Botulism in the Great Lakes

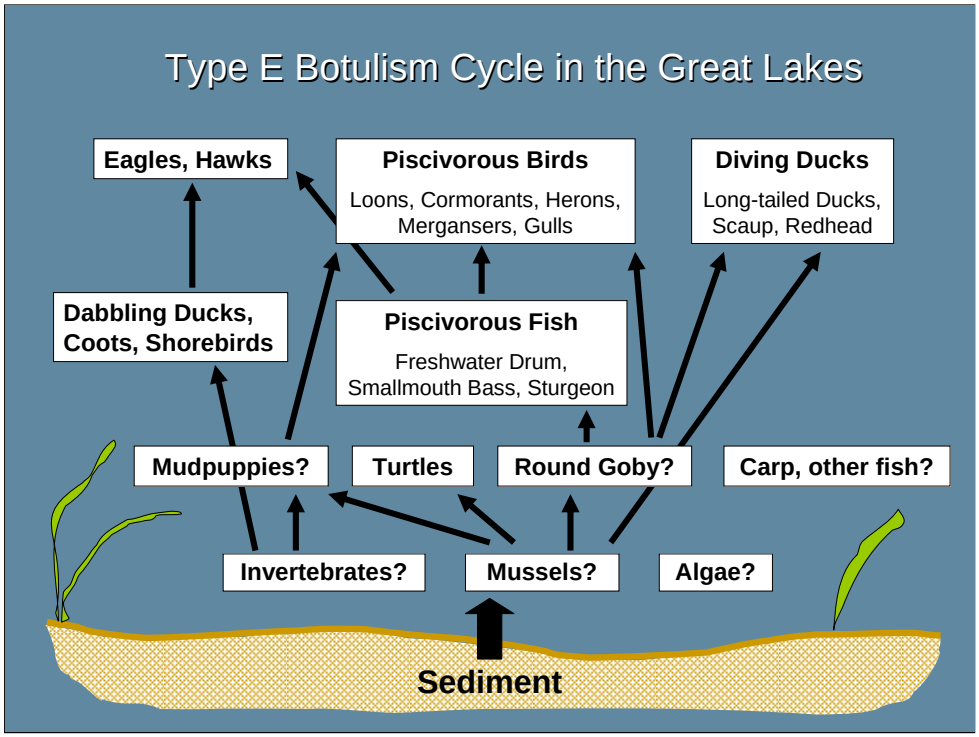
Photo Credit: Patricia Nelson, NYS Department of Environmental Conservation

Now I will discuss another biotoxin that is an important issue: **botulism,** which has caused numerous bird and fish kills in the Great Lakes.

Botulism is a **toxin** produced by the **bacterium *Clostridium botulinum* Type E.** These **ubiquitous anaerobic bacteria** are present in **soil and sediments** of aquatic systems. The toxin causes a **neuroparalytic disease** that is **transmitted through the ingestion of contaminated food**.

Botulism can result from the **ingestion of the neurotoxin or from colonization of the intestinal tract by the bacteria**.

Animals, **especially fish-eating birds, ingest the bacteria in their diet**, become paralyzed by the botulinum toxin, and **often die**, as graphically **illustrated in this slide. Their carcasses then become sites for more *Clostridium* growth**.

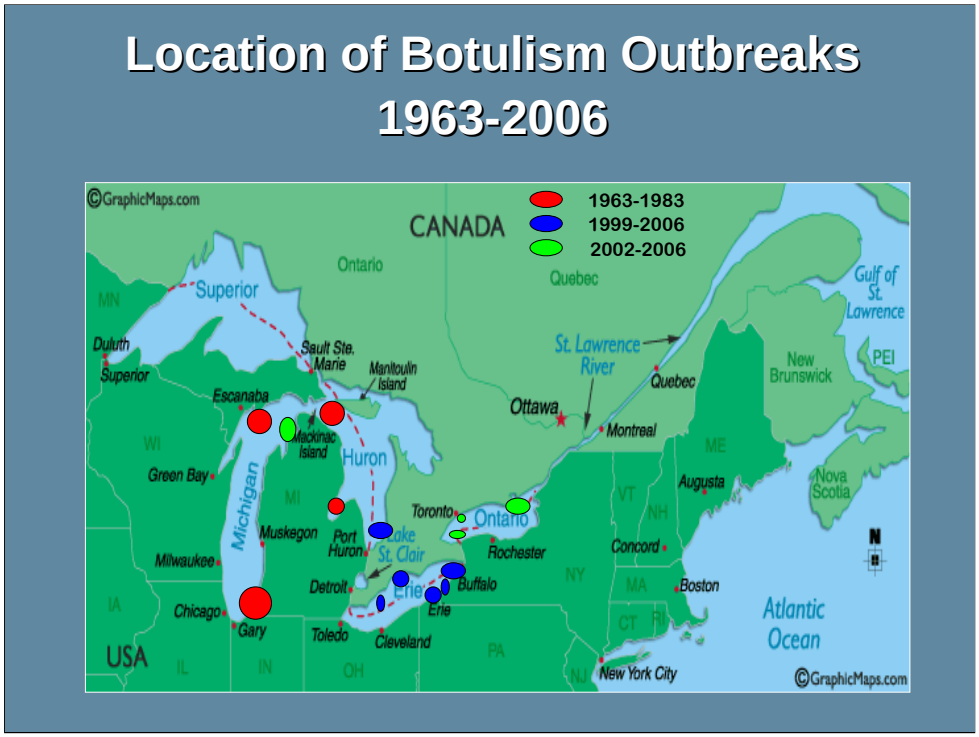


This slide depicts our **current understanding of the Type E botulism cycle in the Great Lakes**. Not all of the pathways are understood, nor are all of the environmental conditions required for an outbreak to occur.

It is known that the **botulism-producing bacteria thrive under oxygen-depleted conditions**, such as anoxic sediments. **Warming lake** temperatures may also **contribute to increased bacterial growth.**

Type E botulism is **unusual because it can concentrate in fish and affect a wide spectrum of wildlife**. Dead or dying fish containing botulism attract **scavengers like gulls and terns** that die when they eat the contaminated fish. **Merganser ducks and loons ingest the toxin by eating live fish.**

Botulism impacts many components of the food web - waterfowl , fish and invertebrates. But the full ecosystem impacts are yet unknown.



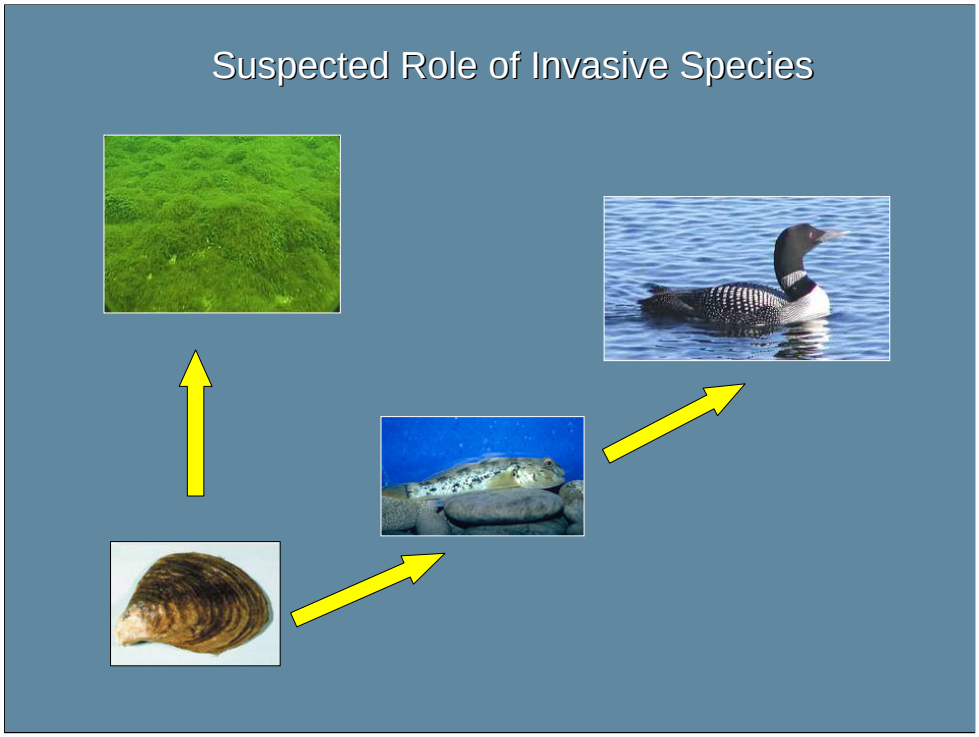
This map shows the **location of botulism outbreaks that resulted in bird kills over the last 40 years in the Gt Lakes**. Botulism was **first detected in L. Michigan in the 1960s**, with outbreaks in **Lakes Michigan and Huron until the 1980s *(red circles)***.

After **subsiding** in the late 1980s, outbreaks **re-intensified** in the **late 1990s and early 2000s in L. Huron, Erie and Ontario (blue circles)**

Although the past few summers have experienced fewer botulism-related waterbird die-offs**, it appears that they have increased in 2006**. This summer, die-offs were reported in Lake Ontario. **In the past two weeks, Lake Ontario and Erie** have been extremely hard hit**. The Lake Ontario bird mortality in this event was among the largest on record, and affected common loons, grebes, and merganser ducks**. It was especially severe for migrating loons in the E end of Lake Ontario.

It is also important to note that **in 2006 botulism outbreaks returned to L. Michigan for the first time in recent history**. An estimated **2,600 waterbirds** were lost along the beaches of Sleeping Bear Dunes National Lakeshore alone. The species hardest hit were horned grebes, mergansers, common loons, cormorants and gulls.

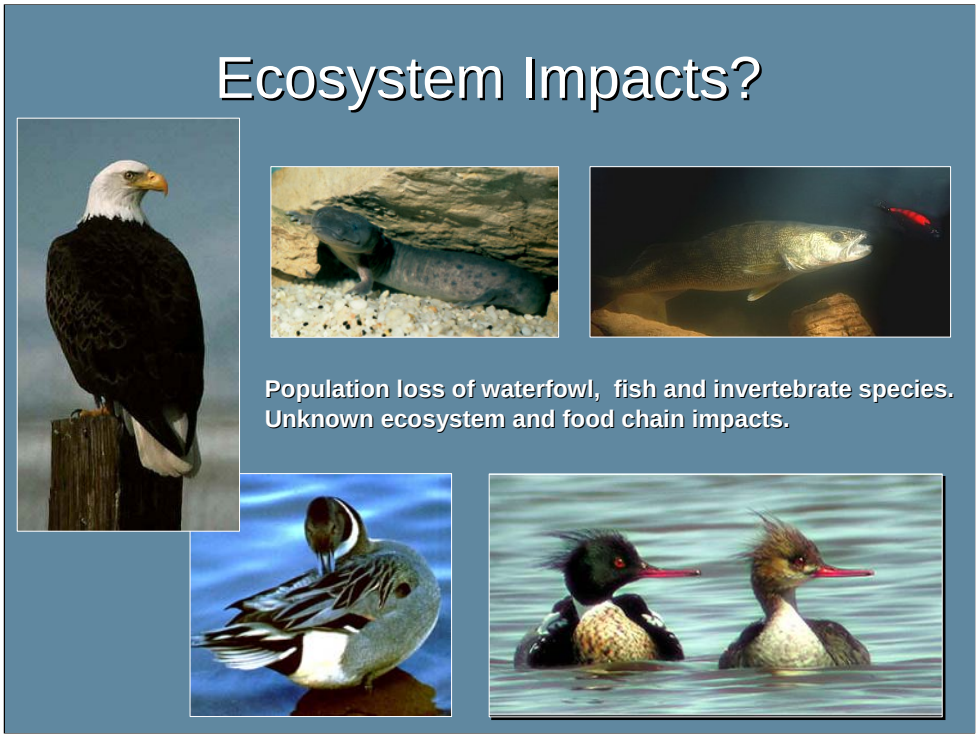
Note the general movement of the outbreaks from West to East….



I mention that trend, because **invasive species have been implicated in the progression of botulism through the Great Lakes and in the increased number and severity of outbreaks in recent years.**

It is hypothesized that the **West to East movement of botulism has tracked the West to East invasion of round gobies in the Great Lakes**. ***As diagrammed here***, **gobies feed on invasive dressenid mussels**. It is believed that the **mussels concentrate the botulism toxin as they filterfeed**. When these **mussels are eaten by gobies, the botulism is concentrated further**. The affected gobies exhibit an erratic thrashing behaviour which attract **predatory fish, mudpuppies, mergansers, loons and other birds.**

In addition, the **mussels may be creating an environment that is more favorable to botulism** production through their filtering activities which have increased **water clarity and nutrient recycling** in many areas of the Great Lakes. This **increases the growth of aquatic plants and algae such as *Cladophora***. The oxygen-deprived environments provided by their decaying biomass promotes botulism growth



<u>So what are the ecosystem impacts of avian botulism in the Great Lakes?</u>

Many species are affected, but the major food web pathways and environmental causes remain poorly understood.

Invasive mussels and gobies are believed to play roles in the recent resurgence of outbreaks.

However, much of the complex cycle and foodweb links remain to be elucidated to better predict the occurrence and impacts of this toxin in these ecosystems.

Summary: *Great Lakes*

Naturally produced noxious chemicals & toxins

- Apparent increased frequency & severity of outbreaks
  - More prevalent in Lower Lakes
  - Taste-odour: widespread, erratic, poorly characterized
  - Cyanobacterial toxins: detectable, generally low, except eutrophic areas
  - Botulism: recent resurgence; suspected role of invasive spp.; potential broad ecosystem impacts

→ Workshop this afternoon to further discuss these topics!

To summarize what we know about **Naturally produced noxious chemicals & toxins in the Great Lakes:**

There is an apparent **increased frequency & severity of outbreaks** .

These appear to be **more prevalent in Lower Lakes**. This may be a reflection of the higher nutrient levels

Taste-odour: widespread, erratic, poorly characterized

Cyanobacterial toxins: detectable, generally low in the open waters but can often exceed advisory levels in more eutrophic inshore areas.

Botulism: has shown a recent resurgence suspected to be linked to invasive spp.

Both botulism and cyanobacterial toxins are likely to have broad ecosystem impacts, the nature of which we have yet to understand.

→ Workshop this afternoon to further discuss these and other