Gulfwatch and Microbial Source Tracking Laboratory

Steve Jones
Department of Natural Resources
Jackson Estuarine Laboratory
Assistant Research Director
NH Sea Grant College Program
Environmental Contaminants

- Status and trends
- Pollution source identification
Gulf of Maine
GULFWATCH PROGRAM

• Toxic contaminant monitoring program in the Gulf of Maine;
• Blue mussel as sentinel species;
• Volunteers in US & Canada, & all 5 jurisdictions;
• Standardized methods, 1991 to 2008

• Support for chemical analyses, data interpretation analysis and outreach by the:
**GULFWATCH PROGRAM**

• Ubiquitous blue mussels are used as the indicator of habitat/biological exposure to toxic chemicals;

• Modeled after and nearly identical to the NOAA *Mussel Watch* program;

• Long-term sampling at sites on a rotational basis to provide wide spatial and temporal baseline of data.
INORGANIC CONTAMINANTS

ME TALS

Ag, Al, Cd, Cr, Cu, Fe, Hg, Ni, Pb, Zn

ORGANIC CONTAMINANTS

AROMATIC HYDROCARBONS

Naphthalene
1-Methylnaphthalene
2-Methylnaphthalene
Biphenyl
2,6-Dimethylnaphthalene
Acenaphthylene
Acenaphthene
2,3,5-Trimethylnaphthalene
Fluorene
Phenanthrene
Anthracene
1-Methylphenanthrene
Fluoranthenes
Pyrene
Benzol[a]anthracene
Chrysene
Benzol[b]fluoranthene
Benzol[k]fluoranthene
Benzol[e]pyrene
Benzol[a]pyrene
Perylene
Indeno[1,2,3-cd]pyrene
Dibenzo[a,h]anthracene
Benzol[ghi]perylene

CHLORINATED Pesticides

Hexachlorobenzene (HCB)
Gammachlorheptachlorobenzene (BCB)
Hectachloroepoxide
Aldrin
Lindane
cis-Chlordane
Trans-Nonachlor
Dieledrin
alpha-Endosulfan
beta-Endosulfan

DDT AND HOMOLOGUES

2,4'-DDT
2,4'-DDD
2,4'-DDT

PCB CONGENERS

PCB 8, PCB 18, PCB 28, PCB 29, PCB 44, PCB 50, PCB 52, PCB 66, PCB 77, PCB 87, PCB 101, PCB 105, PCB 118, PCB 126, PCB 128, PCB 138, PCB 153, PCB 169, PCB 170, PCB 180, PCB 187, PCB 195, PCB 206, PCB 209
GULFWATCH PROGRAM

USES

• Management & Policy
• Monitoring
• Impact/Damage & Remediation Assessment
• Education
• Aquaculture & Commercial Fishing
GULFWATCH PROGRAM

In the Gulf of Maine there have been ~100 sites where blue mussel samples have been analyzed.

In New Hampshire, there have been ~20 sampling sites, including the unique analysis of oysters and soft shell clams.
Overview of Gulfwatch Sampling Sites

- international contaminants monitoring program involving three states and two provinces

Each fall, blue mussels (*Mytilus edulis*) are collected from inter-tidal areas in coastal embayments around the Gulf of Maine and Bay of Fundy.
2006 Gulfwatch Sites

Massachusetts
- MAME
- MACJ and MACG

New Hampshire
- NHDP
- NHSS
- MECC
- NHSM

Maine
- MEBB
- MEKN
- MEBH

Nova Scotia
- NBSC
- NBLB
- NS
- NSYR

Gulf of Maine
Chromium concentrations (ppm) in blue mussels: 1993-2001
Total DDT concentrations (ppb) at NH sites: 1993-2001
**PAHs (polycyclic aromatic hydrocarbons)**

Contamination and recovery in Dover Point mussels

- **16 days after oil spill**
PAH concentrations at NHDP: Detection of oil spills
Summary of Information

- Oil spill detection and recovery
- Status of historical and present-day pollution sources
- Cross-referencing to oysters & soft shell clams (human consumption)
- Provides local and regional perspective on contaminants
- Relate to national Mussel Watch program
NHDES and *Gulfwatch*

- NHDES supporting agency within the GOM Council
- Direct involvement of Coastal Scientist
- Support for some NH sites and different species
- Sample collection & processing
- Shellfish Program applications: harvest area classification guidance
- Key indicator for 305 (b) report and “State of the Estuaries” report
- Impact assessment for management efforts to reduce pollution sources
MICROBIAL SOURCE TRACKING

Approach using one or a variety of methods and target microorganisms; intended to identify the fecal sources impacting a water system.
MICROBIAL SOURCE TRACKING

- identify source(s) as human/non-human, or actual source species
- Track pollution sources in space and time
- determine most significant sources at beaches to support management actions
MICROBIAL SOURCE TRACKING in New Hampshire

- NHDES selected *Escherichia coli* ribotyping as the best available method in 1999 & supported initial research and development
- Application in NH began in 2000 & has continued with Shellfish, Beach Inspection, & Coastal programs, Watershed Management Bureau participation
- Purchase of a RiboPrinter in 2003 (NHDES, CICEET, UNH support)
RIBOTYPING

- Isolate *Escherichia coli* from sources in study area to create a ‘known source library’
- Isolate *Escherichia coli* from water samples
- Compare ribotyping DNA pattern of water samples with those from library (best match)
- Identify source species!
Who/what is the culprit of fecal contamination?
Ribopattern analysis results for sample from Atlantic Coast tributary
## Regional Known Source Library

<table>
<thead>
<tr>
<th>Species category</th>
<th>Source species</th>
<th># of Isolates</th>
<th>Species category</th>
<th>Source species</th>
<th># of Isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOMESTIC ANIMALS</td>
<td>alpaca</td>
<td>3</td>
<td>&quot;HUMANS&quot;</td>
<td>septage</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>buffalo</td>
<td>5</td>
<td></td>
<td>wastewater</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>chicken</td>
<td>3</td>
<td></td>
<td>humans</td>
<td>102</td>
</tr>
<tr>
<td></td>
<td>cow</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>goat</td>
<td>4</td>
<td>PETS</td>
<td>cat</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>horse</td>
<td>28</td>
<td></td>
<td>dog</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>pig</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>sheep</td>
<td>2</td>
<td>BIRDS</td>
<td>cormorant</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>duck</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>geese</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>gull</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>pigeon</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>robin</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sparrow</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>starling</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>wild turkey</td>
<td>13</td>
</tr>
<tr>
<td>WILD ANIMALS</td>
<td>coyote</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>deer</td>
<td>94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mouse</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>muskrat</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>otter</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>raccoon</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>rabbit</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>red fox</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>skunk</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TOTAL</td>
<td></td>
<td>971</td>
</tr>
</tbody>
</table>

-> 31 species/sources, 5 TYPES
MST Study Sites at NH
Atlantic Coast Beaches

Sampling Location

# 1 0 1 2 Miles

Atlantic Coast

ACPS 5
ACPS 10
ACPS 11
ACPS 12

Rye

North Hampton

Portsmouth

Hampton
Shellfish Harvesting Classification near Atlantic Coast Beaches (2004)
# Water Quality in Tributaries to Atlantic Coast Beaches

<table>
<thead>
<tr>
<th>SAMPLING SITES</th>
<th>E. coli CONCENTRATIONS (cfu/100 ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wet Conditions</td>
</tr>
<tr>
<td>Parsons Creek</td>
<td>273</td>
</tr>
<tr>
<td>Pirates Cove Beach</td>
<td></td>
</tr>
<tr>
<td>Bass Beach Brook</td>
<td>200</td>
</tr>
<tr>
<td>Bass Beach</td>
<td></td>
</tr>
<tr>
<td>Chapel Brook</td>
<td>784</td>
</tr>
<tr>
<td>Bass Beach</td>
<td></td>
</tr>
<tr>
<td>Little River</td>
<td>993</td>
</tr>
<tr>
<td>Northside &amp; States beaches</td>
<td></td>
</tr>
<tr>
<td>All Sites</td>
<td>577</td>
</tr>
</tbody>
</table>
Source Species Types Identified at Atlantic Coast Beaches, NH

<table>
<thead>
<tr>
<th>Species type</th>
<th>Wet</th>
<th>Dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>15%</td>
<td>24%</td>
</tr>
<tr>
<td>Wild animals</td>
<td>30%</td>
<td>29%</td>
</tr>
<tr>
<td>Pets</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Birds</td>
<td>5%</td>
<td>8%</td>
</tr>
<tr>
<td>Livestock</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>Unknown</td>
<td>44%</td>
<td>37%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
### Source Species Types Identified at Lake Beaches, NH

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Pawtuckaway State Park (Nottingham)</th>
<th>Sand Dam Village Town Beach</th>
<th>Mill Pond Town Beach (E. Washington)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human</td>
<td>10%</td>
<td>0%</td>
<td>7%</td>
</tr>
<tr>
<td>Birds</td>
<td>15%</td>
<td>52%</td>
<td>40%</td>
</tr>
<tr>
<td>Livestock</td>
<td>20%</td>
<td>16%</td>
<td>33%</td>
</tr>
<tr>
<td>pets</td>
<td>0%</td>
<td>8%</td>
<td>0%</td>
</tr>
<tr>
<td>Wild animals</td>
<td>10%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>Identified</td>
<td><strong>55%</strong></td>
<td><strong>76%</strong></td>
<td><strong>83%</strong></td>
</tr>
<tr>
<td>Unknown</td>
<td>45%</td>
<td>24%</td>
<td>17%</td>
</tr>
</tbody>
</table>

*Quality of LOCAL known source library dictated % identification; (Most significant bird species was Canada geese)*
Main Applications

• TMDLs: Little & Hampton/Seabrook harbors, three lake beaches
• Shellfish Program sanitary surveys
• Storm water modelling at NH coastal beaches
• ~30 surveys & research projects
Wider Applications

- Continued research to optimize application
- WWTF influent/effluent studies
- Sea gull transport of pathogens from landfills/WWTF ponds to marine environment
RESULTS SUMMARY

- Different source species and types suggest different management strategies.
- Helps to focus pollution source reduction efforts & resources in the right place.