Environmental Influences on Numbers of *E. coli* and Enterococci in Beach Water, Grand Traverse Bay, MI

Sheridan K. Haack, USGS

Lisa R. Fogarty, USGS

Chris Wright, Watershed Center, Grand Traverse Bay

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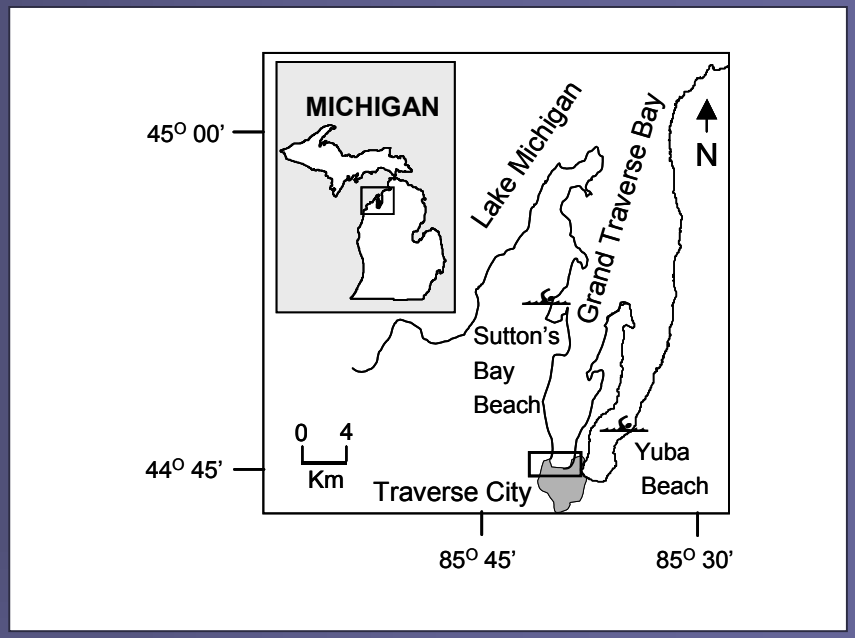
Study Designs

- Pilot Study, 2000
  - Random sampling dates + targeted storm study
  - Water, sediments, ground water, source materials – over 250 samples
  - Coliforms, *E. coli* and enterococci
- Trial Monitoring Program, 2001
  - 5 (triplicate) samples per 30-day interval, May-September
  - Only *E. coli*
- Both: records of environmental conditions



Recreational Water Quality

- **Pilot Study**
  - 4/42 single-sample *E. coli* exceedances
    - EC/ENT – 4.6 to 46.0
  - 11/42 single-sample enterococci exceedances
    - EC/ENT – 0.14 to 11.33
  - Steady state (all available samples for a given beach)
    - *E. coli* exceedance only at 1 beach
    - Enterococci exceedance at all 3 beaches
- **Monitoring Program** (20 *E. coli* samples per beach)
  - 2-5 single-sample exceedances
  - 1-5 steady state exceedances (running geometric mean)
    - Beach with most exceedances – large offshore storm drain

Sources

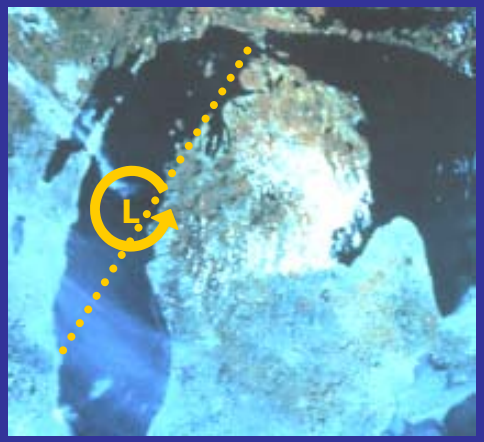
- **Storm drains** (10^7 per day, dry – 10^8 per hour, storm)
- **River** (10^{11} per day, dry – 10^{11} per hour, storm)
- **Birds** (gulls & ducks) – 10^6 per g feces; 10^8 per day per bird
- **Ground Water** – 1-10 x beach water
- **Sands** – 1-2 x beach water; little effect following suspension
- **Detritus** – 4 – 20 x beach water

Environmental Factors

- In Pilot Study, both indicators at 3 south-end beaches were correlated with
  - AM (vs PM) sampling
  - NE-NW (vs SW) wind direction
  - TSS (detritus effect?)
  - Wind speed/wave height
  - Concentrations at Clinch Beach highest 72 hr after storm
- In Monitoring Program,
  - *E. coli* at south-end beaches strongly correlated with 48-72 hour antecedent rainfall, negatively correlated with 24-hr rainfall
  - *E. coli* at east and west shoreline beaches were strongly correlated with 24 hr rainfall
  - All with TSS but wave height & wind speed variable with beach

Environmental Processes

- Regional vs local processes
  - Interactions
- Hydrodynamics
  - Beach orientation with respect to circulation patterns
- Timing of sampling vs frequency of events



3-5 DAY WEATHER CYCLE

Low Pressure
- **SW winds**
- **Rain**
- **Drives water north**

High Pressure
- **N-NW winds**
- **Sunny**
- **Drives water south**

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Due to winds or pressure
- **Vertical movement**
- **Sediment suspension**
- **Currents**