TYPE E BOTULISM IN MICHIGAN: A HISTORICAL REVIEW

Botulism is a paralytic condition that results from consuming a neurotoxin produced by the spore forming bacterium *Clostridium botulinum.* The bacterium resides in the bottom sediments and in the alimentary (digestive) tracts of fish in the Great Lakes. The toxin is produced as the bacterium grows and there are 7 recognized types of botulism neurotoxins in the world, A-G. In Michigan, Type C and Type E botulism have been diagnosed in wild waterfowl.

The first waterfowl die-off attributed to any type of botulism in Michigan occurred in 1941, in the Lake Erie marshes near Monroe. The toxin was identified as Type C and the source of the toxin was the bottom sediments.

The first waterfowl die-off attributed to Type E botulism in Michigan occurred in 1963 on Lake Michigan and the source of toxin was fish. This was the first time Type E botulism was diagnosed in North American. Gulls and Common Loons were the species involved in the die-off which extended from the Indiana border to Leelanau County, nearly the entire Lake Michigan shoreline of the Lower Peninsula. The estimated mortality was 7720 birds of which 3300 were Common Loons.

Once Type E botulism was diagnosed in 1963, die-offs occurred annually through 1968. In 1964 Type E botulism was identified along the Upper Peninsula's Lake Michigan shoreline with an estimated total mortality of 4920 birds of which 3570 were Common Loons. From 1965 to 1968 total mortality of the die-offs were smaller, as were the number of Common Loons that perished. After 1968, mortality attributed to Type E botulism in waterfowl was non-existent until 1976 when a die-off of 600-1000 birds occurred with the mortalities being primarily Common Loons. A small Type E botulism die-off of Common Loons occurred on Lake Superior in 1981 and an estimated die-off of 592 Common Loons occurred in Delta and Schoolcraft Counties in the Upper Peninsula in 1983.

Type E botulism die-offs on Lake Michigan did not occur again until 2006. That year, an estimated mortality of 2985 birds occurred, but only 190 of the dead birds were Common Loons. The die-off occurred in Benzie and Leelanau Counties in the Lower Peninsula and in Schoolcraft County in the Upper Peninsula. Mortalities attributed to Type E botulism of varying severity have occurred annually on Lake Michigan since 2006, ranging from a high of 7500 in 2007 to a low of 108 in 2014. Common Loons are one of the greatest affected species. Other species represented in the die-offs are Long-tailed Ducks, Red-breasted Mergansers, Red-necked Grebes, White-winged Scoters, Ring-billed Gulls, Herring Gulls, and Double-crested Cormorants. In the Type E botulism die-offs that have occurred since 2006, for all of these species, but especially for the Common Loon, the die-offs have normally occurred in the late summer/fall (August to November). This is the time when the birds are staging on the northern portion of Lake Michigan for their fall migration and can involve the Lake Michigan shoreline on

both the Upper and the Lower Peninsula. Most Common Loon mortalities occur on the open lake and their carcasses drift great distances to shore.

In the early Type E botulism die-offs of the 1960's and the 1970's and in the recent die-offs from 2006 on, invasive fish species have been identified as a likely source for the Type E botulism bacterium and toxin. Alewives were a major food item on affected birds in the early die-offs and Round Gobies now appear to be the primary fish species in the current Type E botulism food chain. These fish can either be consumed dead or when sick and easily preyed upon; with the different avian species exhibiting a preference to feed on dead carcasses (Gulls) or to only consume live fish (Common Loons).

The botulism exerts its primary action on nerve endings, preventing the transmission of nerve impulses to the muscles. This results in a loss of motor function and flaccid paralysis of the legs, wings, head, and neck. Labored breathing and eventual respiratory failure due to the paralysis, causes the death of the bird. Oftentimes because of the paralysis, the birds have a difficult time holding their heads up and they may drown.

Pathological changes that occur in Type E botulism affected birds are minimal, with the only changes occurring in the lungs (fluid-filled) as a result of drowning. The birds look otherwise normal and are usually in good to very good physical condition as the toxin kills the birds quickly.

Since the recent Type E botulism die-offs began in 2006, researchers have investigated many reasons to explain why Type E botulism die-offs are being seen once again after several years when no die-offs occurred. Factors investigated to explain why die-offs occur and the severity of the die-offs are: water levels of Lake Michigan, water temperatures of Lake Michigan, storm activity, the source of the toxin and the location where the birds may have consumed it, and the possibility of a *Cladophora* algae/Zebra and Quagga Mussel/Round Goby food web. Attempts to predict the severity of a die-off attributed to this disease and considering these research topics have shown a mixed result of accuracy. It is a complicated disease and there is much to be learned in order to determine the affect that it could have on wild waterfowl, including the Common Loon.

Type E botulism is a disease that can cause significant mortality in the Common Loon population and there is little that can be done to limit the affects of the disease. In years when mortality is high, the Great Lakes (Michigan, Minnesota, Wisconsin, Ontario, Canada) Common Loon population will likely be impacted. It is difficult to know what the impact of this disease on the Common Loon population of the Great Lakes will be, but it could be devastating as this is an uncontrollable mortality factor. Time will tell.

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