Avian Botulism Outbreak Along the Lower Great Lakes

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The tranquillity of a stroll along the beaches of Lakes Erie and Huron was broken last fall by the presence of dying and rotting ducks, grebes, loons, shorebirds and gulls. Allegations were rampant and speculations rose high! As the causes of bird mortality are often obscure and symptoms overlap greatly, it is essential that diagnostic examinations be undertaken to accurately identify the source of the deaths or illnesses. Eventually, a naturally occurring, but often fatal, disease organism was identified as the causal agent — avian botulism Type E.

First reports of the incident were widely distributed via the ONTBIRDS e-mail service sponsored by the Ontario Field Ornithologists, whereby Ontario birders assisted in field assessments and therefore played a key role in identifying impacted areas and species involved. The Ontario Ministry of Natural Resources, Bird Studies Canada, Environment Canada [Canadian Wildlife Service], the Ontario Ministry of the Environment, the Ontario Ministry of Health, Parks Canada, Health Canada and the University of Guelph [Animal Health Laboratory and Canadian Cooperative Wildlife Health Centre] have been involved in monitoring the outbreak and in determining the cause and potential abatement or preventative options.

Identification and Impact of the Outbreak

Botulism is a paralytic, often fatal, disease resulting from ingestion of pre-formed toxins produced by the bacterium *Clostridium botulinum,* and is one of the most significant diseases that affect water bird populations. Although seven types of botulism [identified as A through G] and several subtypes have been identified, only Types A, C and E impact water birds. Type A seems to be limited to domestic fowl populations and will not be further discussed here. Botulism [Types C and E] seems to have a fairly short history in North America, with most outbreaks being reported within the last ninety years and most frequently within the last twenty years. The first reported case of Type C for Canada was in 1913. Other outbreaks of Type C have been documented for the USA, Mexico, Uruguay, Australia, New Zealand, Japan, Denmark, Great Britain, the Netherlands, Germany, Italy, Spain and South Africa, plus at least 10

other countries on all of the continents, except Antarctica. Over 75% of the reported cases of Type C have been detected subsequent to 1970. Most of the reports of Type E for North America have been noted in the Great Lakes region.

Type C botulism is often referred to as Western Duck Sickness and commonly impacts puddle ducks, geese and swans in prairie sloughs and shallow lakes. Additionally, shorebirds, coots, pheasants, raptors, gulls, herons, pelicans, songbirds, dogs, ranch mink, and lions [one case involving captive animals] and fish are susceptible to the bacterium at varying response levels.

Type E botulism, strongly associated with fish, is poorly understood from a causal perspective, but manifests itself in the spring or fall and targets diving birds, such as loons, grebes and ducks, most frequently. Secondary impacts may be noted in some shorebirds and gulls. Intoxications may arise from the incidental ingestion of the spores from the water column, from scavenging opportunities or from a combination of these sources. The frequency of occurrence of *Clostridium botulinum* in either spore [resting] or vegetative [growing] form in live fish remains largely unknown, but these bacteria were confirmed in sturgeon (*Acipenser* sp.) in Lake Huron in 1999 and outbreaks of Type E botulism in people have occurred numerous times as the result of the consumption of uncooked fish. It should be noted that in the 1999 epizootic [refers to a disease which is temporarily prevalent in a population of animals], Common Loons and Red-breasted Mergansers, the principal avian species affected, are fish eaters. Fish were undoubtedly the primary source of toxin, but the distribution of toxin within fish and its effect on fish health and behaviour are unknown.

Botulism is an extremely potent toxin that affects the nervous system by blocking nerve transmission at the synapse between nerve endings and muscle fibres, resulting in flaccid paresis [an incomplete type of paralysis]. This paralysis is progressive, beginning with the wings [often noted by the stricken birds' propensity to propel themselves across the water using only their wings] and subsequently the legs, nictitating membrane of the eye and eventually the muscles of the neck, which may produce "limberneck", which is often considered to be the hallmark of the disease. As the muscles in the neck are impacted, the bird cannot hold up its head and generally dies from drowning or of respiratory failure due to the paralysis of the respiratory muscles.

Biology, Causal Effects and Prevention

The bacterium can survive under a variety of conditions, but is usually

associated with sustained high summer air temperatures, fluctuating water levels [likely more significant for Type C epidemics] and the presence of carcasses [providing an organic source]. Situations involving the absence of oxygen [anaerobic conditions], air temperatures ranging between 15.5°C and 35.5°C [optimally at 25°C], water temperatures around 25°C, a sediment pH of 7 to 8, salinity of <5 parts per trillion and a source of animal protein favours the development of spores which may be the causal agent associated with Type E botulism. These spores are resistant to low temperatures and low moisture conditions and may remain viable for years. Presumably, these spores are transferred through the blood to the muscles. Once the bacteria multiply and die, the toxins are released and the clinical symptoms are manifested. Type C botulism seems to be more closely related to birds eating invertebrates that carry the toxin. Typically this would involve various maggots of flesh flies and blowflies. As little as 2 to 5 toxin-bearing maggots may be enough to kill a duck! A poorly understood relationship with bacteriophages [bacteriolytic viruses that affect bacteria] exists which likely determines if the toxin is produced during the bacterium's growth and multiplication stages.

Type C outbreaks can be minimized if water level fluctuations are avoided during the hottest part of the season. Reflooding of dry areas should be avoided until cooler fall temperatures prevail. Although most authorities advocate the removal of fish carcasses [to remove a medium for maggot development] and any dead or dying birds, there is little concrete evidence to support the fact that this is effective in stopping an outbreak. In Western Canada, despite massive clean-up efforts, botulism mortality remains high on affected lakes. For Type E botulism, control is much more difficult and it may be that the only control device that is available is to collect and bury or otherwise remove the carcasses as soon as possible after discovery. However, some authorities feel that this may not make much of a difference, except to the occurrence of botulism in scavenging birds.

The 1999 Botulism Outbreak in Ontario

Over a period of approximately ten weeks, hundreds or perhaps thousands of water birds, representing several species, died along parts of Lake Huron [Kettle Point to Grand Bend] and Lake Erie [Point Pelee National Park to Rondeau Provincial Park and Turkey Point/Long Point]. Complementary observations were made along the southern shore of Lake Erie [Ohio and Pennsylvania] during this period. It has been speculated that several events may have occurred as follows: (1) a low mortality event

throughout most of the month of September, with an increase about 28 September that lasted a few days; (2) a significant event, commencing 26 October and lasting about two weeks; and (3) a low mortality event in early November. It is further speculated that the first cases of botulism [Type E] may have arisen as early as late July or the beginning of August, probably on 18 July, when large numbers of gulls and shorebirds were noted on Lake Erie. To support this, botulism was confirmed from a Great Black-backed Gull from Long Point [Cooperative Wildlife Health Centre, Guelph, Ontario] and other gulls in Erie, Pennsylvania earlier in the summer [National Wildlife Health Center, Madison, Wisconsin]. Type E botulism was confirmed in Red-breasted Merganser, Common Loon, Ring-billed Gull, and Red-throated Loon from Lake Huron and in Red-breasted Merganser, Common Loon and Great Black-backed Gull from Lake Erie.

The species involved have been well documented, but the numbers of birds have not. Estimates vary widely from about 1700 individuals, consisting of mergansers, mostly from Lake Erie and loons, mostly from Lake Huron, to an MNR estimate of over 2000 loons along the Lake Huron shore, to a much higher estimate of over 7000 birds, of at least sixteen species. Certainly thousands of birds and at least 700 loons were impacted, but the absolute numbers cannot be determined. Therefore, caution must be exercised in using these data to assign accurate numbers to the outbreak. The collections undertaken were happenstance and no accurate records were maintained. It is therefore better to abandon the numbers reported and focus on species involved. To this end, and based on the information from a variety of sources, I have tried to summarize known information in tabular form (Tables 1 and 2).

Reports of birds dying from botulism are widespread and fairly common in certain areas. Incidents involving Type E botulism are much rarer and, as mentioned, are generally confined to the Great Lakes region. Outbreaks have been recorded in Ontario in at least 1994 [Goderich, involving Herring and Ring-billed Gulls] and 1998 [Lake Huron, involving dozens of loons]. In both cases, the type of botulism was not confirmed. An outbreak in Kent County in 1941 likely involved Type C botulism. Other proximal outbreaks included a kill involving approximately 8000 birds in lower Lake Michigan in 1963, where Type E botulism was confirmed.

When one looks at the data presented in Table 2, some interesting patterns become evident. Loons were more frequently impacted on Lake Huron , but mergansers were most affected on Lake Erie. The reason for this geographic pattern is

Table 1: Summary of Reported Species of Birds Impacted

Species	Lake Huron	Lake Erie
Common Loon *(Gavia immer)*	X	X
Red-throated Loon *(G. stellata)*	X	
loon sp.	X	X
Horned Grebe (*Podiceps auritus*)	X	X
Red-necked Grebe (*P. grisegena*)	X	
grebe sp.		X
Great Blue Heron (*Ardea herodias*)		X
Common Merganser (*Mergus merganser*)	X	
Red-breasted Merganser (*M. serrator*)	X	X
merganser sp.		X
Greater Scaup (*Aythya marila*)		X
Oldsquaw (*Clangula hyemalis*)	X	X
Surf Scoter (*Melanitta perspicillata*)	X	
duck sp.		X
Bonaparte's Gull (*Larus philadelphia*)		X
Ring-billed Gull (*L. delawarensis*)	X	X
Herring Gull (*L. argentatus*)		X
Great Black-backed Gull (*L. marinus*)	X	X
gull sp.		X
Sanderling (*Calidris alba*)		X
Spotted Sandpiper (*Actitis macularia*)		X
sandpiper sp.		X

Table 2: Summary of Observations in Botulism Outbreak (Ontario) 1999

Location	Date	Comment
Long Point (Lake Erie)	August	Great Black-backed Gull
Point Pelee National Park, Rondeau Provincial Park, Long Point, south shore of Lake Erie (Ohio & Erie, Pennsylvania)	early September to October 26	shorebirds and carp - Pelee gulls - south shore of Lake Erie gulls and Great Blue Heron - Long Point
Grand Bend (Lake Huron)	October 24	Common Loon and Oldsquaw
Ipperwash (Lake Huron)	October 24	Common Loon, Red-throated Loon, Red-necked Grebe, Horned Grebe, Oldsquaw, Surf Scoter, Ring-billed Gull and Great Black-backed Gull

Rondeau Provincial Park (Lake Erie)	October 26	Common Loon, Horned Grebe, Red-breasted Merganser, Ring-billed Gull, Herring Gull and Great Black-backed Gull
Pinery Provincial Park (Lake Huron)	October 27	Common Loon, Red-breasted Merganser, grebes and gulls, Sturgeon
Erie Beach (Lake Erie)	October 27	Common Loon, Horned Grebe, Red-breasted Merganser, Greater Scaup, Bonaparte's Gull, Ring-billed Gull, Great Black-backed Gull
Port Burwell, Port Bruce, Port Stanley, Rondeau Provincial Park and Wheatley (Lake Erie), Sarnia, Grand Bend (Lake Huron)	October 28	mergansers - Rondeau to Wheatley loons - Sarnia to Grand Bend sturgeon - Sarnia Ring-billed Gull and Great Black-backed Gull - Port Stanley
Grand Bend	October 29	Common Loon, Red-throated Loon
Pinery Provincial Park, Ipperwash	November 2	loon - Pinery loon - Ipperwash low numbers of other unidentified species
Rondeau Provincial Park, Point Pelee National Park	November 3	mergansers, grebes, loons, Bonaparte's Gulls and Oldsquaw
Long Point, Turkey Point Provincial Park (Lake Erie)	November 4	a few gulls at Long Point tip many dead mergansers noted off-shore (date?) Major outbreak in Pelee and Rondeau area in late August involving many gulls and shore-birds (Spotted Sandpipers and Sanderlings mostly)
Pinery Provincial Park	November 4 -5	loons, Common Mergansers, Oldsquaw
Pinery Provincial Park	November 10	loons
Grand Bend, Port Franks	no date	loons, grebes and mergansers

unclear, but may simply be related to the frequency of occurrence of the species involved in the two zones. For example, mergansers, particularly Red-breasted, are very common along the Lake Erie shore, while loons seem to follow the Lake Huron shore and stage along its reaches. The shorebird impact may be more directly related to the pres-

ence of the disease, or again it may reflect the availability of staging areas along the Lake Erie shoreline that do not exist on Lake Huron.

It is difficult to predict if we will have another outbreak of botulism in the near future, but I do hope that, if we do, the observers and agencies monitor both the species involved and the numbers as well. With good record keeping, perhaps we can better assess the species differential between the two bodies of water and therefore draw conclusions as to why it prevailed where and when it did.

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