Type E Botulism in the Great Lakes
Conference Overview

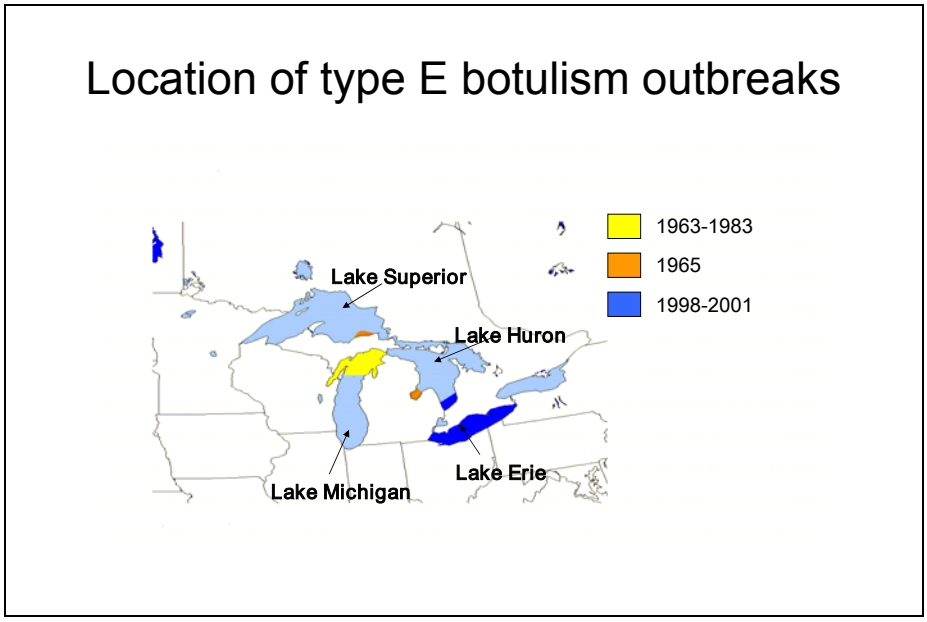
Grace McLaughlin
USGS National Wildlife Health Center

Clostridium botulinum type E

- Spores found primarily in cold water environments (Great Lakes, Baltic Sea)
- Toxin production NOT dependent on a bacteriophage
- Primarily afflicts fish and fish-eating birds
- Causes disease in humans

Type E botulism outbreaks in the Great Lakes

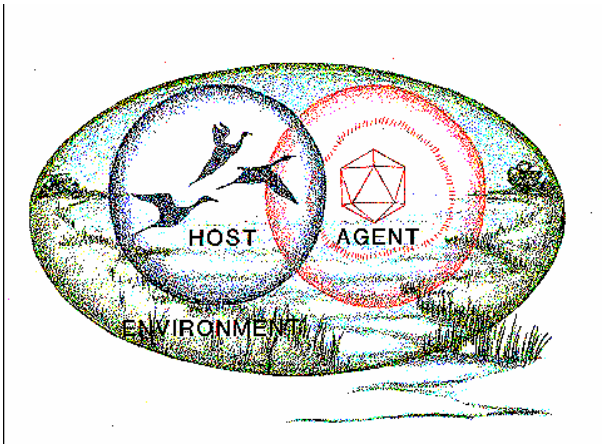
Year	Lake	Number	Species
1963-1964	Michigan	>12,000	Gulls, Loons
1976-1983	Michigan, Huron	>1800	Gulls, Loons
1998-2002	Huron, Michigan	~2500	Mergansers, Gulls, Loons
1999-2001	Erie	>25,000	Mergansers, Gulls, Loons
2002	Erie	>25,000	Long-tail ducks, Gulls, Loons, Mergansers, Cormorants



Locations of other type E outbreaks in birds

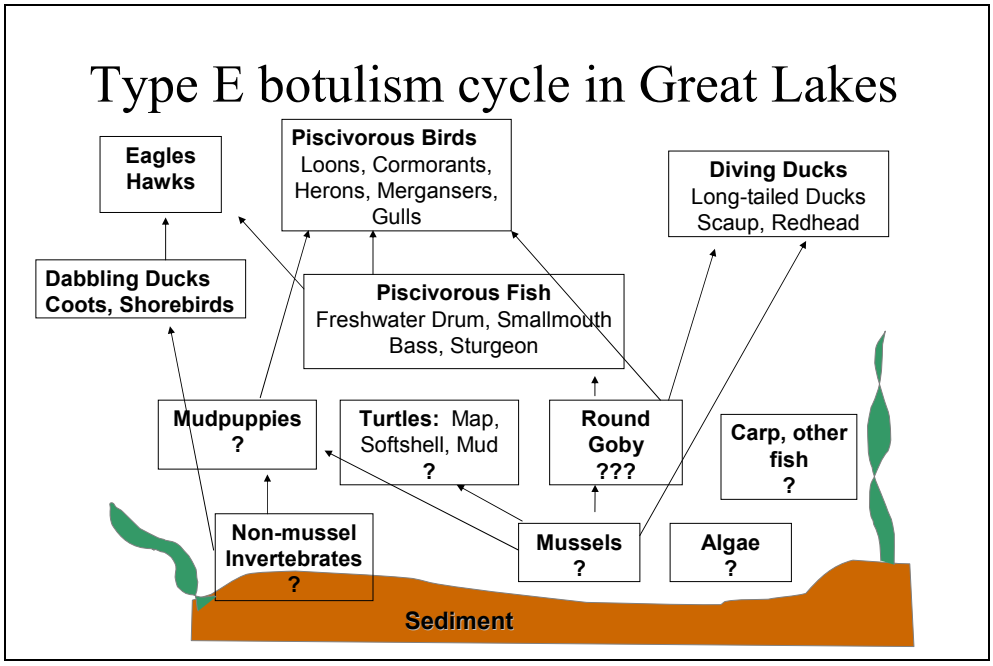
- Canche Estuary, France 1996 − 5-10,000 gulls
- Salton Sea (California) - isolated cases − pelicans, cormorants
- Alaska - isolated cases

Epizootiology of Avian Botulism



Factors involved in avian botulism outbreaks

- Toxigenic bacteria
- Appropriate environmental conditions
- Proper substrate
- Availability of toxin to birds



Research Needs

- Spatiotemporal distribution of type E spores and cells in Great Lake sediments and fish
- Sources of cells and toxin for fish and birds
- Environmental correlates
- Population effects in birds
- Non-avian mortality

Pennsylvania Update 2002
Bob Wellington and Mike Mumau

- March, May – dead alewives, turtles
- June – dead gobies & mudpuppies − less algae than in past years
- July – rapid temperature drop 75˚ ⟶ 50˚F in 2 days
- Monitored water temperature − 70˚-80˚F in July-September, 50˚F November
- Invertebrate mortality
- Several invasive species
  - Alewives, gobies
  - Algae (*Cladophora*? If so, long ago.)
  - Invertebrates (mussels, amphipods)
- Blue-green algae blooms
- ~2000 fish collected ~10 species
  - July 10-11 = 446 (22.3% of total)
- Fewer dead birds than 2001
- Gulls in Summer
- Loons in Fall
- Invertebrates – could be substrate for significant toxin production.

New York Update 2002
Don Einhouse

- Fish mortalities – effects on trends, abundance
  - March-April: alewives, gizzard shad − temperature stress
  - May-June: smelt – spawning, *Glugea*
  - June-July: smallmouth bass – spawning? upwelling?
  - June-August: warmwater species., upwelling
- June 50% gobies
- July 44% sheepshead
  - Also thousands of mudpuppies
- September mortality: 81% sheepshead
  - Only 4% net (live) samples, yellow perch 40%
  - Why don't yellow perch and gizzard shad die?
- Smallmouth bass survival has not changed with Botulism E
- Forage fish composition
- Gobies
  - 1994 – Cleveland
  - 1995 inconclusive numbers
  - 1996 moving East and West in Central basin, into West
  - 1997 into eastern basin
  - 1999 well into NY waters, but low numbers
  - 2000 declining in western basin, including East
  - 2001 huge number in eastern basin
  - 2002 declining in abundance

Sturgeon Mortality

- Rare to find on beach pre-2000
  - 5 in 1996 - upwelling
- >25 in 2001
  - Corresponded with high goby numbers
- Fewer in 2002
  - also fewer gobies in trawls

Changes in Food Web

- Shift to gobies post 1998
- Sheepshead eat mussels

Questions:

- Where is anaerobic environment?
  - In anything that dies. Pockets in substrate.
- Benthic fish species absent from kills – why?
  - Different susceptibility?
- Role of mussels?
- How to determine botulism E mortality?

NY Avian Mortality

Ken Roblee

- >3000 Gulls in June & July
  - Concurrent with mudpuppy mortality
- October-December estimated >17,000 birds
  - >12,600 long-tailed ducks
  - >2000 loons
  - >1000 mergansers

NY Pathological Investigations

Ward Stone

- 7000+ submissions for botulism in 2003
- First diagnosis of type E - 2000
- Food habits: gobies, mudpuppies
- Sheepshead, bass
  - Moribund fish
- Feeding experiments
  - Gobies – gull liver
- Toxin identified in gizzard contents
  - Gulls in summer – mudpuppies
  - Mergansers – mudpuppies, gobies
  - Shorebirds - fly larvae from carcasses
  - Long-tailed ducks – mussels, gobies
- Few puddle ducks
- Scaup undetermined cause of death

New York Mortality – bird pickup numbers

	2000	2001	2002	Totals
Totals	1100	706	7202	9008
Long-tailed ducks	1	44	4877	4913
Gulls	543	228	>1030	>1800
Red-breasted Merganser	424	16	627	1067
Loons	106	303	434	843

Birds still being collected from 2002-2003
Estimates of dead birds much higher

Food Habits

- Gobies:
  - Loons: 56-61%
  - Horned grebe: 54%
  - Long-tailed Ducks: 60% of 169
- Mudpupppies
  - Gulls – 17-82%
  - Mergansers: 20-40%

Feeding Experiments – New York

- Feeding livers – assuming problem is botulism toxin, some negative samples used also
- Gobies, Centrarchids, fatheads susceptible
- Yellow Perch and Painted Turtles show some resistance
  - Yellow Perch impaired up to 1 week
  - Altered swimming ability
  - Change in activity patterns

Botulism Type E Genetics

- 10 different type E strains
  - Fish, sediments

- How do these compare to?
  - Other years
  - Huron
  - Michigan
  - Superior
  - Mediterranean, Baltic
  - France
  - Alaska

Canadian Update
Jeff Robinson

- Mortality distribution
- Food habits
- Loon population data
- Experimental dosing
- Loons
    - Believe Stratum 4 breeders
    - Population 19,000 to 40,000 breeding pairs
- Several Lake Erie events
    - June, July, August: gulls, terns, cormorants
    - September: gulls, cormorants
    - October: gulls
    - Late October & November: Common Loons, Long-tailed Ducks, Red-breasted Mergansers
- Lake Huron - October
    - Grebes, mergansers, Common Loons
    - Goderich and Port Elgin
- Ontario (not confirmed)

Environmental Parameters Associated with Outbreaks of Botulism in Lake Erie
Alicia Perez-Fuentetaja, Ted Lee, Mark Clapsadl

Identify environmental conditions in Lake Erie associated with presence of *Clostridium botulinum* type E.
Are there areas of low oxygen where the bacteria are found?
10m inshore, 20m offshore depths.
Triplicate samples
Physico-chemical parameters 0.5 m above sediment.

- Algal bloom at time of June-July outbreak
- Oxygen, Redox, pH drop in August
    - Rocke, Samuel – JWM
- Weather event in August
    - strong winds, wave action – mixing
- Sample processing in progress

Botulism: Atypical Pathogenesis in Other Species
Dr. Robert H. Whitlock, New Bolton Center, University of Pennsylvania

- Cattle
    - Grains – oat and rye silage
    - 1 Cat carcass killed 431 of 441 cows
    - Feeding in avian botulism site

- Horses
  - Ravens as vectors from carcasses
  - Wounds – castration,
    - drainage contaminated feed
  - 1979 racetrack – 30 horses died
- Diagnosis, vaccine, treatment

Botulism in Fish
Getchell, Bowser, et al.

- Rule outs – bacteria, viruses, weather (750)
- For Botulism E – quantitative PCR
  - Process intestinal contents, liver, etc.
  - Looking for light chain E toxin gene (not toxin)
- Found in sheepshead from July 2001 dieoff
  - Kd, Lv, Sp pool; 3K genome equivalents
- 15-23K genome equivalents GIT contents
  - Only found in very few fish
- 200 – 148K in bird samples
- What about in healthy fish? No vegetative cells

Fish Susceptibility to Botulism E
Moccia et al.

- Fish Botulism Exposure Model
  - Standardize methods
- Temporal aspects, Sensitivity
  - Trout, goby, perch, walleye, mudpuppy
- Dose-response model
- Toxin titers
  - Tissue distribution
- Methods
  - Dosages to intubate fish
  - Temporal pattern, tissue distribution
  - Calculate up-web transport
- Temporal Observations
  - Restless, agitated, inc. swimming
  - Disequilibrium, altered posture, righting response lost
  - Lethargy interspersed with swimming, lack of coordination
  - Head up/tail down posture, breaching
  - Loss of motor function except respiration
  - Respiratory failure
- Prolonged course
- Altered behavior - increased predation risk?
- Tissue distribution?
- Persistence of toxin?