

Fixed and Random Factors Affecting *E. coli* Occurrence at Southern Lake Michigan Beaches

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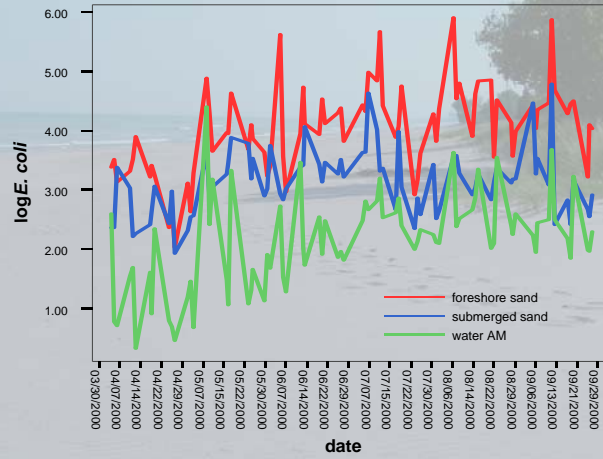


OBJECTIVES

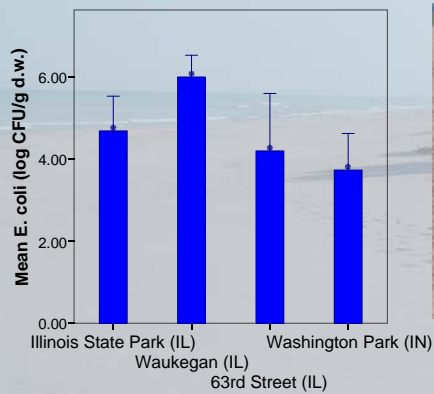
- Determine the effects of **random**, uncontrollable factors on *E. coli* concentrations in beach water
 - *E. coli* in beach sand
 - Sunlight
 - *E. coli* in shoreline *Cladophora*
 - Shorebirds
- Characterize the influence of **fixed**, controllable factors on results of *E. coli* sampling
 - Time of sampling
 - Spatial location: fine and coarse-scale
 - Number of replicates



E. coli in sand and water were correlated at 63rd Street Beach, Chicago, and sand is presumably a source



E. coli counts in *Cladophora* were highest on the beach compared to water or sand; *E. coli* in water and *Cladophora* were seasonally coincidental



Mean log *E. coli* (+1 S.E.) counts in *Cladophora* algae collected along the shoreline

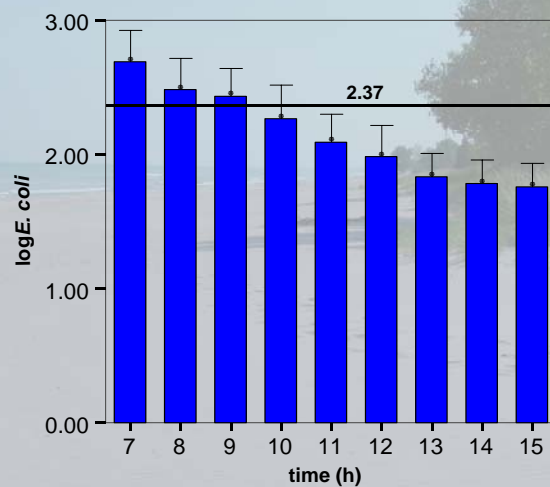


Number of gulls on the beach was correlated with *E. coli* counts the next day

	# gulls unlagged, <i>P</i> values	# gulls lagged 1 day, <i>P</i> values
Foreshore sand	0.133	0.000*
Submerged sand	0.972	0.046
45 cm water AM	0.224	0.004*
90 cm water AM	0.037	0.001*
45 cm water PM	0.916	0.167
90 cm water PM	0.432	0.008



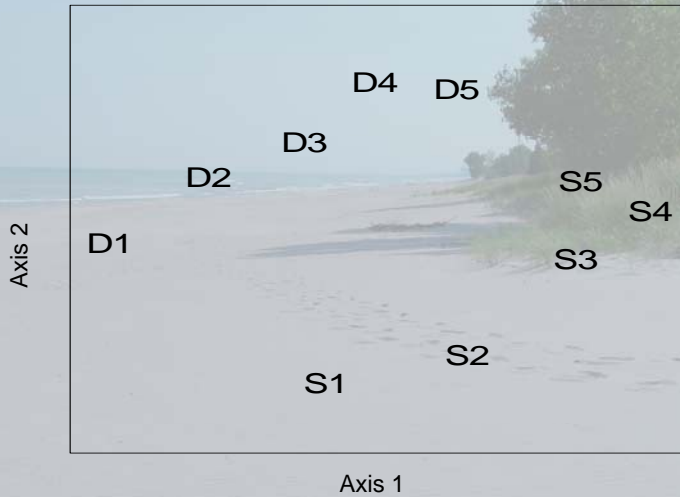
Samples collected in the early morning had higher *E. coli* counts than those collected later in the day



Mean log *E. coli* for ten days; summer 2000
63rd Street Beach, Chicago



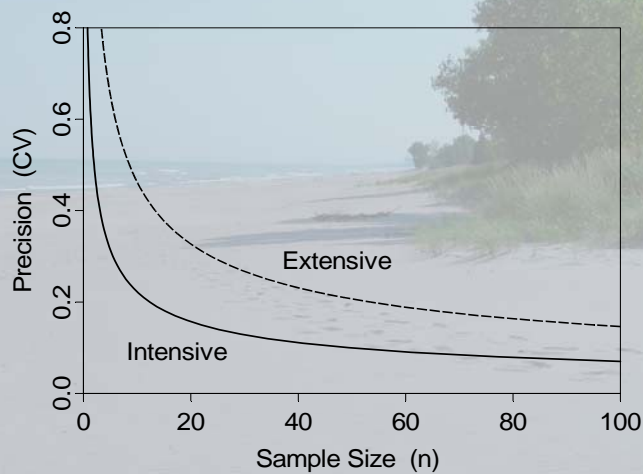
Spatial location influenced *E. coli* testing results



MDS of *E. coli* counts at shallow (S, 45 cm) and deep (D, 90 cm) water transect (1-5) sites; 63rd Street Beach, Chicago



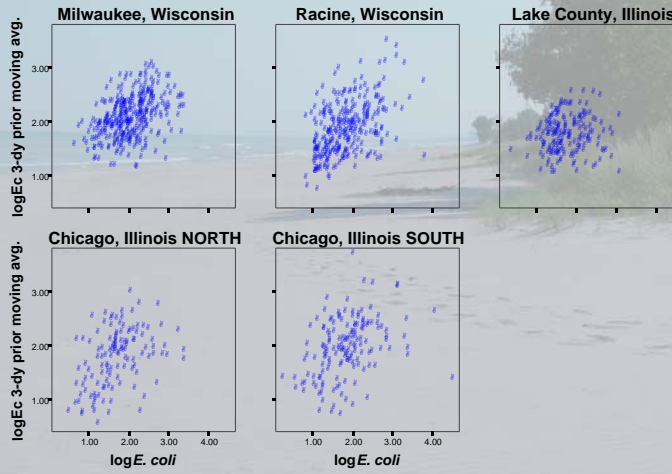
E. coli counts were more variable across the beach than in a single location. Numerous samples would have to be collected to be confident that the variation is included.



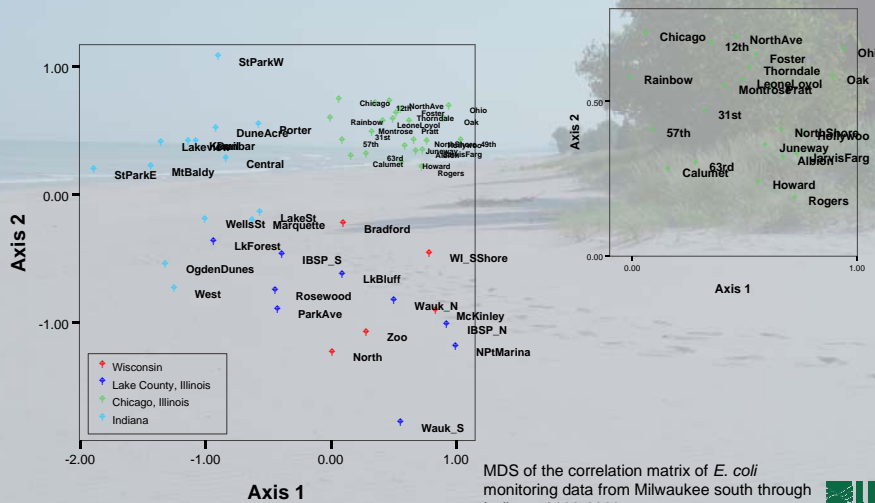
Precision, as coefficient of variation, calculated from 10 samples collected across 500m of beach (extensive) and 10 samples collected at a single sampling location (intensive)



E. coli count was weakly but significantly correlated with the 3-day prior moving average in each beach zone, except for Lake County, Illinois

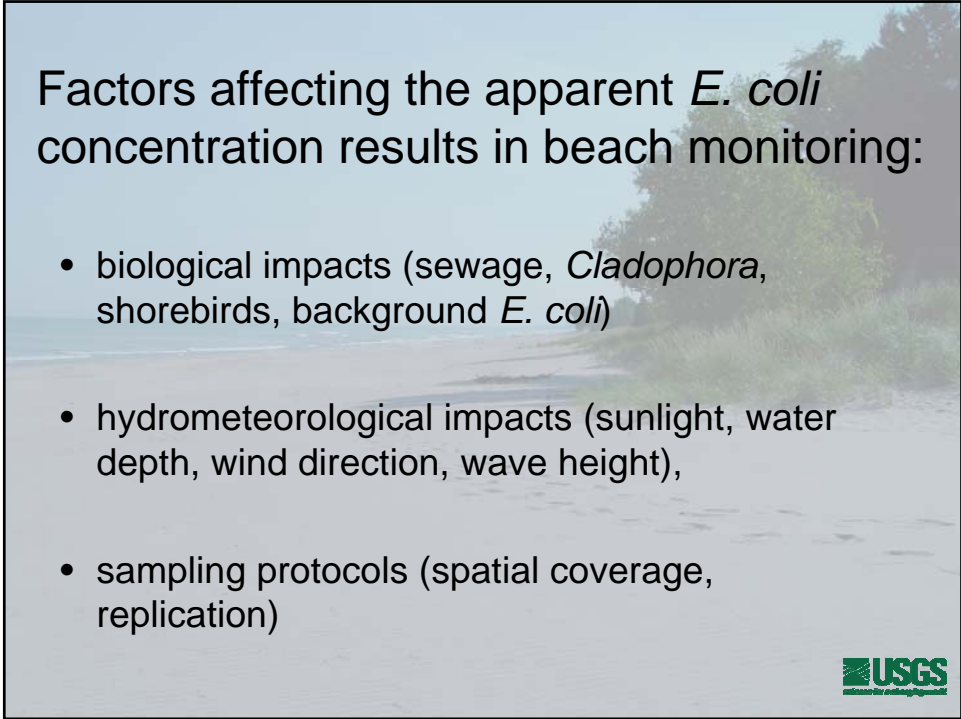


E. coli counts at beaches are more similar within limited regional areas



MDS of the correlation matrix of *E. coli* monitoring data from Milwaukee south through Indiana, 2000-2003.





Factors affecting the apparent *E. coli* concentration results in beach monitoring:

- biological impacts (sewage, *Cladophora*, shorebirds, background *E. coli*)
- hydrometeorological impacts (sunlight, water depth, wind direction, wave height),
- sampling protocols (spatial coverage, replication)

