Modeling Variation in Pathogenic Bacteria Concentrations in Coastal and Estuarine Waters

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Vibrios in the Environment

- V. cholerae
- V. vulnificus
- V. parahaemolyticus

**ENVIRONMENTAL PARAMETERS**
- Temperature
- Salinity
- Precipitation
- Circulation
- Sea surface height
- Nutrients
- pH
- Chlorophyll

- Bacteria
- Copepods

- Shellfish
- Rec. water

Untreated sewage

HUMANS
Total Vibrios in the Gulf of Maine

*Maine Dept. of Health & Human Services
*New Hampshire Dept. of Health & Human Services
*Massachusetts Dept. of Health & Human Services
Massachusetts commercial oyster harvest:
- 2.9 million pounds - $6.9 million in 2010
- 4.1 million pounds - $11.6 million 2012

V. parahaemolyticus outbreaks (Katama Bay ‘outbreak’-2014).
Sea surface temperature at buoys in Long Island Sound, Gulf of Maine and Great Bay Estuary in June
Average monthly estuarine water temperatures in the Great Bay estuary for 3 time periods

Ecosystem conditions became more favorable for \( V_p \) during 2011-13 when water temperatures during June and July were higher than previous years
Historical Trends of *Vibrio* spp. in the Great Bay Estuary

In situ sample detection frequency 2007-2014:
- **Vp** (63%)… 57% in oysters
- **Vv** (14%)
- **Vc** (17%)
Physical Data

Biological Data

Remote Sensed

In situ

Modeled

In situ Vibrio estimation models

Vibrio spp. hindcast

RS chlorophyll

Forecasting

Operational applications

Public health

V. vulnificus

V. parahaem.

V. cholerae
Vibrio Modeling in the Great Bay Estuary

- *Vibrio* spp.
  - 145 oyster samples
  - *V. parahaemolyticus*
  - April–December (2007-2013)

- Probability of presence
  - Generalized Linear Model (GLM)
  - Binary classification
    - MPN/g>30 = 1
  - Environmental Predictors
  - Error metrics
    - 0.5 prediction point

Concentration modeling? 
Risk/exposure modeling?
# Modeling of *V. parahaemolyticus* in the Great Bay Estuary

<table>
<thead>
<tr>
<th></th>
<th>Temp</th>
<th>Saln</th>
<th>DO</th>
<th>pH</th>
<th>Turb</th>
<th>TDN</th>
<th>Chla</th>
<th>PO</th>
<th>Rain</th>
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<tbody>
<tr>
<td>Vp</td>
<td>0.45</td>
<td>0.27</td>
<td>-0.39</td>
<td>0.09</td>
<td>0.18</td>
<td>-0.20</td>
<td>0.30</td>
<td>0.05</td>
<td>0.07</td>
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</tbody>
</table>

- **Vp** = β₀ + β₁(Temp) + β₂(Saln)
- **Vp** = β₀ + β₁(Temp) + β₂(Saln) + β₃(Chl)

[Table showing correlation coefficients]
E. Urquhart and S. Jones, unpubl. data
Please select a sampling station from Great Bay, NH:

<table>
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<tr>
<th>Station Name</th>
<th>SWMP</th>
<th>Real Time</th>
<th>Status</th>
<th>Data Type</th>
<th>Station Code</th>
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<tbody>
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<td>Lamprey River</td>
<td>P</td>
<td>Yes</td>
<td>Active</td>
<td>water quality</td>
<td>LR</td>
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<tr>
<td>Greenland</td>
<td>P</td>
<td>Yes</td>
<td>Active</td>
<td>meteorological</td>
<td>GL</td>
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<td>Squamscott River</td>
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<td>Active</td>
<td>water quality</td>
<td>SQ</td>
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<tr>
<td>Great Bay</td>
<td>P</td>
<td>Yes</td>
<td>Active</td>
<td>water quality</td>
<td>GB</td>
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<tr>
<td>Oyster River</td>
<td>P</td>
<td>Yes</td>
<td>Active</td>
<td>water quality</td>
<td>OB</td>
</tr>
</tbody>
</table>

Your Station Selection: Choose above

http://cdmo.baruch.sc.edu
April 7 Water Temperature

April 10 Water Temperature

Hunt et al. 2006
Great Bay Estuary

- Major inputs
  - Atlantic Ocean
  - Rivers/tributaries
- ~ 40% volume exchange
- 2.5 m tide
- Average depth: 2.7m
- Sea surface temperature:
  - (<0°C to >27°C)
- Sea surface salinity:
  - (0 to 30)
Physical Data

Biological Data

RS chlorophyll

Remotely Sensed

In situ

Modeled

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hindcast

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