SURVEILLANCE OF BOTULISM E RELATED MORTALITY IN WATERBIRDS OF THE WISCONSIN GREAT LAKES

FINAL REPORT

Submitted to the U.S. Fish and Wildlife Service Great Lakes Fish and Wildlife Restoration Act Program

FWS Agreement Number 30181-9-G027

Principal investigators:

Sean M. Strom
WI Dept of Natural Resources
101 S. Webster St.
Box 7921
Madison, WI 53707
Sean.Strom@Wisconsin.gov

Julie A. Langenberg
WI Dept of Natural Resources
Julia.Langenberg@Wisconsin.gov

Mike W. Meyer
WI Dept. of Natural Resources
Michael.Meyer@Wisconsin.gov

Prepared by:
Sean M. Strom, J.K. Batten, C. Courtney, M.W. Meyer, and J. A. Langenberg. WI Dept of Natural Resources

Introduction and Background

Avian botulism is a paralytic, often fatal, disease of birds that results when they ingest toxin produced by the bacterium, *Clostridium botulinum* (Friend and Franson 1999). There are seven distinct types of toxin denoted A through G, based on the serologic specificity of the toxin produced (Austin 2001). Sporadic die-offs of fish eating birds, primarily in the Great Lakes, have been the result of botulism type E (Bot E) toxin.

Spores of *C. botulinum* are widespread throughout the environment and can occur in soil, surface waters, sediments, and in the tissues of fish and other animals (Jensen and Allen 1960, Bott et al. 1966, Reed and Rocke 1992). The type E toxin was found to be widely but unevenly distributed throughout the Great Lakes and fish from all areas are potential carriers. More importantly, type E toxin was identified in 57% of fish collected from Green Bay (Lake Michigan) (Bott et al. 1966).

The botulinum toxin binds to receptors on nerve endings, impacting neuromuscular function resulting in a paralytic effect on birds. Impacted waterfowl typically show signs of weakness, dizziness, inability to fly, muscular paralysis, and respiratory impairment. The toxin also causes paralysis of the inner eyelid or nictitating membrane and the neck muscles, resulting in inability to hold the head erect. When birds reach this stage, they often drown before they might otherwise die from the respiratory failure caused by botulinum toxin (Friend and Franson 1999).

Reports of BotE in birds are largely confined to the Great Lakes area and primarily involve common loons, gulls, and diving ducks (Brand et al. 1988). Epizootics of BotE in birds were first reported in 1963 and 1964 along the southern shore of Lake Michigan, with most mortality occurring in common loons and gulls (Herman 1964, Kaufmann and Fay 1964, Fay et al. 1965). Recently BotE outbreaks have become more frequent and widespread, particularly in lakes Michigan, Huron, Erie, and Ontario. Outbreaks of BotE have been reported annually since 1999 on the lower Great Lakes (Huron, Erie, Ontario) with an estimated mortality of over 50,000 birds (NYDEC 2007). Between 2006 and 2007, BotE was confirmed in Lake Michigan during the fall migration with an estimated mortality of over 10,000 water birds, mostly common loons (M. Jankowski pers. comm.).

Although BotE outbreaks are not new to Lake Michigan, they are becoming more frequent. Monitoring should be a priority given the potential consequences this issue may afflict on species such as the common loon. Specific objectives of this project include:

1. Investigate the occurrence of waterbird mortalities associated with botulism E outbreaks along the Wisconsin shores of the Great Lakes.
2. Understand the scale and scope of the botulism E outbreaks on Great Lakes migratory waterbirds in regards to species involved, numbers impacted and locations of the outbreaks.
3. For Midwestern common loons, identify populations most at risk and estimate potential population impacts.
4. Establish a network of partners to assist with the monitoring of avian mortality events in Wisconsin and coordinate with other Great Lakes botulism E surveillance programs.

Methods

Systematic ground survey methods were used to quantify the number of waterbirds affected by BotE, the dates of highest mortality, and the exact locations of each mortality event. Transects of beaches/shorelines along Green Bay and Lake Michigan were established using a combination of GIS and knowledge of shoreline status. The area to be surveyed includes over 300 miles of shoreline encompassing the Door County peninsula.

Survey transects were established in September of 2008. Transects were located approximately every 10 miles along the shoreline of Door County, incorporating into the potential sample all shoreline that meets a minimum of access and safety conditions (Figure 1). All sites were visited prior to surveillance efforts in order to gauge safety and insure accessibility via landowner contact. Transects were approximately 100-500-meters in length and surveyed at bi-weekly intervals between October-November 2008. These transects were re-visited monthly between June-August 2009 and again at bi-weekly intervals between September-November 2009.

During each transect visit, the number (and species) of sick and/or dead birds was recorded. Any dead birds encountered during the transect visit were collected and submitted to the WDNR's Wildlife Health Program, Madison, WI for full necropsy. At the time of necropsy, samples of heart tissue were submitted to the USGS National Wildlife Health Center, Madison, WI for botulinum screening. Also during each visit, weather conditions as well as the presence of excessive Cladophora accumulations were recorded.

Evaluating WI Loon Population Risk to BotE

Mitro et al. 2008 quantified the adult survival rate of loons breeding in Wisconsin 1992-2001. Satellite telemetry work conducted by Kenow et al. 2002 established that Wisconsin breeding loons utilize the Door County shoreline during fall migration, thus are at risk to botulism E exposure, and increased mortality. Adult survival is the key demographic parameter driving the population status (annual growth rate) of the Wisconsin loon population (Grear et al. 2009). A decrease in adult survival of only a few percent could change the trajectory of the slowly increasing Wisconsin loon population (as measured 2002-2004) to one of decline. It is critical to assess whether adult survival rates in WI have changed since Botulism E die-offs have occurred WDNR and cooperators have banded >2400 common loons in Wisconsin 1991-2009. Banding consists of a USFWS band and 2 or 3 color bands, the combination of which is unique to the individual bird. Annually, 1992-2009, WDNR biologists and cooperators have documented the spring return of color-marked loons to the breeding grounds. During the years 1992-2001 Mitro et al. (2008) documented an annual reobservation rate of 87-88% of color-marked adults at their territorial lake, a displacement rate to adjacent lakes of 5%, resulting in an adult survival estimate (using Program MARK) of 92% for Wisconsin for the period. WDNR and cooperators have continued to monitor annual reobservation rates of a minimum of 300 individual adults annually 2002-2008. We continue to conduct reobservation surveys in spring 2009 and will use Program MARK to compare Wisconsin adult loon survival rates 1992-2001 to the period 2002-2010, the period when BotE has been impacting the migratory loon population in the Great Lakes. We will evaluate the population level impact by including the new adult survival estimate in the Wisconsin Loon Population Model which provides an estimate of annual growth rate for the period 2002-2004 (Grear et al. 2009). We will estimate the annual growth rate for

the period 2005-2010 to evaluate whether there has been a significant change in annual growth rate measured for the time period 2002-2004.

We will also query the USGS Bird Banding Lab to gain all Wisconsin loon band returns, allowing for an independent estimate of adult survival using Program MARK for recoveries only. We have received 130 band returns from the WI banded loon population 1991-2008, a recovery rate of approximately 5%. Fifteen of these band recoveries were reported from Great Lakes states and provinces during fall migration during the period 2002-2007. We will evaluate whether these or recoveries 2008-2009 are associated with BotE mortality events and compare adult survival estimates 1992-2001 to the period 2002-2009.

Results

2008

Beginning in October and continuing through November 2008 biologists conducted surveys of 15 points around the Door County peninsula's shoreline. Points were located approximately every ten miles around the shoreline of the county. At each point, a transect was established ranging from 100 to 500m and surveyed to document any bird mortalities. Transects were visited every two weeks continuing through November.

No significant mortality events were identified during the fall 2008 surveillance effort. A total of three dead birds were recovered, (all near Egg Harbor, WI), including two ring-billed gulls and one Canada goose (Table 1). Both gulls tested positive for BotE toxicity. Staff also observed a small number of sick birds that displayed characteristics of botulism exposure; however, the birds were not recovered. The low number of mortalities seen during the WI DNR's surveillance efforts was similar to the low numbers other Great Lakes States observed during the 2008 BotE season.

2009

No significant mortality events were identified during the fall 2009 surveillance effort (Table 2). A total of five dead birds were recovered, including three ring-billed gulls, one herring gull, and one common loon. The birds were recovered from the following locations:

- 8/19/2009 1 ring-billed gull, Portage park
- 9/17/2009 1 herring gull, Country House Resort
- 10/1/2009 1 ring-billed gull, Sand Bay Resort
- 10/1/2009 1 ring-billed gull, Frank Murphy Park

Lab analysis shows the death of two of the ring-billed gulls was likely related to Botulism poisoning. The herring gull tested negative for Botulism E exposure, and the remaining results are pending. In addition, three dead common loons were submitted to Wildlife Health by staff at White Fish Dunes State Park. Results from these necropsies are pending. An additional 14 dead birds were observed but not collected due to poor post-mortem condition, including 5 double-crested cormorants, 7 unidentified gulls, 1 ring-billed gull, and 1 unidentifiable duck.

Staff also came across a small number of sick birds that potentially displayed characteristics of botulism exposure, but the birds were not recovered. A total of five sick birds were observed, including 3 herring gulls, 1 ring-billed gull, and 1 unidentified diving duck.

Loon reobservations occurred at 110 lakes in Vilas, Oneida, Iron, Forest, Lincoln, and Langlade counties May 1 – July 28, 2010. A total of 220 adult banded loons were encountered during the reobservations. WDNR also banded an additional 133 adult loons and chicks within the study area July – August, 2009. Reobservations of adult loons will again occur within the study area May 1 – July, 2010. Following this reobservation period, the encounter data will be entered into a spreadsheet and the adult survival estimate for the period 2002-2010 will be determined, and compared to that measured 1992-2001. We will also query the USGS BBL in 2010 so that all banded loons recovered are known, and an independent estimate of adult survival can be derived. The comparison of adult loon survival rates using Program MARK will be delayed until 2010 so a more robust sample size can be achieved.

Avian mortality monitoring network

Wisconsin is a member of EPA's Great Lakes Botulism Network and Management Initiative. Results of this project will be shared with the Network and will compliment this basin-wide effort. Project staff will continue to work with colleagues from other Great Lakes states and provinces who are investigating BotE, and with interested stakeholders such as the Wisconsin Bird Conservation Initiative to monitor the impacts of BotE on Midwestern waterbird populations and the lake ecosystems they use. In addition, data from this project will be entered into the newly developed WDNR Wildlife Health database to help evaluate historical and ongoing collections of Lake Michigan water bird mortality data to monitor spatial and other ecologically relevant trends important to understanding the emerging problem of botulism E in the Great Lakes.

Management implications

No large scale mortality events were observed during either the 2008 or 2009 transect year. The low number of mortalities seen during the WI DNR's surveillance efforts was similar to the low numbers of mortalities observed in other Great Lakes states. However, the small number of positive Bot E cases observed in both 2008 and 2009 suggest a constant, low level presence of the botulism toxin in the waters surrounding the Door County peninsula.

Areas for future research

The WI DNR will continue to survey the transects for Bot E related mortality. Additional research is needed to investigate the relationships between aquatic invasive species (quagga mussels, round gobies), Cladophora blooms, Great Lakes water levels, and Bot E related mortality in waterbirds.

References:

Austin, J. W. 2001. *Clostridium botulinum. In* Food microbiology: Fundamentals and frontiers, 2nd Edition, L. R. Beuchat, M P. Doyle, and T. J. Montville (eds.). ASM Press, Washington, D.C., pp. 329-349.

Bott, T. L., J. S. Deffner, E. McCoy, and E. M. foster. 1966. *Clostridium botulinum* type E in fish from the Great Lakes. Journal of Bacteriology. 91(3): 919-924.

Brand, C. J., S. M. Schmitt, R. M. Duncan, and T. M. Cooley. 1988. An outbreak of type E Botulism among common loons (*Gavia immer*) in Michigan's Upper Peninsula. Journal of Wildlife Diseases. 24:471-476.

Fay L. D., O. W. Kaufman, and I. A. Ryel. 1965. Field observations and laboratory investigations concerning recent Lake Michigan bird mortalities. Michigan Department of Conservation and Resource Development Report 25. 14pp.

Friend M., and J.C. Franson. 1999. Field manual of wildlife diseases, general field procedures and diseases of birds. U.S. Department of the Interior, Geological Survey, Information and Technology Report 1999-001. Madison, Wisconsin, USA.

Grear, J.S., **Meyer, M.W**., Cooley, J.H., Kuhn, A., Piper, W., Taylor, K, Kenow, K., Mitro, M., Vogel, H., Nacci, D. 2009. Population Growth and Demography of a Long-lived Piscivorous Bird in Lakes of the Northern United States. J. Wildlife Manage. (In Press)

Herman, C. M. 1964. Significance of bird losses on Lake Michigan during November and December, 1963. University of Michigan, Great Lakes Research Division, Publication Number 11:84-87.

Jensen, W. I., and J. P. Allen. 1960. A possible relationship between aquatic invertebrates and avian botulism. Trans. N. Am. Wildl. Nat. Res. Conf. 25: 171-180.

Kaufmann, O. W. and L. D. Fay. 1964. Clostridium botulinum type E toxin in tissues of dead loons and gulls. Michigan State University, Agricultural Experimental Station, Quarterly Bulletin 47: 236–242.

Kenow K.P., M.W. Meyer, D.C. Evers, D.C. Douglas, and J. Hines. 2002. Use of satellite telemetry to identify common loon migration routes, staging areas and wintering range. Waterbirds 25: 449–458.

Mitro, M. G., D. C. Evers, M. W. Meyer, and W. H. Piper. 2008. Mercury and common loon survival rates in Wisconsin and New England. Journal of Wildlife Management. 72(3):665-673.

New York State Department of Environmental Conservation Report to the Fall Convention of the New York State Conservation Council, Inc. September 2007.

Reed, T. M., and T. E. Rocke. 1992. The role of avian carcasses in botulism epizootics. Wildlife Society Bulletin. 20: 175-182.

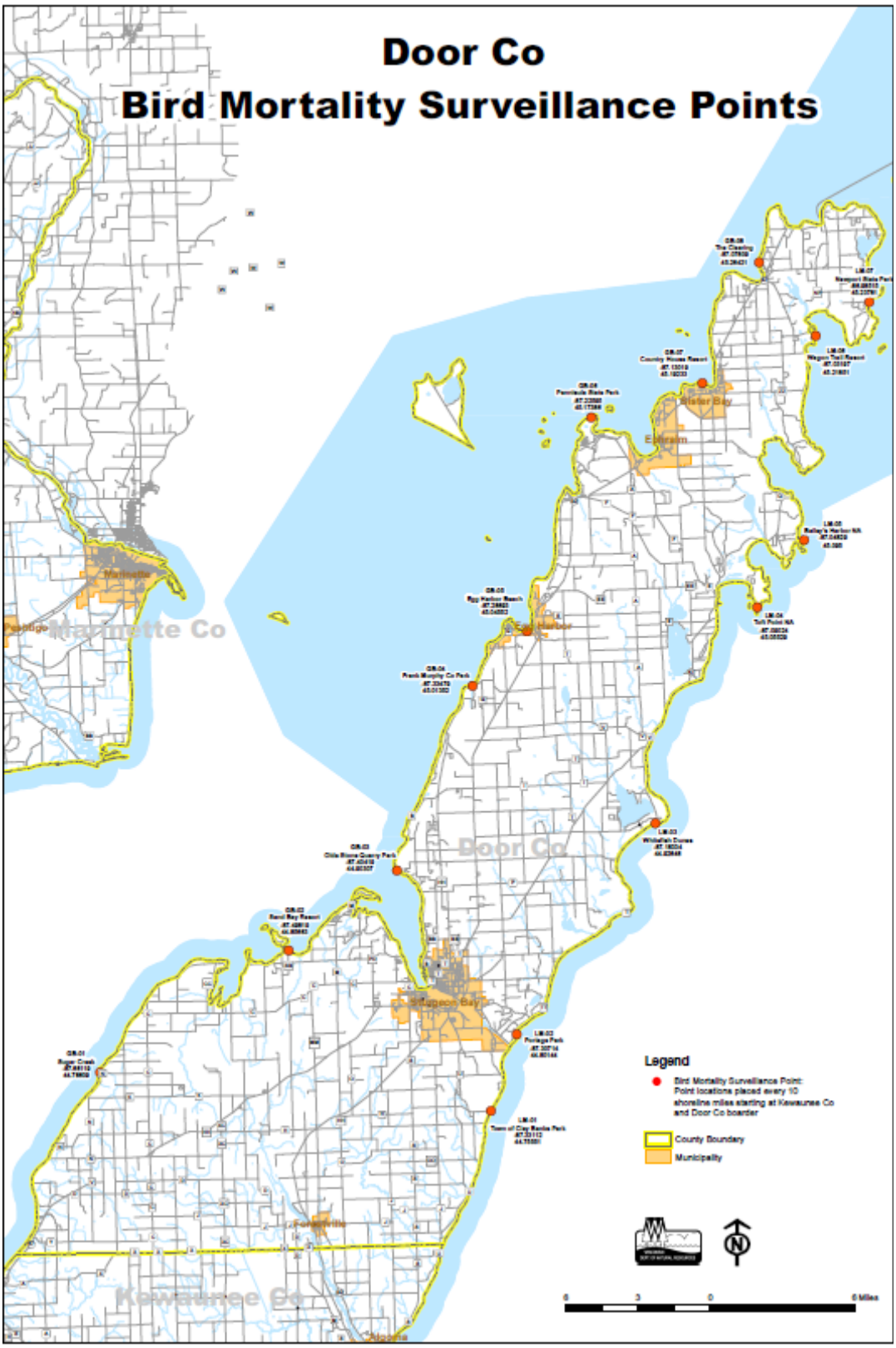

Figure 1: Botulism E Transect Locations

Table 1: 2008 Botulism E Surveillance Transect Summary

Transect ID	Transect Name	Date	Species	Sick/Dead	Collected	Comments
GB-04	Frank Murphy County Park	10/01/2008	ring-billed gull	sick	yes	Bot E positive
GB-04	Frank Murphy County Park	10/13/2008	ring-billed gull	dead	yes	Bot E positive
GB-05	Egg Harbor Beach	10/01/2008	ring-billed gull	sick	yes	Bot E positive
GB-05	Egg Harbor Beach	10/01/2008	ring-billed gull	sick	no	not able to catch, droopy wings and difficulty flying
GB-05	Egg Harbor Beach	10/30/2008	Canada goose	dead	yes	
LM-01	Town of Clay Banks Park	10/13/2008	herring gull	sick	no	weak, young gull
LM-02	Portage Park	10/13/2008	ring-billed gull	sick	no	weak, wings drooping, head upright; near end of transect
LM-02	Portage Park	10/13/2008	ring-billed gull	sick	no	weak, wings drooping, head upright; near end of transect
LM-07	Newport State Park	10/02/2008	great-blue heron	sick	no	approachable within 25-30ft, young bird

Table 2: 2009 Botulism E Surveillance Transect Summary

Transect ID	Transect Name	Date	Species	Sick/Dead	Collected	Comments
GB-02	Sand Bay Resort	10/01/2009	ring-billed gull	dead	yes	Positive for Bot E
GB-03	Olde Stone Quarry Park	08/19/2009	ring-billed gull	Sick	no	bird with fishing hook, tackle, line injury (left at boat landing)
GB-04	Frank Murphy County Park	10/01/2009	ring-billed gull	dead	yes	Positive for Bot E
GB-05	Egg Harbor Beach	08/19/2009	cormorant	dead	no	located about 105m into transect, heavily scavenged and not collected
GB-05	Egg Harbor Beach	10/01/2009	unidentified duck	dead	no	heavily scavenged
GB-06	Peninsula State Park	09/17/2009	unidentified gull	dead	no	carcass decomposed
GB-06	Peninsula State Park	09/17/2009	unidentified gull	dead	no	carcass decomposed
GB-07	Country House Resort	08/19/2009	cormorant	dead	no	heavily scavenged
GB-07	Country House Resort	09/17/2009	cormorant	dead	no	carcass decomposed
GB-07	Country House Resort	09/17/2009	herring gull	dead	yes	
GB-07	Country House Resort	09/17/2009	unidentified gull	dead	no	carcass decomposed
GB-07	Country House Resort	09/17/2009	unidentified gull	dead	no	carcass decomposed
GB-08	The Clearing Folk School	07/06/2009	herring gull	sick	no	wings slightly droopy, head fairly alert, couldn't catch
GB-08	The Clearing Folk School	08/19/2009	unidentified gull	dead	no	approximately 50m north of transect; old and heavily scavenged
GB-08	The Clearing Folk School	10/01/2009	herring gull	sick	no	weak, wings droopy, past end of transect
GB-08	The Clearing Folk School	11/11/2009	common loon	dead	yes	partially scavenged, results pending

LM-02	Portage Park	08/19/2009	ring-billed gull	dead	yes	just past (N) end of transect, results pending
LM-02	Portage Park	10/14/2009	cormorant	dead	no	scavenged
LM-03	White Fish Dunes	08/19/2009	herring gull	sick	no	slightly sluggish, slightly droopy posture, couldn't catch
LM-04	Toft Point State Natural Area	08/19/2009	unidentified gull	dead	no	heavily scavenged/desiccated
LM-04	Toft Point State Natural Area	09/17/2009	cormorant	dead	no	carcass decomposed
LM-05	Bailey's Harbor State Natural Area	10/14/2009	unidentified diving duck	sick	no	sick or injured diving duck swam out of shore vegetation, lost in surf
LM-06	Wagon Trail Resort	08/19/2009	unidentified gull	dead	no	heavily scavenged, only bones and a few feathers remaining
LM-07	Newport State Park	11/11/2009	ring-billed gull	dead	no	scavenged