

Climate Change and Water Safety in the Great Lakes

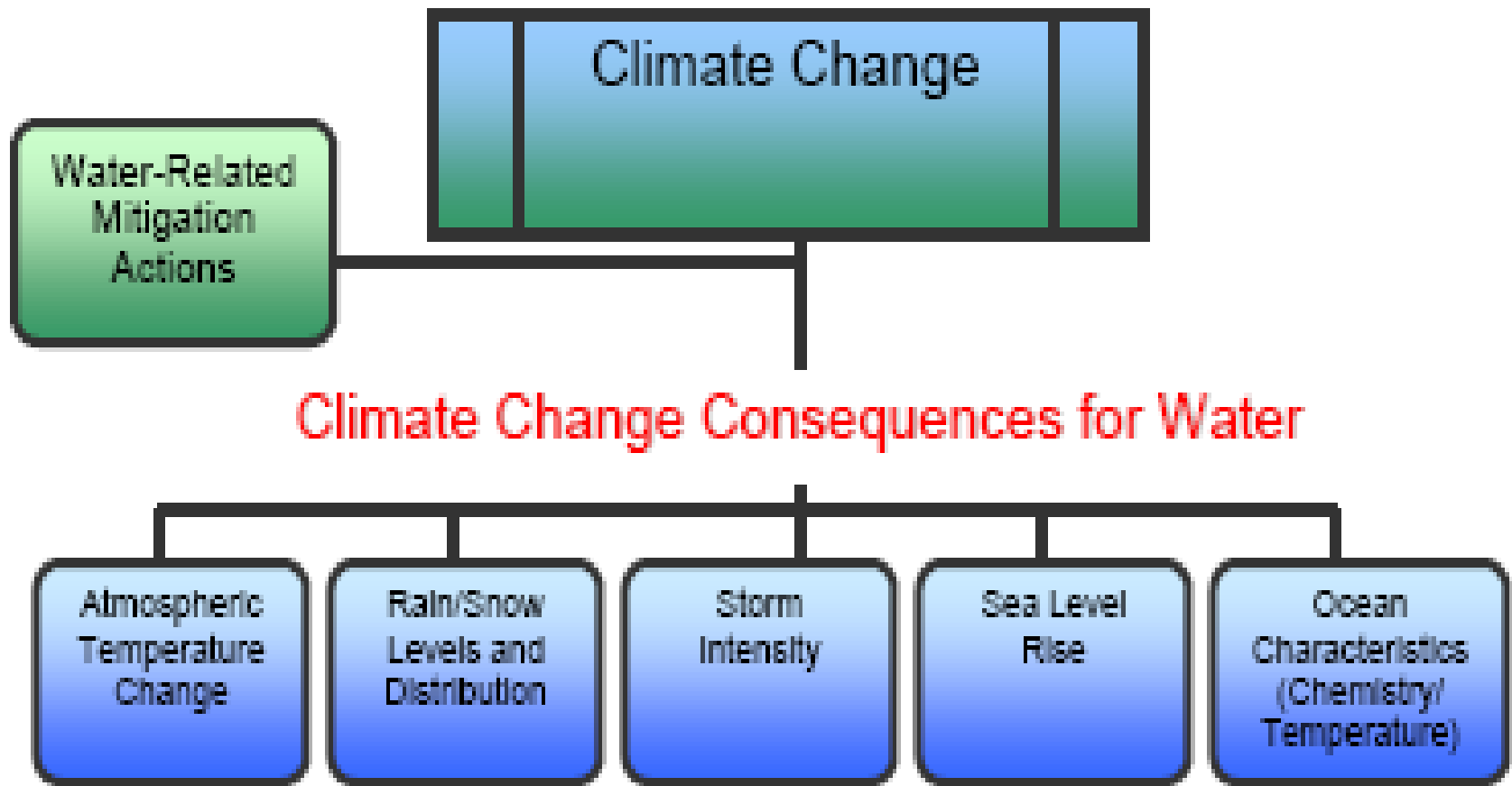
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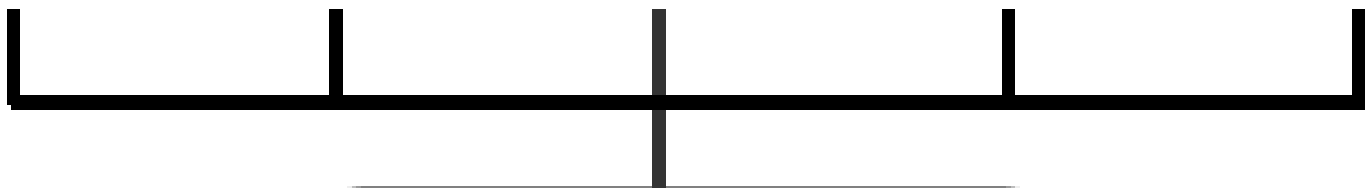
IPCC 4th Assessment Report 2007

- Changes; Causes; Projected effects; Adaptation & Mitigation; Long-term view.
- Increasing warming over land and at most high northern latitudes.
- Contraction of snow cover.
- Increased frequency of hot temperature extremes, heat waves and heavy precipitation.
- Precipitation increases in high latitudes and decreases in most sub-tropical land regions.
- Increases in annual river runoff and water availability at high latitudes and decreases in some dry regions in the mid-latitudes and the tropics.
- Decreases in water resources in many semiarid areas (western US)



Impacts on Water

- Spatial change in freshwater/ wetlands
- Increased distribution of Invasive species
- Increased human use of water
- Fisheries disruption
- Freshwater flow variations
- Drinking water supply Impacts
- Expanded flooding
- Increased runoff/ erosion
- High velocity flow Impacts on biotic Integrity
- Wetland loss
- Shore erosion
- CSO Increases
- Increased runoff/ erosion
- Expanded flooding
- Damage to water Infrastructure
- Wetland loss
- Shore erosion
- Salt water Intrusion to drinking water supply
- Inundation of treatment Infrastructure
- Coral reef Impacts
- Increased distribution of Invasive species
- Reduced CO₂ absorption capacity



Water-Related
Research and
Adaptation Actions

Impacts on Water

- Direct effects
 - Quantity related to precipitation and temperature
- Indirect effect
 - Quality related to landuse, run-off (soil moisture)
- Adequate and sufficient water supply
 - (storage, snow pack, reservoir and groundwater levels) supporting humans, communities, ecosystem services
- Adequate and safe
 - contaminant concentration, spread and distribution.

Health Effects

TABLE 1. LIST OF KEY EFFECTS OF GLOBAL CLIMATE CHANGE AS PRESENTED IN THE NATIONAL ASSESSMENT.

POTENTIAL EFFECT OF CLIMATE CHANGE	DIRECT HEALTH EFFECT	INDIRECT HEALTH EFFECT
EXTREME HEAT	HEAT RELATED MORTALITY	
EXTREME STORMS	FLOOD RELATED MORTALITY	INCREASED PREVALENCE OF ENTERIC PATHOGENS IN SURFACE WATERS; LACK OF ADEQUATE POTABLE WATER
AIR POLLUTION	RESPIRATORY EFFECTS	INCREASE IN ALLERGIES AND ASTHMA
ECOLOGICAL SHIFTS		CHANGES IN PATHOGEN AND/OR VECTOR GEOGRAPHIC RANGE, CHANGES IN VIRULENCE, CHANGES IN INCIDENCE

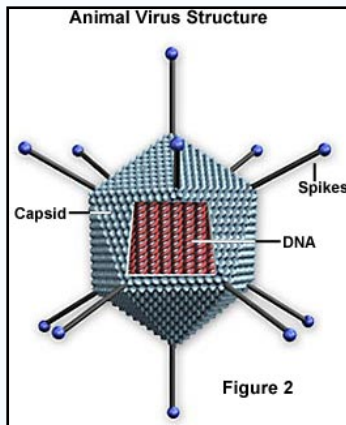
Sources and Types of Microbial Pollution

- Sewage discharges
 - Septic tanks
 - Combined sewer overflows
 - Storm water
 - Storm sewer overflows
 - Agricultural run off
 - Ballast waters
 - People themselves (over use)
- Enteric Bacteria, Parasites and Viruses from human feces and animal feces
-
- Naturally occurring
- Bacteria, Toxic Algae

Predominant Waterborne Microorganisms

- Viruses

- rotavirus
- adenovirus
- coxsackievirus
- echovirus
- calicivirus
- norovirus
- Hepatitis A and E



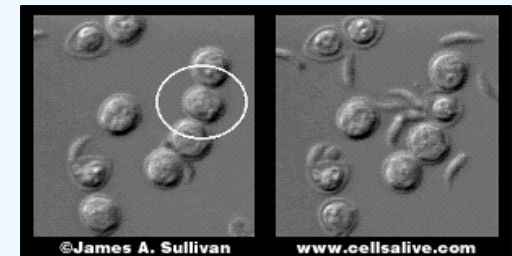
- Bacteria

- *E.coli*
- *Salmonella* spp.
- *Shigella* spp.
- *Aeromonas hydrophila*
- *Campylobacter jejuni*
- *Helicobacter*
- *Mycobacteria*
- *Legionella*



- Protozoa

- *Cryptosporidium parvum*
- *Giardia lamblia*



Factors Influencing Waterborne Diseases

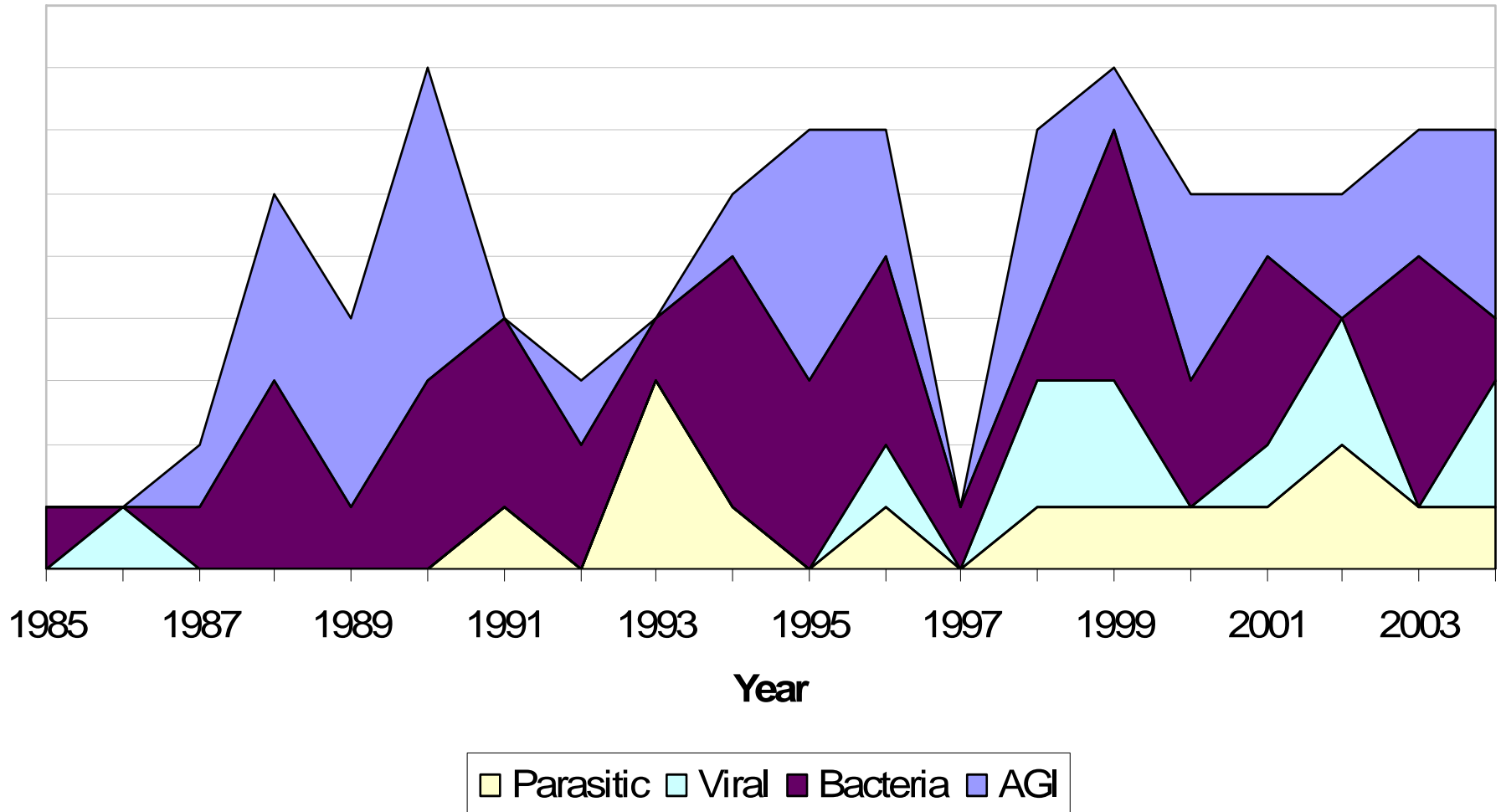
- Sources of pathogens, level of disease in the human and animal population
- Urbanization, waste disposal practices, poverty, overcrowding, poor waste treatment
- Domestic animal practices
- Climate: precipitation (transport: flow, resuspension) and temperature (survival: enterics and growth autochthonous).

Disease Reporting: Outbreaks

- An incident affecting two or more people thought to have a common exposure to a potential source, in which they experience similar illness or proven infection.
- A rate of infection or illness above the expected rate for that place and time, where spread is occurring through cross infection, or person-to-person.
- A single case of certain diseases such as diphtheria, rabies, poliomyelitis or viral haemorrhagic fever, may lead to initiation of the major outbreak plan, although not technically an outbreak.

Disease Reporting: Outbreaks

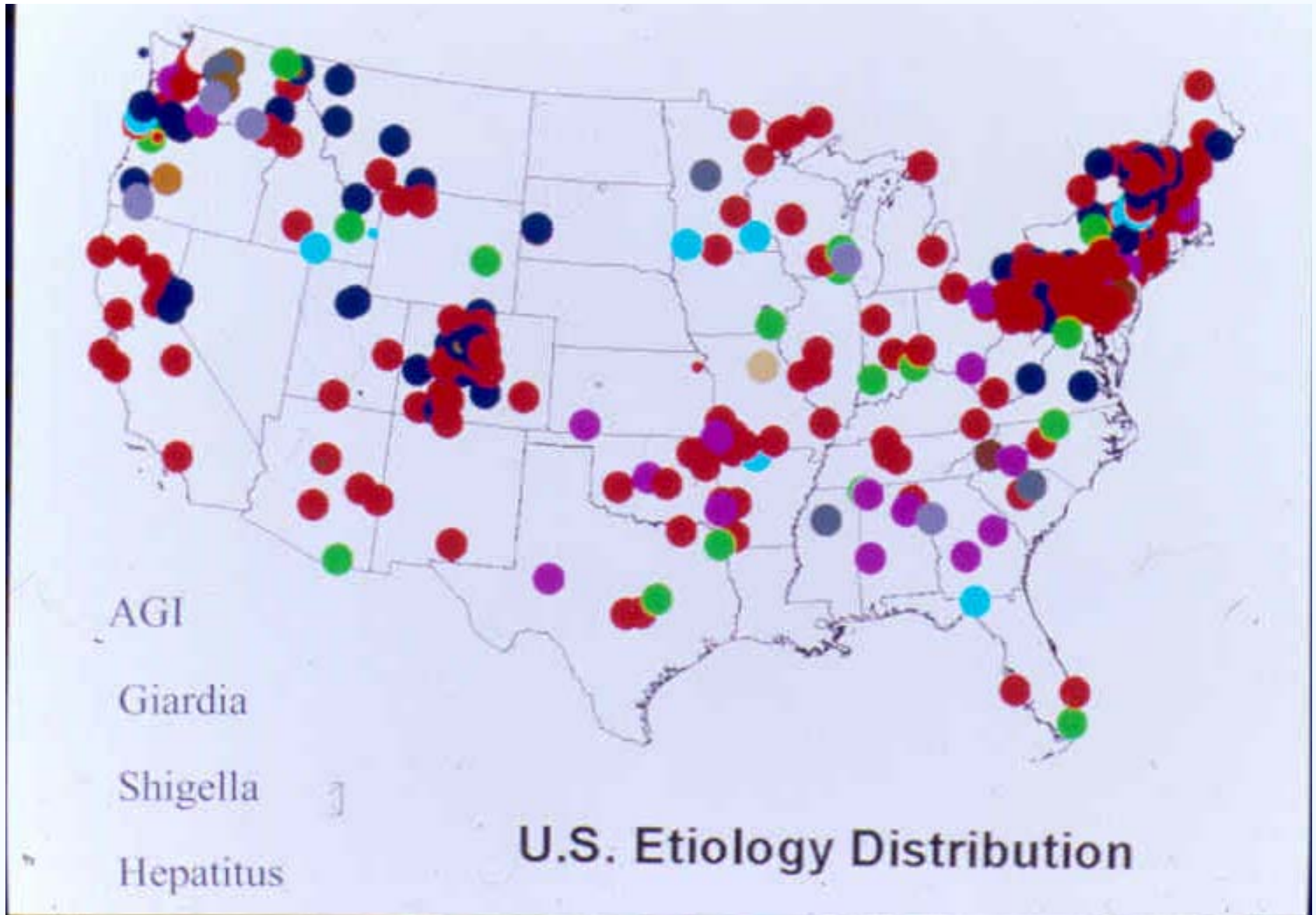
Ambient Recreational Waterborne Outbreaks Over Time



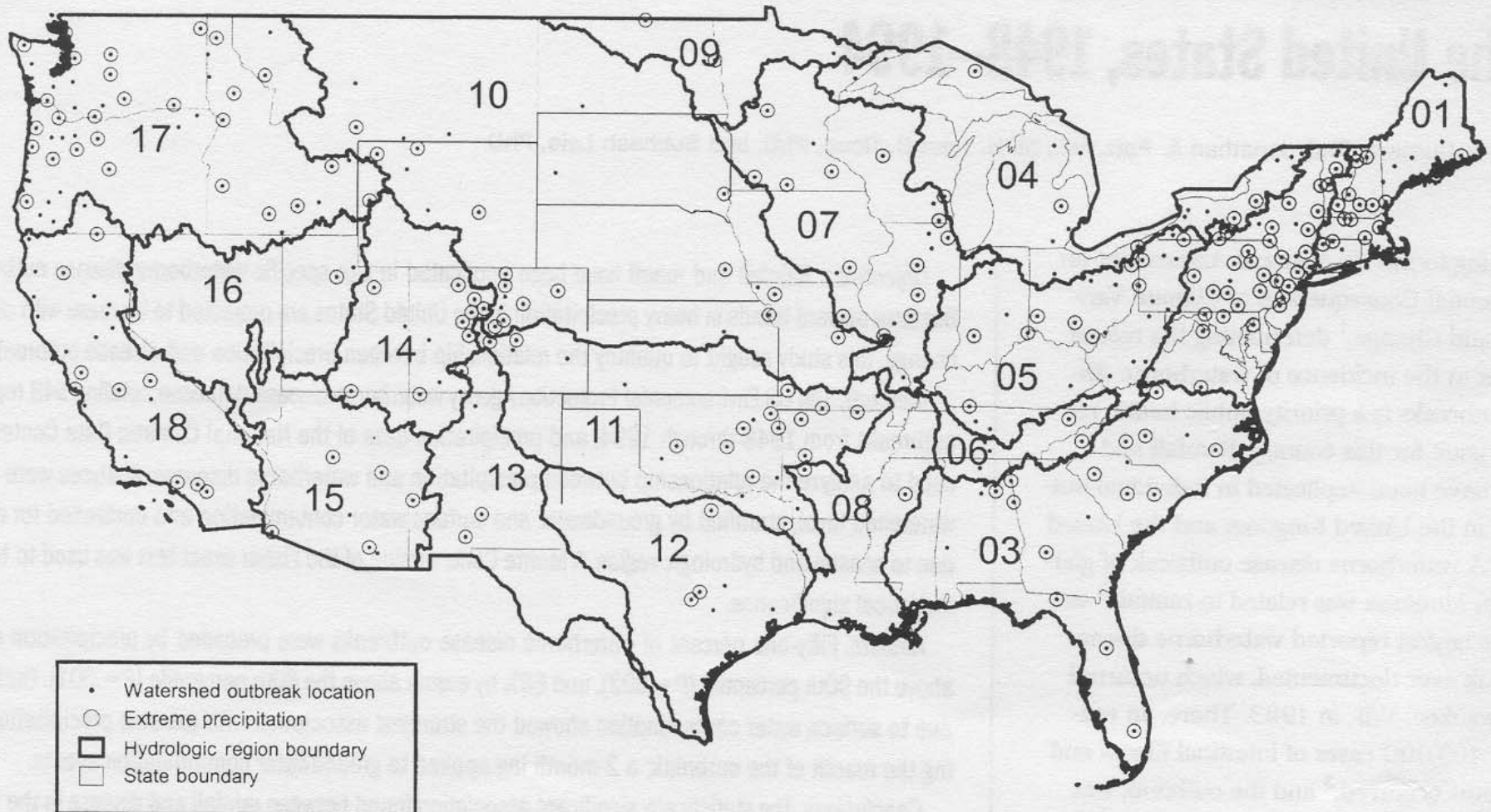
Extreme Precipitation and Waterborne Disease Outbreaks

- Between 1948-1994 in the US
 - 540 outbreaks, surface and ground water, watershed and association in time and place with precip data
 - 51% were preceded by rainfall events above the 90th percentile.
 - Surface waters associated with rain the month of the outbreak and in ground waters a 2 month lag was noted.

Extreme Precipitation and Waterborne Disease Outbreaks



Extreme Precipitation and Waterborne Disease Outbreaks



S. Bass Island Outbreak

Ohio blames groundwater for Lake Erie island outbreak

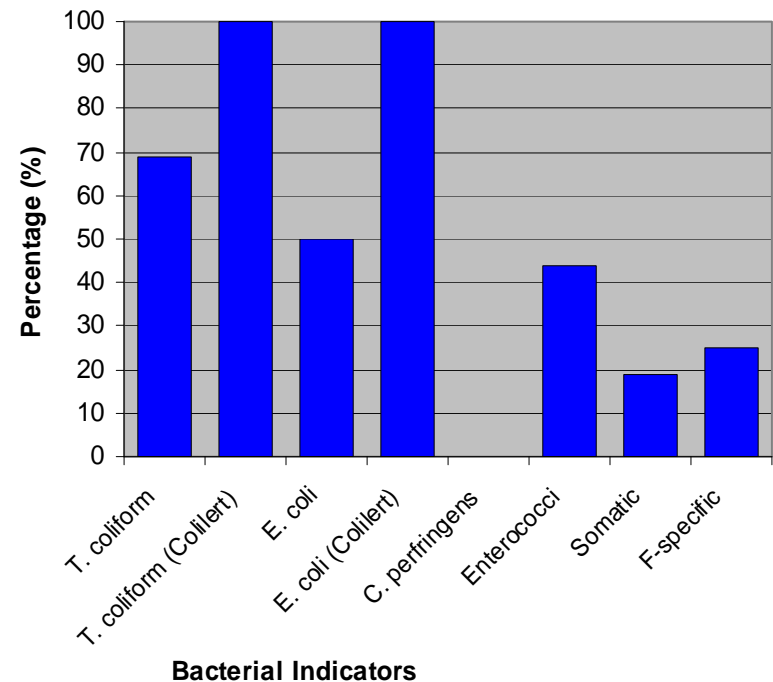
Tuesday, February 22, 2005

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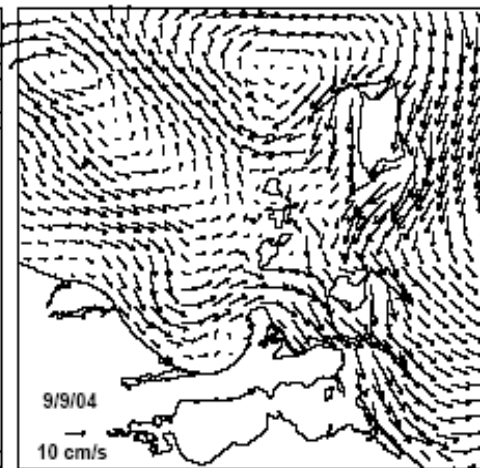
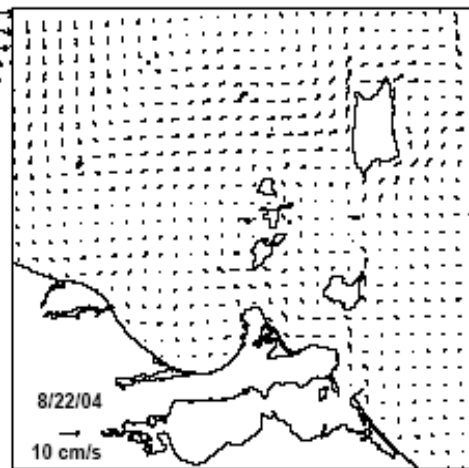
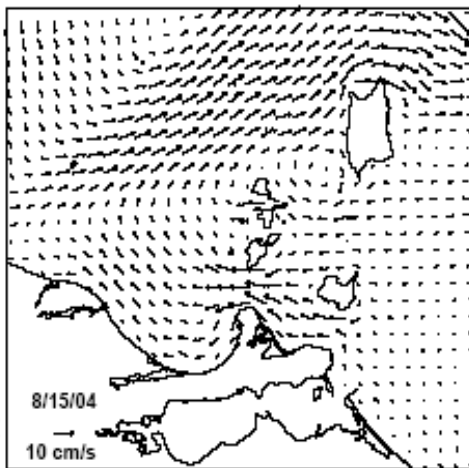
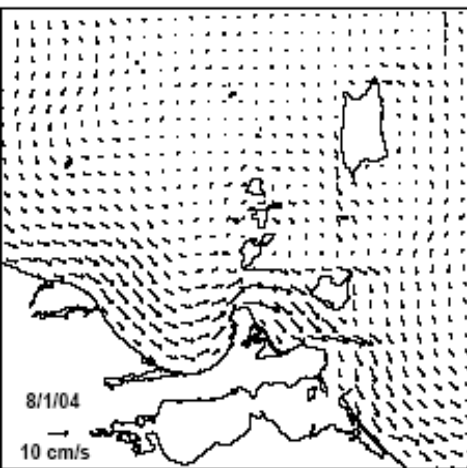
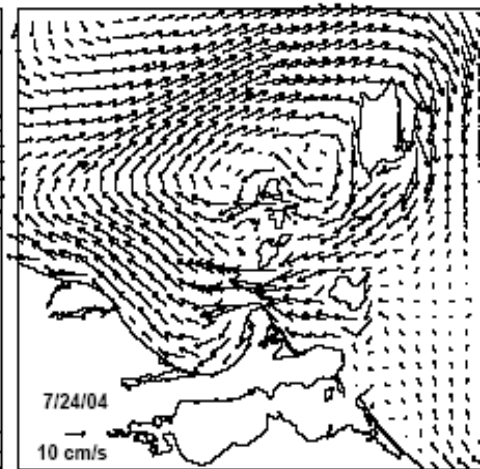
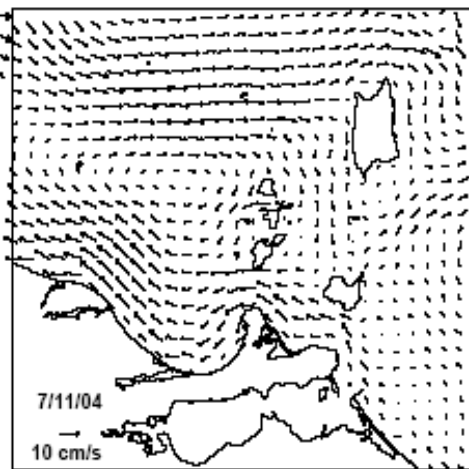
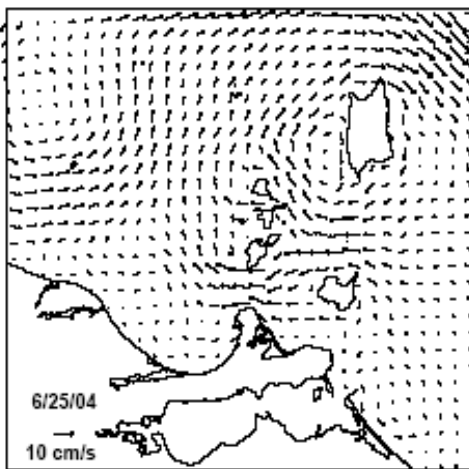
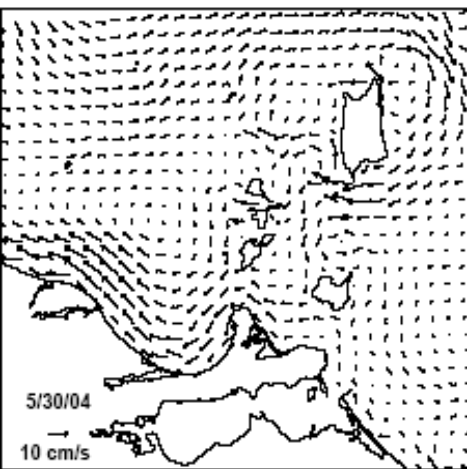
TOLEDO, Ohio -- Widespread groundwater contamination on a Lake Erie resort island was the likely source of illnesses that sickened hundreds last summer, the Ohio health department said Tuesday.

Several sources, including septic tanks, have tainted the South Bass Island's groundwater over a long period, and the contamination may have been worsened last summer because of a season of heavy rains, a health department report said.

The outbreak of gastrointestinal illness sickened about 1,400 tourists and residents, ending the tourist season early for many businesses.



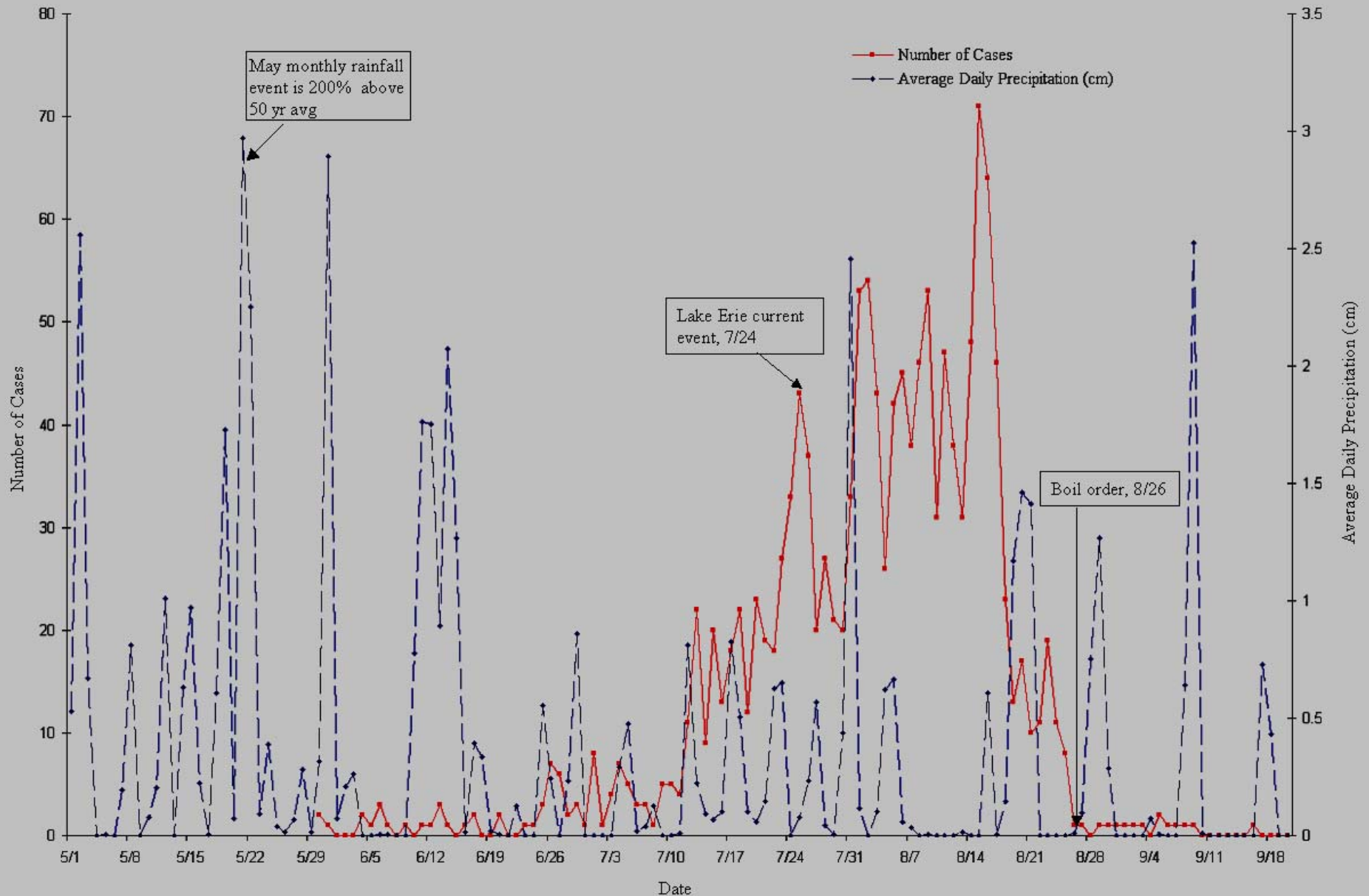
S. Bass Island Outbreak



S. Bass Island Outbreak



S. Bass Island Outbreak



“Muck” in Saginaw Bay

- Algae, detritus, “muck” - not a new development
- Documented problem in Saginaw Bay since the 1960's
- Problem in other areas of the Great Lakes

Bay City State Park in 1929



Saginaw Bay 2007

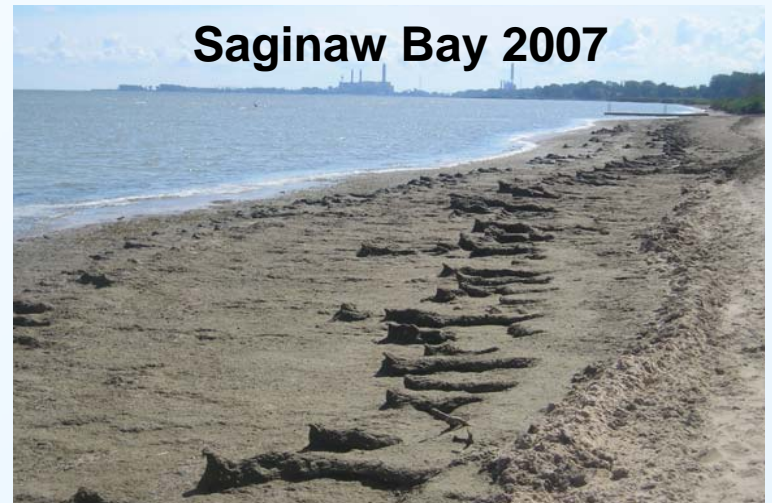
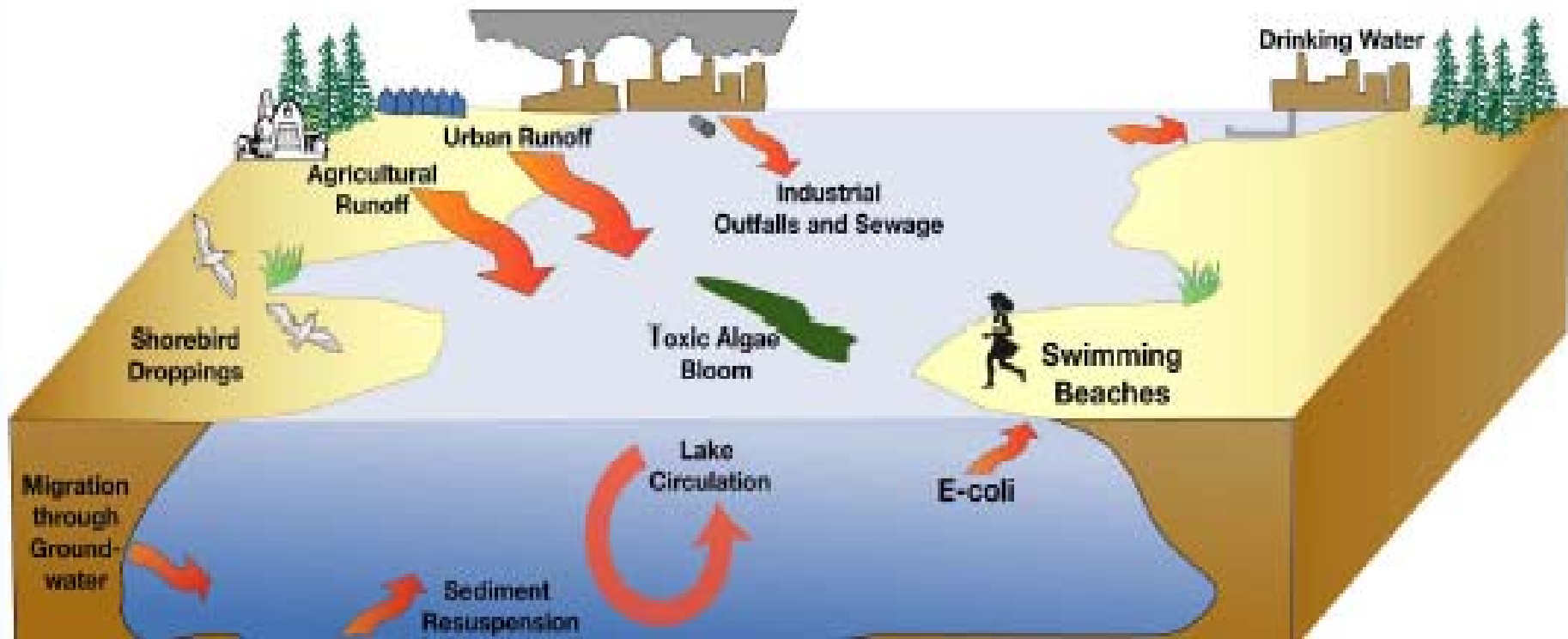
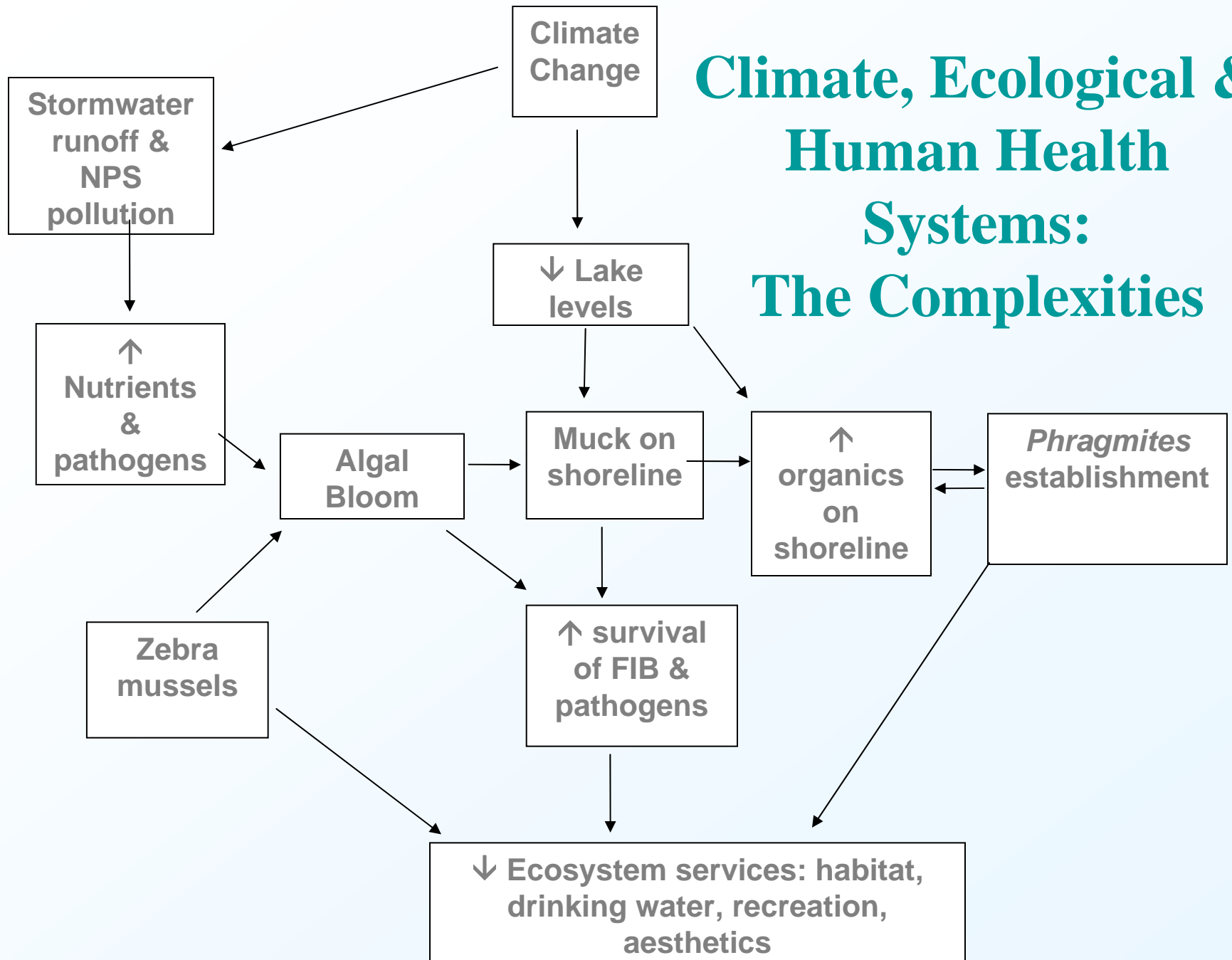


Photo by Juli Dyble

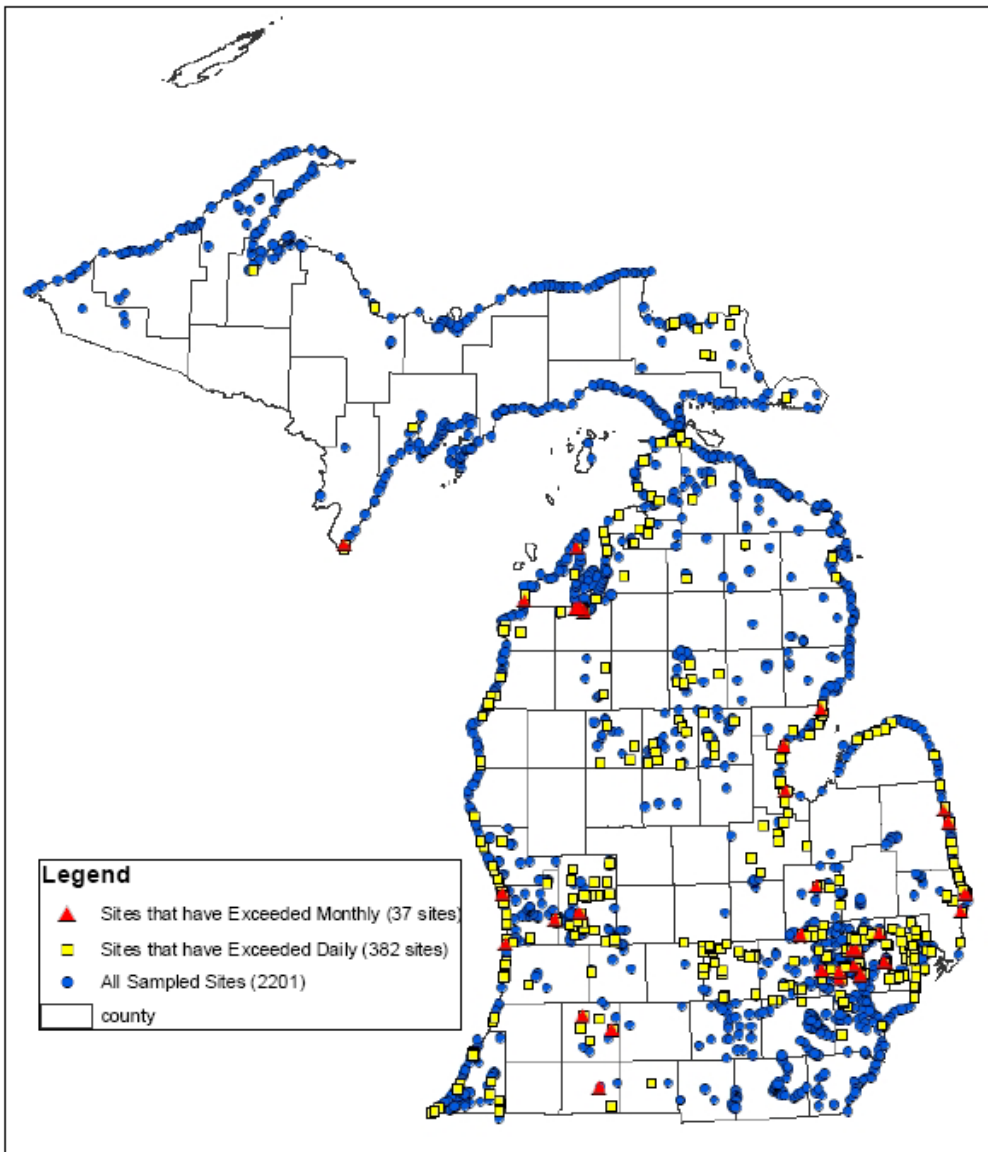
“Muck” in Saginaw Bay



Climate, Ecological & Human Health Systems: The Complexities

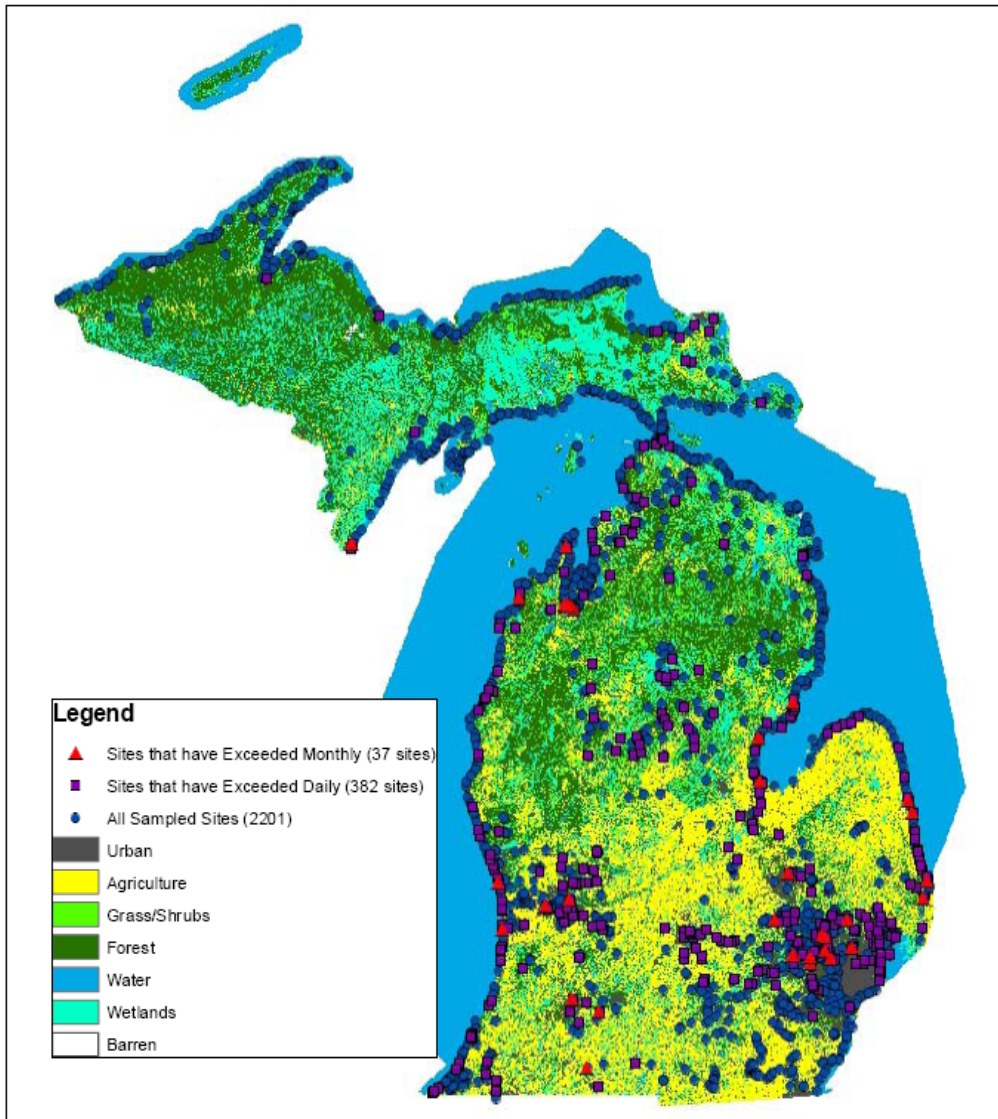


Beach Closures



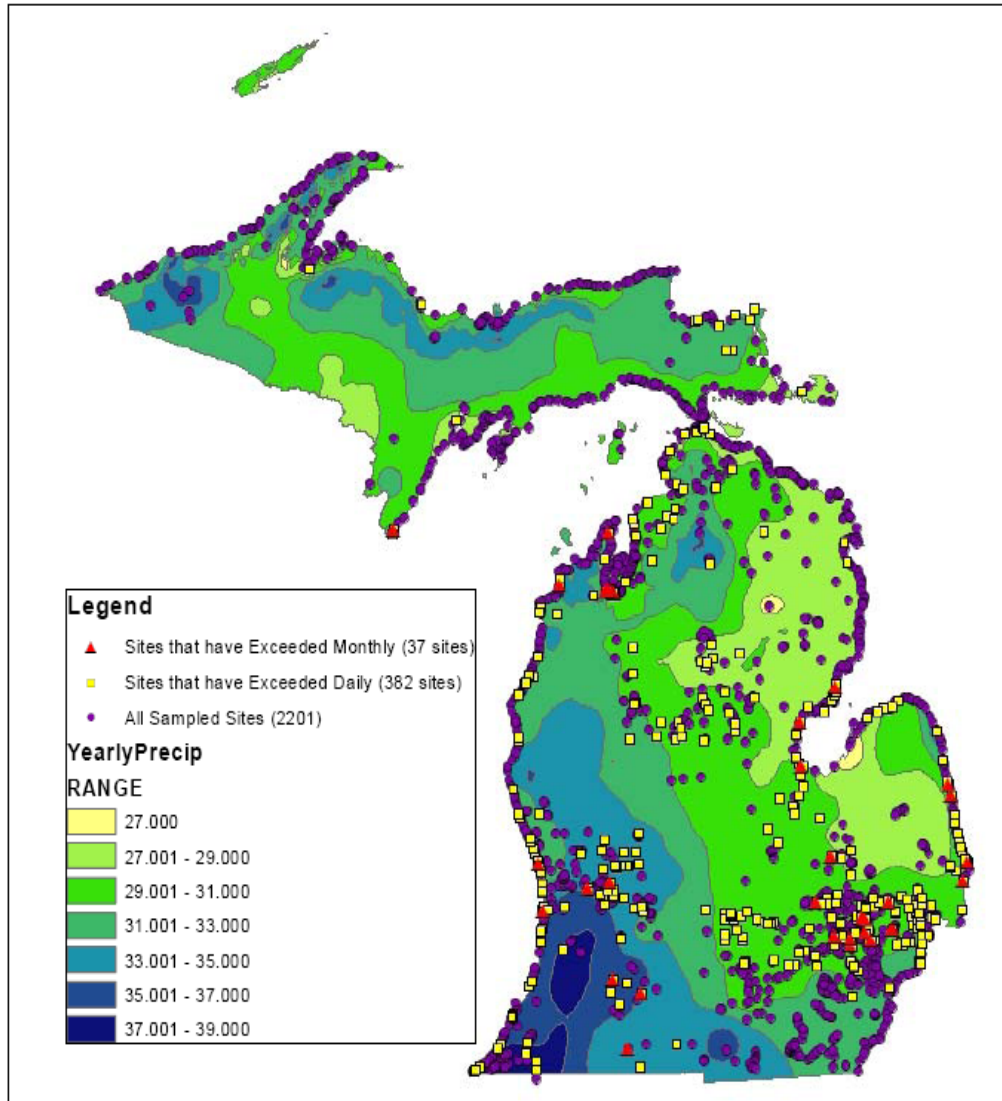
- Those sites which exceeded a monthly or daily standard (based on the Michigan *E. coli* standards) at any point
 - 37 sites that have exceeded a monthly standard
 - 382 sites that have exceeded a daily standard

Beach Closures



- Land Use Data
 - % URBAN ↑
 - % WETLANDS ↓
- What is the land use within a certain radius of the beach within the watershed?
 - 64 sites with sufficient data
- Sources
 - Adaptation Actions

Beach Closures



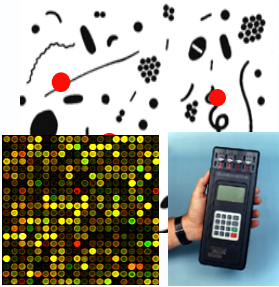
- Precipitation Data
- What does the precipitation trend line look like before, during and after a beach closure event?
 - S. Bass Island
- Forecasting
 - Issue boil orders and beach closures sooner to prevent outbreaks

Risk



• Risk assessment and management

Microbial detection



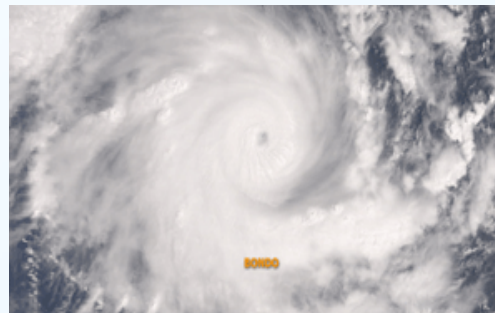
- Disease incidence
- Concentrations in wastes

Sources and Infrastructure

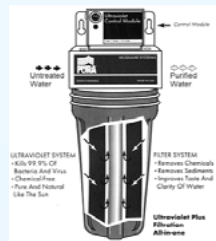


- Surface water, groundwater,
- Transport from Source to the Beach & Modeling Fate

Weather Events



Climate Change



The Future

- Insufficient studies are on-going in the Great Lakes.
- \$ millions needed for clean up in the Great Lakes & investment in infrastructure.
- Invasive species are playing a role in the complexity of the risks.
- Strategy for studying water contamination and public health linkages to sources, climate and solutions.
- Funding is needed for development of key data bases on water quantity, quality, ecosystem functionality.



Thank You