, and again after hatching of eggs. Males demonstrated reduced activity after oviposition and may aestivate.

Seburn, C.N.L. 1990. Population ecology of the Five-lined Skink. *Eumeces fasciatus*, at Point Pelee National Park, Canada. M.Sc. thesis, University of Windsor, Windsor, Ontario.

Servage, D.L. 1979. Biosystematics of the *Ambystoma jeffersonianum* complex in Ontario. M.Sc. thesis. University of Guelph, Guelph, Ontario.

This thesis is an examination of the interrelationships of the four speics of salamander known as the *Ambystoma jeffersonianum* complex (Uzzell, 1964). Ontario specimens of both diploid bisexual species and both triploid unisexual species were subjected to morphological, karyological and genetic analyses, the latter by the examination of the electrophoretic phenotypes of soluable enzymes and serum proteins, in order to test the hypothesis of triploid species origin via diploid species hybidization (Uzzel, 1964). Many triploid individuals do appear as allotriploids although many also appear as autotriploids. Similarities between the two triploid species and the lack of static genetic complements in the triploids lead to the conclusions that recognition of two triploid species is unwarrented and the nature of the asexuality of the triploids may vary geographically, particularly with regard to the degree of recombination exhibited.

Sever, D.M., L.E. Licht, and J.P. Bogart. 1989. Male cloacal anatomy in a hybrid population of *Ambystoma* (Amphibia: Caudata). Herpetologica 45(2): 161-167.

Males of *Ambystoma laterale* from Pelee Island, Ontario, Canada, engage in courtship activity but do not produce spermatophores due to reduction of pelvic glands, Kingsbury's glands, and anterior ventral glands in the cloaca. Males of *A. texanum* from the same population possess hypertrophied cloacal glands while those of hybrid *A. laterale* x *texanum* are partially depleted, but this may be due to previous breeding activity. The absence of spermatophore production by males of *A. laterale*, if generally true for the population, may help account for poor mating success evidenced by low fertilization rates of eggs.

Snyder, L.L. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. I. General introduction. Transactions of the Royal Canadian Institute 18(39): 117-125.

Struger, J., J.E. Elliott, C.A. Bishop, M.E. Obbard, R.J. Norstrom, D.V.C. Weseloh, M. Simon, and P. Ng. 1993. Environmental contaminants in eggs of the Common Snapping Turtle (*Chelydra serpentina serpentina*) from the Great Lakes-St. Lawrence River Basin of Ontario, Canada (1981, 1984). Journal of Great Lakes Research 19(4): 681-694.

Common Snapping Turtle eggs were collected at nesting sites from two locations in 1981 and eight locations in 1984 in Ontario, Canada, and analyzed for chlorinated hydrocarbons. Nine locations were within the Great Lakes–St. Lawrence River basin and one location, Alanquin Provincial Park, served as a control site outside the basin. Total PCBs ranged from 0.057 to 4.76 mg/kg (wet wt.) among the Great Lakes–St. Lawrence River samples. Mean total PCB concentration at Alanquin Park was 0.187 mg/kg. Eggs from Hamilton Harbour, Port Franks, Bay of Quinte/Murray Canal, and Lake St. Clair were the most contaminated among the ten sample locations. There was statistically significant variation in concentrations of all organochlorine compounds among sites. In some locations, there was high variation in contamination among clutches.

A pool of eggs from Hamilton Harbour contained 67 ng/kg of 2378–tetrachlorodibenzo–p–dioxin and 14.0 ng/kg of 23478–pentachlorodibenzofuran. Some dioxin congeners were present in turtle eggs at concentrations higher or equal to that in herring gull eggs from Hamilton Harbour. Comprehensive GC/MS analysis of the Hamilton Harbour eggs also revealed the presence of trace amounts of o,p– dicofol, octachlorostyrene, and toxaphene.

Geographic variation in contaminant levels in Snapping Turtle eggs from wetlands is similar to that in spottail shiners and Herring Gull eggs collected in the pelagic zone of the Great Lakes. This may be due to the consumption of migrant fish by Snapping Turtles in nearshore wetlands.

Thomas, E.S. 1949. A population of Lake Erie Island Water Snakes. Copeia 1: 76.

Uzzell, T.M. Jr. 1962. The Small-mouthed Salamander, new to the fauna of Canada. Canadian Field-Naturalist 76(3): 182.

In the course of examining collections of salamanders of the *Ambystoma jeffersonianum* complex at the University of Michigan Museum of Zoology and Royal Ontario Museum, two specimens of the Small-mouthed Salamander, *Ambystoma texanum* (Matthes), from Pelee Island, Essex Co., Ontario, were discovered. These two specimens are the basis for an addition to the faunal list of Canada.

Walker, R.B. 1980. Road kills on the Causeway, Long Point, Ontario: 1979 and 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Weller, W.F., and W.G. Sprules. 1976. Taxonomic status of male salamanders of the *Ambystoma jeffersonianum* complex from an Ontario population with the first record of the Jefferson salamander, *A. jeffersonianum* (Green), from Canada. Canadian Journal of Zoology 54: 1270-1276.

Nine morphological criteria were used to determine the taxonomic status of the male salamanders of the *Ambystoma jeffersonianum* complex from a population near Streetsville, Toronto Township, Peel County, Ontario: (a) snout–vent length: (b) ratio of tail length to snout–vent length: (c) internarial width: (d) extent of separation or overlap of the toes of adpressed limbs: (e) total length: (f) ratio of tail length to total length: (g) ratio of internarial width to snout–vent length: (h) colouration of dorsal, lateral, and ventral body surfaces: and (i) extent and distribution of the bluish spotting. The results indicate that all of these males resembled *A. jeffersonianum* or *A. platineum* rather than *A. laterale*. Since *A. platineum* males occur very rarely in nature, these Streetsville individuals are logically assigned to *A. jeffersonianum*. This represents the first record of this species from Canada. Based upon this new distributional datum of *A. jeffersonianum* and of the two triploid species from the literature, we suggest that these triploid species may have originated in post–Wisconsin times and subsequently dispersed northward.

Weller, W.F., W.G. Sprules, and T.P. Lamarre. 1978. Distribution of salamanders of the *Ambystoma jeffersonianum* Complex in Ontario. Canadian Field-Naturalist 92(2): 174-181.

New distributional data on the four species of salamanders of the *Ambystoma jeffersonianum* complex in Ontario show that the ranges of *A. tremblayi, A. platineum,* and *A. jeffersonianum* are more extensive than had previously been known. Bruce, Brant, Lincoln, and Russel Counties and Muskoka District are added to the previous range of *A. tremblayi*; *A. platineum* is newly reported from Wentworth, Halton, York, and Northumberland Counties as is *A. jeffersonianum* from Wentworth and Halton Counties. The two diploid species, *A. laterale* a nd *A. jeffersonianum*, occupy different habitats and are almost always allopatric. One possible case of diploid hybridization is discussed.

Young, M. 1980. A survey of the faunal use of the south beach of Long Point. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Zammit, A.E. 1994. A preliminary bibliography for the Herpetofauna of Ontario, with special reference on Long Point and the north shore of Lake Erie. Technical Note 3. In: J.G. Nelson and P.L. Lawrence (eds.). Long Point Environmental Folio Publication Series. Heritage Resource Centre, University of Waterloo, Waterloo, Ontario.

Zeyl, C.W., L.A. Lowcock. 1989. A morphometric analysis of hybrid salamanders (genus *Ambystoma*) and their progenitors on Kelleys Island in Lake Erie. Canadian Journal of Zoology 67: 2376-2383.

Six morphometric characters and one meristic character were measured on 96 adult and 88 juvenile *Ambystoma* from Kelleys Island, where extensive hybridization involves the three species. Canonical variates, discriminant functions, and size–constrained principal components analyses showed that *A. laterale* (represented only in hybrids on Kelleys Island), *A. texanum, A. tigrinum*, and *A. laterale – texanum – tigrinum* are distinguishable from each other and from a complex of hybrids involving *A. texanum* and *A. laterale*. Within the latter complex, different ploidies are not distinct morphologically. Introgression may explain isolated atypical individuals. Adults differ from juveniles in both size and shape, demonstrating allometry.

MAMMALS

Bailey, J.R. 1976. The ecology of the White-tailed Deer on Long Point. M.Sc. thesis. The University of Western Ontario, London, Ontario.

The objectives of this study were to investigate the ecology of the White–tailed Deer on Long Point, Ontario, so that a deer management plan could be written. This would be necessary should, as has been suggested, a national or provincial park be created on Long Point. Population estimates were 550 deer (or 10.6 $\pm$ 3.01 deer/km^2) in 1967 and 539 deer (or 10.4 $\pm$ 3.12 deer/km^2) in 1968. The deer had an estimated reproductive rate of 0.35 fawns per doe, an annual mortality rate of 8 percent, an almost equal sex ratio of 85 bucks:100 does and an age ratio of 56 adults:25 yearlings:19 fawns during the study. The average home range size, determined from sightings of 22 naturally marked deer, was 2.6 km^2 in summer, 3.9 km^2 in winter for bucks and 1.9km^2 in summer and 2.6km^2 in winter for does. Home range size and deer distribution were probably influenced by food availability and cover requirements. Analysis of group sizes and composition indicated that the deer were essentially solitary. Observations revealed a crepuscular activity pattern from May through October and a diurnal activity pattern from November through April. Too many deer, on the study area appear to have caused habitat deterioration and apparent "stress" in the herd.

Baker, M.R., and R.C. Anderson. 1975. Seasonal changes in abomasal worms (*Ostertagia* spp.) in White-tailed Deer (*Odocoileus virginianus*) at Long Point, Ontario. Canadian Journal of Zoology 53: 87-96.

Three species of nematodes were recovered from the abomasa of White–tailed Deer (*Odocoileus virginianus*) collected at Long Point, Ontario, from September 1972 to August 1973. *Ostertagia odocoilei* was recovered from 45 deer (96%), *O. mossi* from 31 (66%), and *O. dikmansi* from 30 (64%). Abundance of adult stages of all three species was greatest in summer and least in winter. *O.odocoilei* was the most abundant species, especially during winter. Females were more abundant than males at all times of the year, particularly during winter.

Numerous inhabited early fourth–stage larvae were recovered during winter and early spring, while few were found in July and August. The decrease in numbers of inhabited larvae in spring was coincident with a corresponding increase in abundance of adult worms. This is the first indication of the existence of inhibition (previously reported in domesticated animals) in species of *Ostertagia* parasitizing deer. Inhibition was not related to host age, indicating that the phenomenon is probably not due to development of immunity by the host over the grazing season.

Banfield, A.W.F. 1961. Notes on the mammals of Pelee Island. Nature Museum of Canada Bulletin 183: 118-122.

Bednarik, K.E. 1953. An ecological and food habits study of the Muskrat in the Lake Erie marshes. M.Sc. thesis, The Ohio State University, Columbus.

Bildfell, R. 1980. A small mammal survey of Long Point National Wildlife Area conducted during the summer of 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Bildfell, R. 1980. A small mammal survey of Big Creek National Wildlife Area conducted during the summer of 1980. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Burness, G.P., and R.D. Morris. 1993. Direct and indirect consequences of Mink presence in a Common Tern colony. Condor 95: 708-711.

Calvert. E.W. 1920. Notes on the fauna and flora of East and Middle Sister and North Harbor Islands, Lake Erie. Canadian Field-Naturalist 34: 109-110.

Campbell, C.A., L.B. Needham, and S.M. Nevin. The mammals of Pelee Island. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 150-162. Ohio State University Press, Columbus, Ohio.

Dewey, K. 1981. Fish inventory, hydrographic mapping, biolimnological sampling, bird, reptile, amphibian, and large mammal utilization of six island ponds in Gravelly Bay area of Long Point National Wildlife Area. Unpublished report to Canadian Wildlife Service, London, Ontario.

Dewey, K. 1982. Muskrat management considerations for Big Creek and St.Clair National Wildlife Areas. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Dewey, K. 1983. Factors affecting muskrat density in a section of Big Creek National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Donohoe, R.W. 1961. Muskrat reproduction in areas of controlled and uncontrolled water level units. M.Sc. thesis, The Ohio State University, Columbus, Ohio.

Douphine, T.C. 1978. Deer exclosure at Long Point. Canadian Wildlife Service Memorandum. London, Ontario.

Duncan, B.W. 1985. Opossums (*Didelphis virginiana*) in the Niagara Peninsula. Ontario Field Biologist 38: 5-10.

Peterson and Downing (1956) reviewed the status of the opossum (*Didelphis virginiana*) in Ontario and concluded that it seemed "to be in the process of becoming well established as a resident of southern Ontario at (that time)". They also wondered whether it would become permanently established or whether events would lead to its virtual disappearance in the province. This paper presents information concerning the distribution and biology of the opossum in southern Ontario.

Fall, M.W. 1966. Variations in populations of the White-footed Mouse (*Peromyscus leucopus noveboracensis*) on islands in Lake Erie. M.A. thesis, Bowling Green State Universi ty.

Flynn,C.A. 1980. Big Creek marsh Muskrat house count. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Glooschenko, V., G.D. Haffner, R. Edwards, D.R. Lazar, and J. Jones. (manuscript). Mink harvest and PCB body burdens from Great Lakes and inland regions of southern Ontario, Burlington, Ontario.

Toxic chemicals have been implicated in population declines of wild Mink (*Mustela vison*) and a closely related species, the river otter in some parts of the world. Environmental contamination from PCBs and possibly other chemicals have made fish from the Great Lakes unsuitable as food for ranch mink. Using trapper harvest data from 1970–1985, this study compared population levels of mink and muskrat from townships in two study areas along the Great Lakes coast and St. Lawrence River and in two inland areas of southern and central Ontario. Numbers of mink were significantly lower in the Great Lakes and St. Lawrence River study sites than in inland areas. Comparison of muskrat numbers did not show a significant difference between sites. Wet weight and lipid levels (ug/kg) for total PCBs, non– ortho and mono–ortho congeners in liver were determined for 80 mink taken in 1988 from 15 townships in the four study areas.

Highest levels of PCB on a lipid basis (mg/kg) were seen in mink taken from Mersea (32.19 + 49.70), Cornwall (18.85 + 24.56), Otonabee (15.76 + 11.74) and darlington townships (9.41 +

9.19). Principal component analyses was used to show spatial distribution of PCBs in mink from various townships. Mean values and ranges for nine mink taken from Mersea township fall within the range of PCB levels seen in adult mink which caused embryotoxicity, following a diet enriched with PCBs from consumption of Great Lakes fish in controlled feeding experiments (Michigan State University). Wild mink in this area along the Lake Erie shoreline may therefore be exposed to PCBs from the aquatic food chain which could affect natural reproduction of this species.

Hebert, C.E., C.A. Bishop, and D.V. Weseloh. 1993. Evaluation of wetland biomonitors for the Great Lakes: A review of contaminant levels and effects in five vertebrate classes. Canadian Wildlife Service Technical Report No. 182, Ontario Region.

The purpose of this review was to identify species which could be used as indicators of wetland contamination. Five vertebrate classes; Osteichthyes (bony fishes), Amphibia (amphibians), Reptilia (reptiles), Aves (birds) and Mammalia (mammals) were included in the review. Within each class, species were compared using seven criteria. These criteria were based upon the characteristics for biomonitors suggested by the International Joint Commission's Ecosystem Objectives Subcommittee. The first four criteria examined our understanding of the biology of the species. No detailed literature review was conducted for these criteria. However, an attempt was made to evaluate them to provide an overall assessment of the species as wetland biomonitors. The remaining three criteria were used to evaluate the availability of information regarding contaminant levels and effects on wetland species. This review focused on the published literature pertinent to these three criteria.

A score was calculated for each species using the seven criteria. Within each class, the species scores were tabulated and the species were ranked. These rankings reflected the relative merits of the individual species as wetland biomonitors. Within the constraints imposed by field studies, i.e. local species availability, the highest scoring species should be the most useful in evaluating contaminant levels and effects in wetlands. These results are summarized at the end of each chapter.

These scores can be used when selecting species to evaluate wetland contamination but they should not be used exclusively. It is unlikely that one species will be able to meet the data requirements of all studies. It is incumbent upon the researcher to choose those species best suited to accomplishing the goals of the study. For example, if the purpose of the research is to examine the extent of sediment contamination in a wetland, then those species associated with benthic food–webs should be selected, regardless of whether other species scored higher in this review. Alternatively, if the intent of the study is to examine the implications of wetland contamination to humans consuming wildlife, then selection of a game species might be warranted. These considerations are endless, thereby precluding any attempt to suggest one species as the "best" wetland biomonitoring species. It is anticipated, however, that this review will provide a rational framework for selecting species as wetland biomonitors and draw attention to some of the work which has already been completed.

Herdendorf, C.E., S. Hartley, and M. Barnes. 1981. A summary of knowledge of the fish and wildlife resources of the coastal wetlands of the wetlands of the U.S. Great Lakes. Center for Lake Erie Area Research. Ohio State University, Columbus, Ohio.

Jackson, W.B. 1988. Small rodents of the Lake Erie Islands. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 145-14 9. Ohio State University Press, Columbus, Ohio.

Kroetsch, D.J. 1980. Deer exclosure sites, Long Point National Wildlife Area: Vegetation sampling. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Kroll, R.W., R.L. Meekes. 1985. Muskrat population recovery following habitat re-establishment near southwestern Lake Erie. Wildlife Society Bulletin 13: 483-486.

In 1972 and 1973, sustained high water levels in Lake Erie destroyed the shoreline marshes of the 1,775–ha Winous Point Shooting Club near southwestern Lake Erie, Ohio. Muskrat trapping harvest decreased to 10% (N = 376) of average harvest previous to the marsh loss. A 570–ha portion of the destroyed marsh was re–established by reconstructing dikes to permit water–level control. Drawdown management was used to restore suitable muskrat habitat in 1 growing season, and numbers of Muskrat houses peaked the third year. Trapping data and Muskrat house counts indicated that Muskrats moved into the re–established habitat immediately and reproduced at high rates. As populations increased, reproduction decreased. Muskrat harvests were directly correlated to the area of emergent (especially cattail) vegetation.

Managers of restored marshes should initially emphasize moist soil and shallow flooding management techniques to encourage perennials. Trapping can be permitted the first winter. Unscheduled drawdowns for access by heavy equipment can cause Muskrat emigration and, if required, should be conducted when suitable habitat is available nearby.

Lloyd, H. 1925. The acclimatization of the Fox Squirrel at Pelee Island, Ontario. Canadian Field-Naturalist 39(6): 138.

Lomolino, M.V. 1988. Winter immigration abilities and insular community structure of mammals in temperate archipelagos. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 185-196. Ohio State University Press, Columbus, Ohio.

Species composition of insular mammals in north temperate archipelagos is strongly influenced by differential immigration abilities. Moreover, relative immigration abilities of mammals in these and other types of archipelagos may be estimated, a priori, based upon physiological and behavioural characteristics of the species, and the characteristics of the archipelago in question. Even for such systems where immigration is important, however, insular community structure should result from the combined effects of factors affecting survival as well as immigration. This is clearly illustrated by the insular distributions of the two most common small mammals in the Thousand Island region, Meadow voles and Short–tailed Shrews (*Microtus pennsylvanicus* and *Blarina brevicauda*; Lomolino 1984). Meadow Voles combine the advantages of a relatively good immigrator and good survivor (i.e., small, generalist herbivore) and thus exhibit the highest insular rank of all mammals considered. The Short– tailed Shrew, the smaller species (18 versus 45g), is a relatively poor immigrator and thus is almost completely restricted to the near islands (those < 700 m from the mainland or nearest larger island). In contrast, voles inhabit even the most distant islands (> 1km) where they occupy habitats considered atypical for the species. On the near islands, however, voles are absent or restricted to their typical habitat (grasslands) by shrews which selectively prey on juvenile voles (Lomolino 1984, 1986).

Future studies should provide some valuable insights into the factors affecting immigration abilities of other faunas and the degree to which faunas in general are influenced by selective forces operating both during and subsequent to immigration.

McCullough, G.B., and J.T. Robinson. 1988. Overbrowsing of vegetation by White-tailed Deer on the Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

In 1980 the CWS initiated a fenced deer exclosure/open control plot study to determine the effect of deer browsing on the regeneration of woody vegetation at Long Point NWA. The results to date clearly demonstrate that the elimination of deer browsing enables existing plants to grow, promotes the regeneration of woody vegetation and allows the infilling of exposed sand by herbaceous

ground cover.

McKeeman, K.L. 1982. Soil study of Squire's Ridge and the Deer exclosures at Long Point National Wildlife Area, Lake Erie. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Peterson, and Downey. 1956. Distributional records of the Opossum in Ontario. Journal of Mammalogy 37: 431-435.

Proulx, G., D.V.C. Weseloh, J.E. Elliot, S.Teeple, P.A.M. Anghern, and P. Mineau. 1987. Organochlorine and PCB residues in Lake Erie Mink populations. Environmental Contamination and Toxicology 39: 939-944.

PCB poisoning has been found in Mink (*Mustela vison*) fed on Great Lakes fish (Aulerich et al. 1973) but is poorly known for wild Mink populations (O'Shea et al. 1981). The objective of this study was to determine whether mink from the Lake Erie basin were accumulating levels of PCB and organochlorine residues high enough to cause health effects.

Robinson, J.T. 1979. A preliminary small mammal survey of the Big Creek Marsh conducted during the summer of 1979. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Robinson, J.T. 1986. Deer track count at base of Long Point. Canadian Wildlife Service Memorandum, London, Ontario.

Snyder, L.L. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. I General introduction. Transactions of the Royal Canadian Institute 18(39): 117-125.

Snyder, L.L. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. The mammals of Long Point and vicinity. Transactions of the Royal Canadian Institute 18(39): 127-138.

Soper, R. 1981. A small mammal survey of the interior ponds, Gravelly Bay area, Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Toms, I.D., and J.T. Planck. 1981. Mammalian fauna of the Gravelly Bay and Bluff Point areas of Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Urban, D. 1968. The ecology of Raccoons on a managed waterfowl marsh in southwestern, Lake Erie. M.Sc. thesis, The Ohio State University, Columbus, Ohio.

Urban, D. 1970. Raccoon populations, movement patterns, and predation on a managed waterfowl marsh. Journal of Wildlife Management 34 (2): 372-382.

Populations, movement patterns and denning of Raccoons (*Procyon lotor*), and relationships between Raccoons and nesting waterfowl were studied on a managed waterfowl marsh on western Lake Erie. Density of Raccoons per square mile was estimated to be 45.3. Nine Raccoons were instrumented with radio transmitters to determine movements, home ranges, and denning habits. These animals were radio–tracked 87 nights during fall and spring. The average home range included 119.6 acres but varied greatly depending on sex and age–class. Eighty–seven percent of the average home range was marsh, 8 percent woodlot, 4 percent wet meadows, and 1 percent farmland. During nocturnal hours, Raccoons spent more time in the marsh than in the vicinity of the dikes. Females frequented wooded areas more than males. Seventy–three percent of all Raccoon activity occurred in shallow water areas. Raccoons did not change their movements during the waterfowl nesting season as compared to other times of the year. There was no evidence of an influx of Raccoons into the marsh from surrounding areas during the waterfowl

nesting season. Muskrat (*Ondatra zibethica*) houses were used extensively as dens by 89 percent of the radio–tagged Raccoons. Of 64 waterfowl nests found on the dikes of the study area during the 1967 and 1968 nesting seasons, only one was successful. Raccoons terminated 39 percent of the dike nests.

Watson, T.G., and R.C. Anderson. 1975. Seasonal changes in louse populations on White-tailed Deer (*Odocoileus virginianus*). Canadian Journal of Zoology 53: 1047-1054.

The hides of 47 White–tailed Deer (*Odocoileus virginianus*) shot at Long Point, Ontario, between September 1972 and August 1973 were examined for lice. Adult *Tricholipeurus lipeuroides* were most abundant from January to April and *T. parallelus* from May to August. The distributions of biting lice changed over the study period, possibly influenced by environmental factors such as solar radiation, temperature, rainfall, and changes in pelage. *Solenopotes ferrisi* was found throughout the study period. There was no significant change in abundance of the various louse stages throughout the study, although all stages were slightly more numerous during winter. Adults primarily infested the head and neck, while immature stages infested upper body regions. Changes in distribution of lice may be the result of environmental and host pelage changes.

Young, M. 1980. A survey of the faunal use of the south beach of Long Point. Unpublished Report to Canadian Wildlife Service, London, Ontario.

PLANTS

Albright, D.M. 1966. Vascular plants of Honey Point, North Bass Island, Ottawa County, Ohio. M.Sc. Thesis, The Ohio State University, Columbus, Ohio.

Ashenden, J.E. 1981. Vegetation of six island ponds in the Gravelly Bay area of Long Point. Unpublished Report fo Canadian Wildlife Service, London, Ontario.

Bartolotta, R.J. 1978. An analysis of the vascular flora and the succession of plant communities of the earthen dikes bordering Sandusky Bay and western Lake Erie in Erie, Lucas, and Ottawa Counties, Ohio. M.Sc. thesis. The Ohio State University, Columbus, Ohio.

Bayly, I.L. 1979. Report, Lake Erie and St.Lawrence marshes. Unpublished Report to Department of Biology, Carleton University, Ottawa, Ontario.

Bayly, I.L. 1979. The Marshes of Long Point, Ontario. The Lake Erie Peninsulas: Management Issues and Directions. Contact 11: 36-51.

Included is a description of a number of marsh characteristics such as wetland soil, water quality, and vegetation. The author makes recommendations in the form of programs to improve marsh quality. Some of these recommendations include restricting hunting, water diversion, controlling erosion, and halting development.

Boivin, B. 1953. Additons to the flora of the Erie Archipelago (Ontario). Rhodora 55: 224-226.

Boughner, L.J. 1898. Notes on the flora of Long Point Island, Lake Erie, Province of Ontario. Canadian Field-Naturalist 12(1898): 105.

Bradfield, G.E., and L. Orloci. 1975. Classification of vegetation data from an open beach environment in southwestern Ontario: cluster analysis followed by generalized distance assignment. Canadian Journal of Botany 53: 495-502.

Vegetation data from a tract of open beach in southwestern Ontario were classified in two stages to aid in the description and mapping of the plant communities of the area. Firstly, the similarity matrix generated for half the sample was analyzed by a method of similarity clustering designed to produce homogeneous and distinct groups. The four groups that emerged conformed with the main topographic features in the study area, these being the shoreline zone, the middle beach zone, the wet slack zone, and the upper beach zone. This four–type classification was then imposed upon the rest of the sample, using generalized distance (D^2) as the assignment function. The problem faced in the inversion of the singular group covariance matrix (S_k) for each group was overcome by orthogonal transformation. Although considerable computation was involved, the results indicated that D^2, when used in a deterministic sense, has much potential in helping to allocate individuals to groups.

Bryant, J.E. 1965. Private marshes in Southwestern Ontario. Canadian Wildlife Service, Progress Report, London, Ontario.

Operators of thirty–seven private marshes bordering Lake St. Clair and Lake Erie were interviewed concerning habitat management, hunting and costs of operation. Acreages and some other details of other private and public marshes were also obtained. There are 55,700 acres of marsh in the study area of which 47,600 (85%) are privately owned. The private marsh holdings included an additional 11,100 acres of upland and water areas which were directly contributive to the marsh

operations and which were managed as integral parts of the private marshes. Canadians own 54% of the private acreage but have primary control over only 14%: the remainder is leased to United States citizens. Water–level control was artificially maintained on 25,100 acres of diked marshes. Weed–cutting, burning, planting of aquatics, blasting and herbicides were also used to manipulate habitat for hunting. There was little management for waterfowl production. Hunting intensity was light, averaging only one bird killed for every three acres and approximately 90 hunter–days per 1,000 acres per year. Hunter success averaged just under four birds per hunter–day when the bag limit was five per day. The average annual kill during 1959–63 was 20,000 birds. Annual operating expenses averaged $19 an acre on marshes with water–level control and $7 an acre on the others. The average was $14 an acre. Total cost of operation including capital costs other than for land, was $1,150,000 per year for 57,400 acres. The private marshes are deemed to be the primary bulwark against serious depletion of the resource through habitat destruction and too intensive hunting pressure.

Calvert. E.W. 1920. Notes on the fauna and flora of East and Middle Sister and North Harbor Islands, Lake Erie. Canadian Field-Naturalist 34: 109-110.

Campbell, C.A., and A.A. Reznicek. 1977. New vascular plant records on Pelee and East Sister Islands, Essex County, Ontario. Canadian Field-Naturalist 92(1): 384-390.

Pelee Island, the southernmost part of Canada, had a diverse and very interesting flora containing many species rare or absent elsewhere in Canada. Reported as new to Canada are seven species of vascular plants: *Carex davisii, Carex divulsa* subsp. *leersii, Sedum telephioides, Euphorbia obtusata, Myosotis macrosperma, Lycopus virginicus var. virginicus*, and *Senecio glabellus.* These are briefly discussed. In addition, we report on the status of 13 very rare species known previously from the area: *Camassia scilloides, Spiranthes magnicamporum, Celtis tenuifolia, Chenopodium foggii, Thalictrum dasycarpum, Corydalis flavula, Cydonia oblonga, Ammannia coccinea, Chaerophyllum procumbens, Phacelia purshii, Conobea multifida, Eupatorium altissimum*, and *Eclipta prostrata.* Fifty–five other species that are additions to the published flora of the Erie Archipelago, Pelee Island, and East Sister Island are listed as well.

Core, E.L. 1948. The Flora of the Erie Islands: An annotated list of vascular plants. Franz Theodore Stone Laboratory, Ohio State University, Columbus, Ohio.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service. FWS/OBS-79/31.

Crowder, A.A., and J.M. Bristow. 1988. The future of waterfowl habitats in the Canadian lower Great Lakes wetlands. Journal of Great Lakes Research 14(1): 115-127.

Waterfowl utilization of wetlands along the Canadian shore of the lower Great Lakes, and the impact of eutrophication, mental pollution, organic pollution, and sedimentation on both the wetlands and the birds are reviewed. The following stages of eutrophicaton have been identified in the region: increased biomass of filamentous algae, increased submerged macrophyte biomass, increased planktonic algal biomass followed by loss of submergent weedbeds, loss of floating–leaved plants and annual emergents, increased areas of cattail marsh followed by decline, bare mud substrates with anoxic sediments resulting in botulism–related mortality of birds. Comparison with a European model suggests that eutrophication, pollution, and sediment loads act synergistically to cause deterioration of these habitats. Restoration will require not only the control of point sources of pollution, but also a change in farming practices such as drainage and intensive crop production which, through runoff, are major contributors to sediment loads and eutrophication.

Crowder, A., and M. Bristow. 1986. Wetland vegetation in relation to future changes in nutrient loadings and pollutants i n the Lower Great Lakes/St. Lawrence River system. Unpublished Report to

Canadian Wildlife Service, London, Ontario.

The purpose of this report is to review current changes in wetlands on the north shore of the lower Great Lakes, from the St. Clair River to the Quebec border, and to attempt to forecast the effects of these changes on wildfowl.

Dewey, K., and G.B. McKeating. 1983. An environmental screening statement on the marsh management development proposals, Big Creek National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Dodge, C.K. 1914. Annotated list of flowering plants and ferns of Point Pelee, Ontario and neighbouring districts. Canadian Department of Mines, Geological Survey Memorandum 54(2).

Duncan, T., and R.L. Stuckey. 1970. Changes in the vascular flora of seven small islands in western Lake Erie. Michigan Botanist 9(3): 175-200.

Duncan, T. 1973. Three plant species new to Canada on Pelee Island: *Triosteum angustifolium* L., *Valerianella umbilicata* (Sull.) Wood, and *Valerianella intermedia* Dyal. Canadian Field-Naturalist 87: 261-265.

Triosteum angustifolium, Valerianella umbilicata, and *V. intermedia* were collected on Pelee Island, Essex County, Ontario, Canada. This is the first report of these species in Canada. Distribution maps for each species are included with comments concerning the phytogeography of these three range extensions. An unique assemblage of plants, found in association with these three species, for the Erie Islands, is listed and discussed.

Flynn, C.A. 1979. The identification and mapping of aquatic vegetation in the Big Creek Marsh. Unpublished Report to Canadi an Wildlife Service, London, Ontario.

Foggo, D., and R. Battson. 1983. Wetland evaluation of Rondeau Bay - Northwest Shore. Ontario Ministry of Natural Resources, Chatham Distict. Unpublished Report, Simcoe, Ontario.

Foggo, D. 1984. A historical account of shoreline changes to Rondeau Bay - Northwest Shore. Ontario Ministry of Environment, Southwestern Region, Simcoe, Ontario.

Gleason, H.A. 1922. The vegetational history of the Middle West. Association of American Geography Annual Report 12: 39-85.

Glooschenko, V., B. Parker, L.Coo, R. Kent, C. Wedeles, A. Mason, J. Dawson, D. Herman, and P. Smith. 1987. Provincially and regionally significant wetlands in southern Ontario. Interim Report. Prepared for Ontario Ministry of Natural Resources, Wildlife Branch and World Wildlife Fund.

Griggs, R.F. 1901. Additions to the Sandusky flora. Ohio Naturalist 1(6): 97-98.

Hanna, J.E., and Associates Inc.. 1984. A management strategy for the restoration of aquatic vegetation in Rondeau Bay, Lake Erie. Prepared for Ontario Ministry of Environment, Simcoe, Ontario.

Heffernan, S.E., and B.D. Ralph. 1978. Vegetation of Long Point, Ontario (from Courtright Ridge to the tip). Unpublished Report to Canadian Wildlife Service, London, Ontario.

Herdendorf, C.E. 1992. Lake Erie coastal wetlands: An overview. Journal of Great Lakes Research 18(4): 533-551.

Coastal wetlands of Lake Erie fall into three categories, depending on the type of protection

available to the wetland vegetation: (1) coastal lagoons behind barrier beaches, (2) managed marshes protected by earthern and rip–rap dikes, and (3) estuarine tributary mouths. At one time the most important protection was that afforded by barrier bars or other natural shoreline features which formed quiet lagoons and embayments. Very few natural wetlands of this type still exist in Lake Erie. Most of the lagoon–type coastal marshes, if they have not been drained or filled or engulfed by the lake, have been replaced by the second type: managed–waterfowl marshes which are now protected by earthen rip–rap dikes. The third type of protection is the natural isolation from lake storms provided by the estuaries of virtually all of the tributaries entering Lake Erie, particularly at the western end. Large wetlands have developed along most of the estuaries where disturbance has been minimal. Estuarine coastal marshes currently form the majority of the naturally protected wetlands bordering western Lake Erie.

Herdendorf, C.E., and W.G. Duffy. 1987. The ecology of the coastal marshes of western Lake Erie: a community profile. U.S. Fish and Wildlife Service Biological Report 85(7.9). 171 pp. + microfiche appendices.

Herdendorf, C.E., and M.L. Bailey. 1989. Evidence for and early delta of the Detroit River in western Lake Erie. Ohio Journal of Science 89(1): 16-22.

Test borings in the western basin of Lake Erie have revealed an extensive sub–bottom deposit of sand in a triangular region bounded by Stony Point on the mainland shore of Michigan, Middle Sister Island in Ontario, and West Sister Island in Ohio. The 550 km^2 deposit is overlain by up to 7 m of more recent lacustrine silts and clays. The sand beds have an average thickness of 2.3 m, yielding a total volume of approximately 1.3×10^9 m^3 of sand. A preliminary interpretation is that when the ancestral Detroit River first flowed into Early Lake Erie about 4–5,000 years B.P. deltaic sediments were deposited in the northern portion of the western basin. The material of these beds is primarily a clean, medium–to fine– grained, moderately well–sorted sand that appears to have commercial extraction quality.

Hunt, G.S. 1963. Wild Celery in the lower Detroit River. Ecology 44(2): 360-370.

Hunt, G.S., and P.G. Mickelson. 1976. Ecological studies at the Erie shooting and Fishing Club Marsh and their management implications, Monroe County, Michigan. Unpublished report to the Erie Research Commitee, University of Michigan, Ann Arbor, Michigan.

Kellerman, W.A. 1901. Notes on the flora of Sandusky. Ohio Naturalist 1(6): 82-85.

Kellerman, W.A. 1904. Flora of Hen and Chicken Islands. Ohio Naturalist 4(8): 190-191.

King, D.B., and G.S. Hunt. 1967. Effect of Carp on vegetation in a Lake Erie marsh. Journal of Wildlife Management 31: 181-188.

This study was made in 1964 and 1965 on the 1,000–acre diked Erie Shooting Club on western Lake Erie, to determine (1) the effect of carp (*Cyprinus carpio*) on the abundance and species composition of aquatic vegetation, (2) the stage in the life cycle of plants most affected by carp, and (3) the recovery made by vegetation after carp were reduced or eliminated. Exclosures 1–milacre in size were the primary method of study. Carp significantly affected the total abundance of vegetation in both years. The effect was greater at higher carp population levels. A definite selective effect was noted on chara and leafy pondweed; sago and crispus appeared to be least effected by carp activity. Vegetation was most affected early in the growing season when plants were young and delicate. Chara recovered very well within 2 months after carp were removed. Carp retard growth of chara types primarily by feeding on them; on pondweed types the uprooting during feeding activity is probably the most important influence.

Klinkenberg, B. 1988. The theory of island biogeography applied to the vascular flora of the Erie islands. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 95-105. Ohio State University Press, Columbus, Ohio.

The results of the bivariate regression analyses indicated that the power model, when used in its nonlinear form, provided the best fit for the observed species totals of the Erie Islands. In addition, there were differences between the parameters when the models were applied to the native species totals and the alien species totals. The results of the multiple regression analyses indicated that models of alien species distributions were different from models of native species. These results supported the contention that differing factors influenced the distributions of alien and native species, and that these differences were observable even on the basis of their respective species–area relationships.

Knapton, R.W. 1993. Mapping of submerged vegetation and benthic invertebrates in the Dunnville Marshes. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Kreutzwiser, R.D. 1980. Recreational significance of the Long Point Marsh, Lake Erie. Research Report, Department of Geography, University of Guelph, Guelph, Ontario.

Kreutzwiser, R. 1981. The economic significance of the Long Point Marsh, Lake Erie, as a recreational resource. Journal of Great Lakes Research 7(2): 105-110.

Recreation competes with agricultural, residential, and other uses of wetlands and decisions regarding wetland use invariably have been made in the absence of information on the economic significance of wetland recreation. During 1978, data to assess the economic significance of wetlands for recreation were obtained from 703 users of public marsh at Long Point and Point Pelee on the north shore of Lake Erie. The Long Point marsh provided various recreational opportunities including nature viewing, fishing, and waterfowl hunting for over 17,000 users. It is estimated conservatively that these users placed a willingness to pay (consumer surplus) value on the recreation derived of over $213,000 and generated directly and indirectly some $225,000 in local spending on travel, food, accommodation, and other items. The Point Pelee experience demonstrates opportunities for enhancing the recreational and eductional value of the Long Point marsh.

Kroetsch, D.J. 1980. A preliminary study of selected plant communities: Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Kroetsch, D.J. and P. Lepson. 1980. Mapping of emergent vegetation of Boucks Pond in Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Lindsay, K.M. 1982. Rare vascular plants of twelve provincial parks in the deciduous forest region of southern Ontario. Ontario Field Biologist 36(2): 53-70.

Twelve provincial parks in the Deciduous Forest Region of southern Ontario provide habitat for 203 provincially rare plants, 33% of the rare plants listed by Argus and White (1977) for Ontario or 56% of the rare plants found in the Deciduous Forest Region. These parks contain natural environments both representative and unusual in this region, ranging from tall–grass prairie to southern deciduous forest and savanna, dunes, marsh, river valleys and conifer swamp. In order of park size, the number of rare plants recorded are as follows: Rondeau (78), Pinery (42), Bronte Creek (8), Short Hills (16), Turkey Point (16), Wheatley (39), Long Point (8), Ojibway Prairie (69), Fish Point (56), Lighthouse Point (38), Ipperwash (6), and East Sister Island (17). All twelve areas are either existing or proposed provincial nature reserves, or provincial parks which contain proposed nature reserve zones.

Lyon, J.G., and R.G. Greene. Use of aerial photographs to measure the historical areal extent of Lake Erie coastal wetlands. Photogrammetric Engineering and Remote Sensing 58(9): 1355-1360.

McDonnell, M.J. 1988. Landscape, birds, and plants: Dispersal patterns and vegetation change. In: J.F. Downhower (ed.). The Biogeography of the Island Region of Western Lake Erie. pp. 214-220. Ohio State University Press, Columbus, Ohio.

From this discussion it is apparent that the process of plant establishment, and consequently the pattern of vegetation change, is influenced by many events or mechanisms (e.g., dispersal, predation, herbivory, germination, etc.) which are functioning at many different organizational levels (e.g., population, community, ecosystem, etc.). Even though the process of plant establishment is extremely complex, the pattern of vegetation change is predictable if one knows the nature of the conditions present at a site which influence the probability certain events (e.g., dispersal, predation, etc.) will occur.

Similar patterns of vegetation change occur in time and space because the conditions present at a site, which affect the probability of events occurring, repeat in time and space. Conversely, different patterns of vegetation change come about because conditions exist which produce different probabilities events will occur. For example, the probability that wind–dispersed seeds will reach a recently disturbed site is directly related to the distance the site is from available seed sources. The probability bird–dispersed seeds will reach a recently disturbed site is related not only to the distance from the available seed source, but also to the attractiveness of the site (e.g., the existing structure and composition of the vegetation) to dispersal agents. Changes in the conditions which affect dispersal, influence the probability dispersal events will occur and thus effect the rate and direction of vegetation change.

Meeks, R.L. 1963. The effect of drawdown date on plant succession - A 7-year ecological study of four southwestern Lake Erie marsh units. M.Sc. thesis. The Ohio State University, Columbus, Ohio.

Meeks, R.L. 1969. The effect of drawdown date on wetland plant succession. Journal of Wildlife Manage ment 33: 817-821.

A 7–year study was begun on the Winous Point Shooting Club in 1956 to determine the effect of drawdown date on plant succession. An 80–acre marsh was diked into four units, one of which was drained yearly in mid–March, one in mid–April, one in mid–May, and one in mid–June. All of the units were reflooded during September. Plant succession followed the same general trend on all units, going from semi–aquatic species to predominantly annual weeds. Fewer years were required with early drawdowns for annual weeds to replace semi–aquatic species. The May drawdown unit had the best plant associations for wildlife after 7 seasons. Draining during mid–to–late May should allow muskrats (*Ondatra zibethica*) to raise two litters without interruption, and not interfere with duck nesting.

Muencher, W.C. 1929. Vegetation of the Niagara River and the eastern end of Lake Erie . In: A Biologic al Survey of the Erie-Niagara system. Pp. 189-197. New York Conservation Department Supplement 18th Annual Report, 1928.

Mudroch, A. 1979. Big Creek Marsh, Lake Erie, Ontario. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Neil, J.H., and J. Warren, Limnos Ltd.. 1990. Aquatic plant survey Rondeau Bay, Lake Erie: Distribution, species composition, biomass and historical trends. Unpublished Report Prepared for Ontario Ministry of Environment, Simcoe, Ontario.

Pauls, K., and R. Knapton. 1993. Submerged macrophytes of Long Point's Inner Bay: their distribution

and value for waterfowl. Technical Paper 1. In: J.G. Nelson and P. Lawrence (eds.). Long Point Environmental Folio Series, Heritage Resources Centre, University of Waterloo, Waterloo, Ontario.

This paper is divided into four sections: Study Area, Method, Results, and Discussion. First, a detailed description of the Inner Bay is provided to show abiotic factors which may influence macrophyte growth. Second, the steps and materials involved in the macrophyte survey of the Inner Bay as well as the steps and materials involved in diet analyses of waterfowl are outlined. Third, the 1992 distribution of the most frequently observed submerged macrophytes are presented and then are compared to findings of the 1991 survey and of Smith's 1976 survey. This section also outlines the dietary habits of nine different species of waterfowl (n=409) sampled at Long Point. Fourth, the discussion section interprets data, and discusses possible implications and limitations of these findings.

Pieters, A.J. 1902. The plants of western Lake Erie, with observations of their distribution. U.S. Fisheries Communication Bulletin 21: 57-79.

Ralph, B.D., and S.E. Heffernan. 1978. Vegetation of Big Creek National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Schaffner, J.H. 1902. The flora of Little Chicken Island. Ohio Naturalist 3(2): 331-332.

Schloesser, D.W., and B.A. Manny. 1990. Decline of wildcelery buds in the lower Detroit River, 1950-85. Journal of Wildlife Management 54(1): 72-76.

American wildcelery buds (*Vallisneria americana*), an abundant food eaten by diving ducks (*Aythini*) during migrations, decreased in the lower Detroit River of the Great Lakes from 1950 to 1985. Bud densities decreased at 2 (−14 and −18 buds/m^2) of 5 locations and were similar at 3 (−2, +2, and +3 buds/m^2) of 5 locations. Net change in all 5 areas combined, however, was a decrease of 36,720,000 buds, a 72% decline. Estimated potential losses of waterfowl feeding days caused by the decreased bud densities were 147,000 for Canvasbacks (*Aythya valisineria*), 241,000 for Redheads ducks (*A. americana*), or 664,000 for Lesser Scaup (*A. affinis*). Thus, the decline of wildcelery in the Detroit River may have contributed to decreased use of Michigan migration routes by some waterfowl species between 1950 and 1985.

Siegley, C.E., R.E.J.Boerner, and J.M. Reutter. 1988. Role of the seed bank in the development of vegetation on a freshwater marsh created from dredge spoil. Journal of Great Lakes Research 14(3): 267-276.

The contribution of the seed bank to the early seral flora of a wetland created in Sandusky Bay, Ohio, using dredge spoil was evaluated by comparing results from greenhouse germination experiments with those from field surveys. Germinable seeds were patchily distributed both among and within the three dredge spoil–filled marsh areas and the unfilled control area. The unfilled control had the most diverse seed bank (22 species), though not the densest (1,029 germinable seeds/m^2 of marsh bottom down to 10 cm). The seed banks of the spoil–filled areas averaged 13 species (range 7–15) and 980 germinable seeds/m^2 (range 300–1,711). Total seed bank density was 1/6 to 1/20 of those of natural wetlands. Germination conditions were the most important factor governing seeding emergence, with more germination occurring in mudflat conditions than submerged conditions. Approximately 18% of the total early seral flora and 28% of the early wetland species flora were represented in the seed bank, though again the proportions were higher in the unfilled control area than in the dredge–spoil filled cells. The seed bank and early seral floras differed little from species lists in historical records of the area. Many of the early seral species cited as important as wildlife or waterfowl food sources originated in the seed bank whereas the major pest species dispersed into the study site from outside the marsh. The above findings are useful for predicting vegetation dynamics of deredge–spoil wetlands suitable for

waterfowl and other wildlife.

Smith, P.G.R., V. Glooschenko, and D.A. Hagen. Coastal wetlands of three Canadian Great Lakes: Inventory, current conservation initiatives, and patterns of variation. Canadian Journal of Fisheries and Aquatic Sciences 48: 1581-1594.

The decline of wetlands, including those in the Great Lakes coastal zone, prompted the Government of Ontario to initiate steps towards a wetland management policy in 1981. Wetland inventory and evaluation in southern Ontario began in 1983. To date, 1982 wetlands have been evaluated totalling 390 000 ha. These include 160 coastal wetlands, 64 of these on Lake Ontario and the remainder on the other Great Lakes and connecting channels. Current wetland conservation initiatives are outlined including the Wetlands Planning Policy Statement and Conservation Lands Act. Although the values of Ontario's coastal wetland areas are increasingly being recognized, there has been no comprehensive study to show patterns in coastal wetland ecology. Aided by analysis of variance, ordination, and cluster analysis, we show patterns of variation in wetland and site types, soils, dissolved solids, vegetation complexity, and rare flora and fauna which differ between wetlands along Lakes Ontario, Huron, Erie, St. Clair, and connecting channels. Wetlands of Lake Huron reflect a more northern species composition, less organic soil, and more swamp and fen habitat. Along Lakes Erie, Ontario, and St. Clair the predominant marshes have smaller swamp components, organic soils, and considerable dissolved solids.

Stewart, L. 1980. Aquatic vegetation monitoring at Big Creek National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Stewart, L. 1980. Aquatic vegetation monitoring at Long Point National Wildlife Area. Unpublished Report to Canadian Wildlife Service, London, Ontario.

Stuckey, R.L. 1968. Distributional history of *Butomus umbellatus* (Flowering-rush) in the western Lake Erie and Lake St.Clair region. Michigan Botanist 7: 134-142.

Stuckey, R.L. 1969. The introduction and spread of *Lycopus asper* (Western Water Horehound) in the western Lake Erie and Lake St.Clair region. Michigan Botanist 8(2): 111-120.

BIOLOGICAL SUMMARIES AND BIBLIOGRAPHIES

Bradstreet, M.S.W. 1977. The biological inventory of Long Point, Lake Erie: an overview. Unpublished Report to the Nature Conservancy of Canada, Toronto, Ontario.

Canadian Wildlife Service. 1989. A bibliography for Long Point, Lake Erie, Ontario. London, Ontario.

Downhower, J.F. (Ed.) 1988. The Biogeography of the Island Region of Western Lake Erie. Ohio State University Press. Columbus, Ohio.

Herdendorf, C.E., S.M. Hartley, and L.J. Charlesworth. 1974. Lake Erie Bibliography in Environmental Sciences. Bulletin of the Ohio Biological Survey 4(5). The Franz Theodore Stone Laboratory, Ohio State University.

A comprehensive bibliography of published research in the environmental sciences relating to Lake Erie has been compiled. It contains approximately 3,000 entries subdivided into eleven categories dealing with the biological, physical, and sociological aspects of the Lake Erie basin. The bibliography encompasses research during the period 1800 to mid–1972.

Klenkenberg, R. 1985. Life Science Areas of Natural and Scientific Interest in Site District 7-1: A review and assessment of significant natural areas. Parks and Recreational Areas Section, Ontario Ministry of Natural Resources, Southwestern Region, London, Ontario. viii + 82 pp. + folded map, illus.

Lindsay, K.M. 1984. Life Science Areas of Natural and Scientific Interest in Site District 7-2: A review and assessment of significant natural areas. Parks and Recreational Areas Section, Ontario Ministry of Natural Resources, Central Region, Richmond Hill, Ontario and Southwestern Region, London, Ontario. viii + 131 pp. + folded map, illus.

Macdonald, I.D. 1990 A Biological Invertory and Evaluation of the Point Albino Peninsula Area of Natural and Scientific Interest. Parks and Recreational Areas Section, Ontario Ministry of Natural Resources, Central Region, Aurora, Ontario. ix + 235pp. + 3 maps.

Manney, B.A., T.A. Edsall, and E. Jaworski. 1988. The Detroit River, Michigan: an ecological profile. U.S. Fish and Wildlife Service Biological Report 85(7.17).

Ohio Department of Natural Resources. 1994. Ohio wildlife population status and hunting forecast. Unpublished Report. Columbus, Ohio.

Snyder, L.L. 1931. A faunal investigation of Long Point and vicinity, Norfolk County, Ontario. I General introduction. Transactions of the Royal Canadian Institute 18(39): 117-125.

Stuckey, R.L. 1988. Jacob E. Reighard and the first biological survey of Lake Erie (1898-1901). Michigan Academician 20(4): 379-396.

The Biological Survey of Lake Erie (1898–1901) was the third phase of the Biological Survey of the Great Lakes conceived by Jacob E. Reighard. It followed the surveys conducted at Lake St. Clair in 1893 and at Little Traverse Bay on Lake Michigan in 1894. The Lake Erie survey was as important as the earlier surveys, in that special attention was given to biological interactions in the lake, in the anticipation that an understanding of these interactions would contribute to an explanation of the decline of food fish species. However, the third survey appears to be less well–known than the earlier studies. It was overlooked by historians of Great Lakes limnology

Smith (1957) and Egerton (1985, 1987) and mentioned in one sentence by Beeton and Chandler (1963, p. 544).

As the originator of these limnological surveys, Reighard organized teams of uncompensated, but extremely cooperative investigators in the various specialities of aquatic biology, and his skill in so doing helped to overcome what might otherwise have been unsurmountable limitations of budget, personnel, and equipment. The chief investigators were in their thirties and the research assistants were in their early twenties. Both groups were intelligent, highly motivated, and committed to publishing the results of their work. Even though they had only small boats and an occasional small steamer for field sampling trips, these survey groups made notable contributions to the knowledge of the Great Lakes biota, and carried out more extensive projects than could have been achieved by a single organization or by a few individuals working independently.

Reighard's approach heralded a new and more productive era of limnological research on the Great Lakes. It set high standards for the many subsequent limnological surveys (Smith 1957). Reighard's investigators were truly a "who's who" in aquatic biology at the turn of the century.

Zammit, A.E. 1994. A preliminary bibliography for the Herpetofauna of Ontario, with special reference on Long Point and the north shore of Lake Erie. Technical Note 3. In: J.G. Nelson and P.L. Lawrence (eds.). Long Point Environmental Folio Publication Series. Heritage Resource Centre, University of Waterloo, Waterloo, Ontario.