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Type E Avian Botulism Outbreaks: Lake Erie Outbreaks in Relation to Type E and Type C Outbreaks from a National Perspective

Summary: A brief overview of the USGS National Wildlife Health Center (NWHC) was provided, including its mission, facilities, and functional capabilities. Functional capabilities, including diagnostic assistance, rapid field response and investigation of wildlife disease outbreaks, and directed research on specific wildlife disease problems and issues. Studies of avian botulism have been a significant portion of the center's activities since its establishment in 1975. While most efforts have involved type C avian botulism, the center has been involved in diagnosis and field investigation of type E outbreaks.

The history and changing geographic patterns of occurrence of avian botulism, types C and E, were discussed and presented on a map from the USGS National Atlas (www.nationalatlas.gov/wildmortfrm.html). Avian botulism outbreaks over the course of history in the U.S. and Canada have been almost exclusively due to type C, with the exception of a small number of type E outbreaks in the Great Lakes, one in Alaska, and several individual cases from other locations: near Panama City, Florida, and the Salton Sea in southern California (unpublished data from NWHC diagnostic and epizootic data bases).

Prior to the recent outbreaks of type E avian botulism on Lake Erie, type E outbreaks have been documented periodically on Lake Michigan and Lake Huron during 1964 - 1984. These outbreaks have been summarized by Brand et al. *(1983, Wilson Bulletin 95:269-275)* and Brand et al. *(1988, Journal of Wildlife Diseases 24:471-476)*. The first reported occurrences of type E avian botulism in 1963 and 1964 were investigated by the Michigan Department of Natural Resources and reported by Fay et al. *(1965, Pub. 13, Great Lakes Research Division, University of Michigan)*. These widespread outbreaks along Michigan's southern shore of Lake Michigan (1963) and the southern shore and Upper Peninsula shores (1964) killed over 12,000 birds total (primarily loons and gulls). Following these incidents and the occurrence of 11 cases of human type E botulism from consuming improperly prepared fish from the Great Lakes during 1960-1963, surveys for *Clostridium botulinum* type E in healthy fish (Bott, *1966, Journal of Bacteriology 91:919-924;* and in lake sediments (Bott et al., *1968, Journal of Bacteriology 95:1542-1547*; Sugiyama et al., *1970, Proc. First U.S. - Japan Conf. on toxic microorganisms: 287-291;* Graikoski et al., *1970, Proc. First U.S. - Japan Conf. on toxic microorganisms* 95:271-277*)* disclosed the widespread environmental occurrence of type E botulism bacteria in all lakes,

particularly in Lake Michigan and Lake Huron. Field investigations of three type E avian botulism outbreaks on Lake Michigan by the NWHC in collaboration with the Michigan Department of Natural Resources, Wisconsin Department of Natural Resources, and Illinois Department of Conservation during 1980-1983 provided additional observations and documentation contributing to the scant knowledge on the epizootiology of this disease, including:

- demonstration of preformed type E toxin in fish in the proventriculus and ventriculus of birds sick and dead from avian botulism;

- demonstration of type E toxin in dead fish along Lake Michigan shores in association with late fall type E outbreak (including alewife, burbot, and smelt);

- demonstration of toxins from both type C and type E in individual birds dying during outbreaks during summer months;

- absence of carcass-maggot cycle involved in late fall outbreaks.

An overview of the current state of knowledge of type C avian botulism was presented and compared and contrasted with type E. While there are some similarities, there are also major differences in molecular biology, microbiology, and ecology between *C. botulinum* types C and E which may explain the different epizootiological presentations of these diseases. Some of the major, but basic, questions regarding type E avian botulism include: the role of various fish species in transferring toxin to birds; whether fish are susceptible to type E toxin or toxin in fish is primarily formed postmortem in fish carcasses; whether fish-eating birds such as loons scavenge dead fish or mistake them for live fish; the importance of the carcass-maggot cycle during type E outbreaks in the summer; human health risks from sick or dead birds during outbreaks, as well as directly from fish; current prevalence and distribution of *C. botulinum* type E in fish and sediments of Lake Erie (as well as other Great Lakes); the impact of type E botulism on loon populations; and specific ecological conditions required for type E toxin production and transfer to birds.