Marine Environmental Quality Monitoring Programs in the Gulf of Maine: An Inventory

Prepared for the Gulf of Maine Working Group by the Maine State Planning Office

Augusta, Maine
May 1989
Financial assistance for the preparation of this document was provided by a grant from Maine’s Coastal Program, through funding provided by the U.S. Department of Commerce, Office of Ocean and Coastal Resource Management, under the Coastal Zone Management Act of 1972, as amended.
Table Of Contents

Chapter 1, Introduction.................................................. 1

Chapter 2, Proposed Programs............................................. 13
  Maine Marine Environmental Quality
    Monitoring Program.................................................. 14
  Great Bay Citizen Monitoring Program............................... 15
  Midcoast Citizen Monitoring Program................................ 17

Chapter 3, Ongoing Programs............................................ 19
  Ocean Dumping Control Act (ODCA) Monitoring....................... 20
  Benthic Surveillance Project,
    Status and Trends Program......................................... 22
  Mussel Watch Project,
    Status and Trends Program......................................... 28
  Paralytic Shellfish Poisoning Monitoring,
    Canada................................................................ 33
  Paralytic Shellfish Poisoning Monitoring,
    Maine................................................................ 34
  Monitoring of the L’Etang Inlet...................................... 35
  Boston Harbor Monitoring Program..................................... 36
  Toxic Chemicals in Canadian Seabirds................................. 40
  Shellfish in Great Bay.................................................. 45
  Hydrocarbons in Marine Mammals...................................... 46
  Water Resources Data.................................................... 48
  National Water Quality Data Bank..................................... 51
  National Coastal Pollutant Discharge Inventory.................... 53
  Regional Inventory of Pollution Sources.............................. 55
  Marine Resources Monitoring, Assessment
    and Prediction Program.............................................. 56
  National Shellfish Sanitation Program, Canada..................... 58
  Maine Shellfish Sanitation Program................................... 59
  New Hampshire Shellfish Sanitation Program......................... 61
  Massachusetts Shellfish Sanitation Program......................... 62
  North Shore Monitoring Program...................................... 63
  Local Water Quality Initiatives, Cape Cod........................... 65
  Maquoit Bay Monitoring Program...................................... 68
  Acadia Park Monitoring Program....................................... 69

Chapter 4, Historic Programs............................................ 70
  Northeast Monitoring Program.......................................... 71
  Georges Bank Monitoring Program...................................... 77
  Metals in Northern New England Estuaries............................ 78
  Outer Continental Shelf Environmental Benchmark...................... 80
  Metals in Maine Estuaries............................................. 82
  Butyltin in Great Bay.................................................. 84
  Metals in Saint John Harbor........................................... 86
  Metals in Great Bay and Jeffreys Basin............................... 88
  Dredge Spoils, Penobosot Bay.......................................... 89
  "Argo Merchant" Oil Spill Monitoring................................ 90
  "Northern Gulf" Oil Spill Monitoring................................ 91
List of Figures

Figure 1, The Study Area............................. 7

List of Tables

Table 1, A Guide to Ongoing Contaminant Monitoring Activities in the Gulf of Maine by Media and Contaminant Type.............. 3
Table 2, A Guide to Ongoing Biological Effects Monitoring Activities in the Gulf of Maine.............................. 4
Table 3, A Guide to Historic Monitoring Activities in the Gulf of Maine......................... 5
Table 4, Aromatic Hydrocarbons, National Status and Trends Program.................... 23
Table 5, Organochlorine Pesticides, National Status and Trends......................... 24
Table 6, Analytical Parameters, Benthic Surveillance Project............................. 25
Table 7, Analytical Parameters, Mussel Watch Project............................. 30
Table 8, Monitoring Programs Using Mollusks as Indicator Organisms..................... 32
Table 9, Analytical Parameters, Boston Harbor Monitoring Program.................. 37
Table 10, Collection Sites and Analysis, Canadian Registry of Toxic Chemicals........ 42
Table 11, Seabird Contaminant Studies............................. 44
Table 12, Parameters, United States Geological Survey, Water Resources Data........... 49
Table 13, Local Water Quality Monitoring Studies............. 66
Table 14, Variables Analyzed, Northeast Monitoring Program........................... 72
Table 15, Contaminant Analyses in Tissue, Northeast Monitoring Program.................. 74
Table 16, Sampling Activity and Station Type, Outer Continental Shelf Benchmark..... 80-A
Chapter 1
Introduction
Introduction

This report presents the findings of an inventory of marine environmental quality monitoring programs in the Gulf of Maine. The inventory incorporates ongoing, historic, and proposed monitoring programs, including federal, state, local, volunteer and private efforts, and status and trends, biological effects and compliance-type programs.

Parameters by which programs are compared include: objectives, region covered, contaminants considered, and methodologies used. The purpose of this inventory is to allow for comparison and integration of different programs. The inventory is not intended to be a compilation of program findings; it is primarily concerned with the type of data collected by various workers, and the methodologies they utilize, not with their results or conclusions.

Descriptions of ( )proposed, ( ) ongoing and ( ) historic programs are included. The ongoing and historic programs are summarized in Tables 1, 2 and 3 below.

This inventory utilizes a very broad definition of marine environmental monitoring: activities which provide information on the source, transport, fate and effect of contaminants in the marine environment, and supply information useful for identifying and controlling anthropogenic impacts on the environment. For the purpose of this report any program which provides data on contaminants or their effects, and which might be of value to marine resource managers is considered to be a monitoring program.

For purposes of this survey, the Gulf of Maine region includes Georges Bank as well as the Bay of Fundy. The seaward boundary is approximate, and extends from Cape Sable, Nova Scotia, south to the eastern limit of Georges Bank, then follows the edge of Georges Bank at about the 100 meter contour to the South Channel from which it extend northward to Monomoy Island off of Cape Cod. The region is illustrated in Figure 1.

The focus of this report is on ongoing programs. The discussion of historic programs is less comprehensive. These programs are discussed in detail proportionate to the extent of the original work, and its relevance to ongoing programs.

Background

Recognizing the economic and environmental significance of the Gulf of Maine, and the transboundary nature of many
<table>
<thead>
<tr>
<th>Study</th>
<th>Sampling Media</th>
<th>Sediments</th>
<th>Organics</th>
<th>Contaminants</th>
<th>Traditional / Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediments</td>
<td></td>
<td>HC-</td>
<td>CHC-</td>
<td>Aid-</td>
<td>Aid-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrocarbons</td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Aldrin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes petroleum and non-petroleum species</td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>All non-Chlorinated hydrocarbons includes petroleum and non-petroleum species</td>
<td></td>
<td>Aid-</td>
<td>Aldrin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CHC-</td>
<td>Aid-</td>
<td>CHC-</td>
<td>CHC-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Chlorinated Hydrocarbons</td>
<td>Aldrin</td>
<td>Benzen Hexachloride</td>
<td>Benzen Hexachloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td>includes all species not otherwise listed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Target</td>
<td>Frequency</td>
<td>Ag</td>
<td>Al</td>
<td>As</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>-----------</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Coastal Effluents</td>
<td>All PFP Monitoring</td>
<td>Weekly</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>MARPOR</td>
<td>Weekly</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ocean Dumping Permit</td>
<td>Semi-Ann</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>North Shore Harbors JIP</td>
<td>Weekly</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NESAT Benthic</td>
<td>Annual</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Region Higher At P</td>
<td>Variable</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ADFP Park Program</td>
<td>Annual</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Natural Bay</td>
<td>Weekly</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Local Programs /Case Ce</td>
<td>Variable</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:**
- **HC:** Hydrocarbons. All non-Chlorinated hydrocarbons- includes petroleum and non-petroleum species.
- **CHC:** Other Chlorinated Hydrocarbons- includes all species not otherwise listed.
- **As:** Arsenic
- **Cd:** Cadmium
- **Cr:** Chromium
- **Cu:** Copper
- **H:** Haplosporin
- **HC:** Hepatic Stromal
- **HC:** Hexachlorobenzene
- **HCB:** Hexachlorobenzene
- **HCB:** Hexachloroethane
- **HN:** Hexachloroethane
- **MT:** Methane
- **Non:** Nonachlor
- **PCB:** Polychlorinated Biphenyl
- **PFP:** Paralytic shellfish poisoning
- **Phy:** Physical factors- temperature, salinity, turbidity
- **DO:** Dissolved oxygen
- **Nut.:** Nutrients
- **Bac.:** Bacteria and sewage indicators
- **RN:** Radionuclides
<table>
<thead>
<tr>
<th>Study</th>
<th>Sampling Frequency</th>
<th>Started</th>
<th>Anc.</th>
<th>Al.</th>
<th>B</th>
<th>RN</th>
<th>Nut.</th>
<th>Bac</th>
<th>PSP</th>
<th>Phy</th>
<th>DO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean Dumping Permit</td>
<td>Irregular</td>
<td>1976</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Benthic</td>
<td>Annual</td>
<td>1984</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Mussel Watch</td>
<td>Annual</td>
<td>1986</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean Dumping Permit</td>
<td>Irregular</td>
<td>1976</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Benthic</td>
<td>Annual</td>
<td>1984</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Mussel Watch</td>
<td>Annual</td>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional / Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can PSP Monitoring</td>
<td>Weekly</td>
<td>1958</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L'Etang Inlet Monitoring</td>
<td>Irregular</td>
<td>1971</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Benthic</td>
<td>Annual</td>
<td>1984</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Mussel Watch</td>
<td>Annual</td>
<td>1986</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boson Harbor M P</td>
<td>Variable</td>
<td>1986</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tissue</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic Chemicals in Seabirds</td>
<td>4 Yrs</td>
<td>1972</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Benthic</td>
<td>Annual</td>
<td>1984</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Mussel Watch</td>
<td>Annual</td>
<td>1986</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boson Harbor M P</td>
<td>Variable</td>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxic Chemicals in Seabirds</td>
<td>4 Yrs</td>
<td>1972</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HCs in Marine Mammals</td>
<td>Irregular</td>
<td>1979</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Benthic</td>
<td>Annual</td>
<td>1984</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Mussel Watch</td>
<td>Annual</td>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional / Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can PSP Monitoring</td>
<td>Weekly</td>
<td>1958</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME PSP Monitoring</td>
<td>Weekly</td>
<td>1958</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USGS Water Resources</td>
<td>Quarterly</td>
<td>1970</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAQUADAT</td>
<td>Monthly</td>
<td>1971</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCPDI</td>
<td>Variable</td>
<td>1985</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIPS</td>
<td>Variable</td>
<td>Unk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USGS Water Resources</td>
<td>Quarterly</td>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAQUADAT</td>
<td>Monthly</td>
<td>1971</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MARMAP</td>
<td>Semi-Ann</td>
<td>1972</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCPDI</td>
<td>Variable</td>
<td>1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIPS</td>
<td>Variable</td>
<td>Unk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional / Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MA Shellfish Sanit. Prod.</td>
<td>Semi-Ann</td>
<td>Unk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH Shellfish Sanit. Prod.</td>
<td>Semi-Ann</td>
<td>Unk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USGS Water Resources</td>
<td>Quarterly</td>
<td>1970</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAQUADAT</td>
<td>Monthly</td>
<td>1971</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L'Etang Inlet Monitoring</td>
<td>Irregular</td>
<td>1971</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Shore Harbors MP</td>
<td>Weekly</td>
<td>1981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NCPDI</td>
<td>Variable</td>
<td>1985</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RIPS</td>
<td>Variable</td>
<td>Unk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boson Harbor M P</td>
<td>Variable</td>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Massnut Bay</td>
<td>Weekly</td>
<td>1989</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Programs (Cape Cod)</td>
<td>Variable</td>
<td>Unk</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations**

HC: Hydrocarbons
CHC: Other Chiral Compounds
Ald: Aldrin
Chl: Chlordane
Dield: Dieldrin
End: Endrin
<table>
<thead>
<tr>
<th>Study</th>
<th>Sampling</th>
<th>Frequency</th>
<th>Started</th>
<th>Ag</th>
<th>AI</th>
<th>B</th>
<th>RN</th>
<th>Nut</th>
<th>Bac</th>
<th>PSP</th>
<th>Phy</th>
<th>DO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can PSP Monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ME PSP Monitoring</td>
<td>Weekly</td>
<td>1958</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MARMAP</td>
<td>Semi-Ann</td>
<td>1972</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean Dumping Permit</td>
<td>Irregular</td>
<td>1976</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Shore Harbors MP</td>
<td>Weekly</td>
<td>1981</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS&amp;T Benthic</td>
<td>Annual</td>
<td>1984</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boston Harbor M P</td>
<td>Variable</td>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acadia Park Program</td>
<td>Irregular</td>
<td>1987</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Musquod Bay</td>
<td>Weekly</td>
<td>1989</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Programs (Cape Cod)</td>
<td>Variable</td>
<td>Unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:**
- HC - Hydrocarbons All
- CHC - Other Chlorinate
- Ald- Aldrin
- Chi- Chlordane- include
- Dield-Dieldin
- End- Endrin
# A Guide to Historic Monitoring Activities in the Gulf of Maine

<table>
<thead>
<tr>
<th>Study</th>
<th>Page</th>
<th>Sampling</th>
<th>Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sediments</strong></td>
<td></td>
<td>Frequency</td>
<td>Dates</td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEMP</td>
<td></td>
<td>Irregular</td>
<td>1979 1987</td>
</tr>
<tr>
<td>Georges Bank Monitoring Program</td>
<td></td>
<td>Irregular</td>
<td>1982 1986</td>
</tr>
<tr>
<td>Metals in Northern New England Estuaries</td>
<td></td>
<td>Once</td>
<td>1980</td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td></td>
<td>Quarterly</td>
<td>1976 1977</td>
</tr>
<tr>
<td>Metals in Maine Estuaries</td>
<td></td>
<td>Irregular</td>
<td>1975</td>
</tr>
<tr>
<td>Butyltin in Great Bay</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Metals in St John Harbor</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Metals in Great Bay and Jeffreys Basin</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Metals in Boston Harbor</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Metals in Sediments &amp; Water, Boston Harbor</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Metals in Massachusetts Bay</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Dredge Spoils</td>
<td></td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td><strong>Organics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast Monitoring Program</td>
<td></td>
<td>Irregular</td>
<td>1979 1987</td>
</tr>
<tr>
<td>Georges Bank Monitoring Program</td>
<td></td>
<td>Irregular</td>
<td>1982 1986</td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td></td>
<td>Quarterly</td>
<td>1976 1977</td>
</tr>
<tr>
<td>&quot;Argo Merchant&quot; Oil Spill Monitoring</td>
<td></td>
<td>Once</td>
<td>1976 1977</td>
</tr>
<tr>
<td>&quot;Northern Gulf&quot; Oil Spill Monitoring</td>
<td></td>
<td>Once</td>
<td>1974</td>
</tr>
<tr>
<td><strong>Traditional / Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bay of Fundy Project</td>
<td></td>
<td>Irregular</td>
<td>1977 1980</td>
</tr>
<tr>
<td><strong>Tissue</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Metals</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georges Bank Drilling Project</td>
<td></td>
<td>Unk</td>
<td>1987 1988</td>
</tr>
<tr>
<td>Northeast Monitoring Program</td>
<td></td>
<td>Irregular</td>
<td>1979 1987</td>
</tr>
<tr>
<td>Georges Bank Monitoring Program</td>
<td></td>
<td>Irregular</td>
<td>1982 1986</td>
</tr>
<tr>
<td>National Pesticides Monitoring Program</td>
<td></td>
<td>Irregular</td>
<td>1964 1984</td>
</tr>
<tr>
<td>Metals in Coastal Seaweeds</td>
<td></td>
<td>Once</td>
<td>1983</td>
</tr>
<tr>
<td>Metals in New England Snails</td>
<td></td>
<td>Once</td>
<td>1982</td>
</tr>
<tr>
<td>Metals in Maritime Scallops</td>
<td></td>
<td>Once</td>
<td>1981</td>
</tr>
<tr>
<td>United States Mussel Watch</td>
<td></td>
<td>Annual</td>
<td>1976 1978</td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td></td>
<td>Quarterly</td>
<td>1976 1977</td>
</tr>
<tr>
<td>Metals in Selected Seafoods</td>
<td></td>
<td>Once</td>
<td>1975</td>
</tr>
<tr>
<td>Metals in Maine Estuaries</td>
<td></td>
<td>Irregular</td>
<td>1975</td>
</tr>
<tr>
<td>Organochlorines in Marine Mammals</td>
<td></td>
<td>Irregular</td>
<td>1969 1973</td>
</tr>
<tr>
<td>Metals in United States Scallops</td>
<td></td>
<td>Once</td>
<td>Unk</td>
</tr>
<tr>
<td>Nova Scotia Striped Bass</td>
<td></td>
<td>Unk</td>
<td>Unk</td>
</tr>
<tr>
<td>Study</td>
<td>Page</td>
<td>Sampling Frequency</td>
<td>Dates</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>---------------</td>
<td>--------------------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>Tissue, Continued</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast Monitoring Program</td>
<td>Irregular</td>
<td>1979</td>
<td>1987</td>
</tr>
<tr>
<td>Georges Bank Monitoring Program</td>
<td>Irregular</td>
<td>1982</td>
<td>1986</td>
</tr>
<tr>
<td>National Pesticides Monitoring Program</td>
<td>Irregular</td>
<td>1964</td>
<td>1984</td>
</tr>
<tr>
<td>Organochlorines in Common Terns</td>
<td>Annual</td>
<td>1971</td>
<td>1981</td>
</tr>
<tr>
<td>United States Mussel Watch</td>
<td>Annual</td>
<td>1976</td>
<td>1978</td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td>Quarterly</td>
<td>1976</td>
<td>1977</td>
</tr>
<tr>
<td>&quot;Argo Merchant&quot; Oil Spill Monitoring</td>
<td>Once</td>
<td>1976</td>
<td>1977</td>
</tr>
<tr>
<td>Organochlorines in Eiders and Gulls</td>
<td>Once</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organochlorines in Eagle Food</td>
<td>Twice</td>
<td>1966</td>
<td>1974</td>
</tr>
<tr>
<td>&quot;Northern Gulf&quot; Oil Spill Monitoring</td>
<td>Once</td>
<td>1974</td>
<td></td>
</tr>
<tr>
<td>Hydrocarbons in Aquatic Fauna</td>
<td>Twice</td>
<td>1972</td>
<td>1974</td>
</tr>
<tr>
<td>Organochlorines in Shearwaters</td>
<td>Once</td>
<td>1974</td>
<td></td>
</tr>
<tr>
<td>Organochlorines in Marine Mammals</td>
<td>Irregular</td>
<td>1969</td>
<td>1973</td>
</tr>
<tr>
<td>Organochlorines in Cormorants</td>
<td>Annual</td>
<td>1966</td>
<td>1967</td>
</tr>
<tr>
<td>DDT in Shellfish</td>
<td>Once</td>
<td>1967</td>
<td></td>
</tr>
<tr>
<td>Nova Scotia Striped Bass</td>
<td>Unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bay of Fundy Bird Eggs</td>
<td>Unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Traditional / Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>United States Mussel Watch</td>
<td>Annual</td>
<td>1976</td>
<td>1978</td>
</tr>
<tr>
<td><strong>Water</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butyltin in US Harbors</td>
<td>Once</td>
<td>1985</td>
<td></td>
</tr>
<tr>
<td>Metals in Coastal Seaweeds</td>
<td>Once</td>
<td>1983</td>
<td></td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td>Quarterly</td>
<td>1976</td>
<td>1977</td>
</tr>
<tr>
<td>Metals in Maine Estuaries</td>
<td>Irregular</td>
<td>1975</td>
<td></td>
</tr>
<tr>
<td>Butyltin in Great Bay</td>
<td>Unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metals in Sediments &amp; Water, Boson Harbor</td>
<td>Unk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td>Quarterly</td>
<td>1976</td>
<td>1977</td>
</tr>
<tr>
<td>&quot;Argo Merchant&quot; Oil Spill Monitoring</td>
<td>Once</td>
<td>1976</td>
<td>1977</td>
</tr>
<tr>
<td>Particulate Oil Pollution</td>
<td>Twice</td>
<td>1971</td>
<td>1972</td>
</tr>
<tr>
<td><strong>Traditional / Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast Monitoring Program</td>
<td>Irregular</td>
<td>1979</td>
<td>1987</td>
</tr>
<tr>
<td>Georges Bank Monitoring Program</td>
<td>Irregular</td>
<td>1982</td>
<td>1986</td>
</tr>
<tr>
<td>Bay of Fundy Project</td>
<td>Irregular</td>
<td>1977</td>
<td>1980</td>
</tr>
<tr>
<td><strong>Biological Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast Monitoring Program</td>
<td>Irregular</td>
<td>1979</td>
<td>1987</td>
</tr>
<tr>
<td>Georges Bank Monitoring Program</td>
<td>Irregular</td>
<td>1982</td>
<td>1986</td>
</tr>
<tr>
<td>National Pesticides Monitoring Program</td>
<td>Irregular</td>
<td>1964</td>
<td>1984</td>
</tr>
<tr>
<td>Metals in New England Snails</td>
<td>Once</td>
<td>1982</td>
<td></td>
</tr>
<tr>
<td>Organochlorines in Common Terns</td>
<td>Annual</td>
<td>1971</td>
<td>1981</td>
</tr>
<tr>
<td>Georges Bank Benchmark</td>
<td>Quarterly</td>
<td>1976</td>
<td>1977</td>
</tr>
</tbody>
</table>
Figure 1, The Study Area
anthropogenic impacts on Gulf resources, the States and Provinces bordering the Gulf have initiated a cooperative effort to protect and enhance the ecological integrity of the Gulf, and to meet the needs and expectations of the Gulf's user communities without compromising the present and future health of the Gulf.

At the request of the Governors of Maine, New Hampshire, and Massachusetts, and the Premiers of New Brunswick and Nova Scotia, representatives of State and Provincial environmental and fisheries agencies, with the cooperation of United States and Canadian Federal agencies, have formed a Gulf of Maine Working Group to facilitate joint efforts to protect the Gulf from environmental degradation.

The Working Group has elected to develop a monitoring program to evaluate the status and trends of environmental quality in the Gulf as a prerequisite to effective management. Such a program would entail an ongoing assessment of: the sources, fates and effects of contaminants in the Gulf system; causes, rates and effects of habitat loss; causes and impacts of other anthropogenic activities within the Gulf ecosystem; and effectiveness of remedial actions.

It is anticipated that the Gulf-wide monitoring program will build upon existing monitoring efforts in the Gulf.

Interest in the health of the marine environment, and the economic, aesthetic, and recreational activities that depend upon it has led to a variety of monitoring programs in the Gulf, however, they do not address regional issues. If coordinated, these programs could form the basis of an effective Gulf-wide effort.

This inventory is prepared by the Maine State Planning Office on behalf of the Working Group as an initial step in the organization of a comprehensive monitoring effort that will serve Gulf-wide objectives.

Discussion

Monitoring effort has changed over time to reflect changing needs, problems, perceptions, and analytical capabilities. Many types of monitoring are considered here. The emphasis is on monitoring of contaminant concentrations and effects. Other monitoring activities are beyond the scope of this work.

Contaminant Monitoring

Bacterial contamination of coastal waters, resulting in an unsafe food resource, led to some of the earliest monitoring programs established in Gulf waters. These programs have focussed on the identification of bacteria in the water which
indicate the presence of sewage contamination. Many of these were underway in the 1940s and continue today.

Dinoflagellate induced shellfish toxicity also creates a hazard to human health which led to a monitoring program in Canada in the 1940s. Similar programs followed in the United States as the problem became evident further south and west.

Accumulation of DDT, mercury, and other toxic substances in the marine environment, and awareness of the potential impacts of these substances, led to increasing concern over their distribution and concentration. In the late 1960s and early 1970s many programs appeared which analyzed sediments, the tissues of marine organisms, or occasionally sea water, for metals and organic compounds.

Exceedingly low concentrations of some of these substances may have impacts on the marine system, and analytical procedures for accurate detection of such low levels were developed through these early programs. Techniques varied substantially between programs, and were often changed during the course of the same program as improved methods were discovered. This evolution of analytical methodology complicates comparison of the results from earlier studies with those of later ones.

Many metals exhibit high degrees of toxicity to humans and marine life. While metals occur naturally in the oceans, elevated levels of metals are associated with some human activities. Metals accumulate in tissues and in sediments, and most programs analyze for them in one of these media. Analysis of water for metals is less common, as the residence time of metals in sea water is generally low.

A recent development in monitoring for metals is the awareness of the different forms which metals take in the marine system. Organic and inorganic forms may have very different toxicity characteristics. Two recent programs in the Gulf investigated the relative concentrations of methyl and butyl forms of tin in an estuarine system.

Organochlorine pesticides are among the organic contaminants most commonly investigated by monitoring programs. Some are highly persistent in the marine environment and in tissues, becoming concentrated in the tissues of predators. PCB, an industrial chemical, is another organochlorine which is highly toxic, and persistent in the marine environment. It is also a common subject of monitoring activity.

Early monitoring efforts established the presence of many contaminants in the marine system. Programs to assess the trends in contaminants over time, and their differential distribution along the coast followed shortly thereafter. The range of
contaminants included in monitoring programs increased dramatically during the 1970s.

The sources of the contaminants in the marine system also became a focus for monitoring activity at this time. Discharge permits were instituted for many types of point source discharges. These permits often required that monitoring programs be established to assure compliance with the discharge allowances.

The results of individual compliance programs are difficult to access. The results of many of these programs are compiled in data bases which are more accessible than is the original data. Compliance programs are largely incorporated into this document under inventories of these data bases maintained by the Federal governments. More specific information on discharges in certain regions or by certain industries might be obtained from a more detailed examination of compliance programs.

Hydrocarbon contamination became a focus of concern in the late 1970s as several oil spills occurred in the region, and interest in leasing for oil exploration on Georges Bank intensified. This led to an increase in the number of programs investigating petroleum contamination, and to several large scale surveys of the Georges Bank region.

Hydrocarbons consist of hundreds of compounds in a broad array of forms and combinations. These present a diversity of physical and chemical characteristics depending on their source. Reporting of hydrocarbon concentrations is complicated by these factors. It is often not possible to distinguish the specific substances, or even the appropriate group of hydrocarbons being analyzed.

Crude oil and petroleum products are one source of hydrocarbon contamination to the marine system. Hydrocarbons also arise as the by-products of combustion. These are increasingly recognized as an important source of hydrocarbon contamination to the marine system. Some hydrocarbons are even the products of normal metabolism of marine animals. Reporting of hydrocarbon concentrations seldom allows for a separation of the different types of hydrocarbons.

Nutrient enrichment and eutrophication, long recognized as problems in fresh water systems increasingly appear to pose problems in inshore coastal areas as well, especially where flushing rates are low. Programs are proliferating which examine the presence of nutrients, and the impact of these nutrients through decreases in dissolved oxygen levels.
Biological Effects Monitoring

While the primary focus of monitoring activities today is the determination of contaminant levels in the marine system, it is increasingly clear that management of contaminants will require a clearer understanding of their biological effects.

Differentiating between contamination and pollution is often extremely difficult. It entails an understanding of the impact of the contaminant substance on the ecosystem. Impacts on individual organisms are often difficult to assess, given the range of natural variability, and the poor state of understanding of many marine organisms. Impacts on communities or ecosystems are even more difficult to assess given the enormous complexity of these systems.

Biological effects monitoring is an increasingly important part of environmental monitoring in the Gulf, and several program are included in this inventory which monitor effects such as histological and pathological abnormalities, and changes in community structure, or other ecosystem characteristics.

Other Environmental Issues

Not all of the factors pertinent to understanding marine environmental quality are incorporated into this report. Some important considerations beyond the scope of this report are discussed briefly below.

Studies of animal population dynamics may provide indicators of environmental health. Those studies associated with contaminant gradients are an indication of biological effects, and are included in the inventory. Other types of population studies may be enlightening about marine environmental quality, but are not included, as distinguishing anthropogenic influence from natural variability in the absence of contaminant data is extremely difficult. Studies of the ecosystem effects of fish harvesting are also not included.

Certain habitats are crucial to the lives of marine animals, and thus to ecosystem health. Disturbance of these habitats can cause environmental damage disproportionate to the extent of the physical damage. Few surveys of critical habitats, and their loss or alteration were discovered, and these are not considered in this inventory.

These fields provide insight into the state of the marine environment. Any one is worthy of its own inventory, however, insufficient data was found to adequately include these areas here.
Remote Sensing

New types of analytical procedures are also evolving which will transform the future of monitoring. Remote monitoring techniques are among the most important of these. The ability to determine given parameters synoptically and nearly instantaneously across the entire Gulf, presents many possibilities. Researchers are already putting the techniques of remote sensing, and photography from space to use on problems relating to marine environmental quality. However, insufficient data was found on these programs to include them in this inventory.

Other Inventories Pertinent to the Gulf of Maine

For more detailed information on two regions of the Gulf the reader is directed to the following documents which were not completed in time for incorporation into this inventory.

[Data bases- Canada- Environ Canada-] This inventory of data bases relevant to marine environmental quality in Atlantic Canada is similar in form and purpose to the present inventory, however it is not specific to the Gulf.

[Boston Harbor/ Mass Bay programs- MCZM] The waters near Boston are highly contaminated, and are the site of extensive studies by many groups. For a comprehensive description of monitoring in this area, the reader is directed to this document.
Chapter 2
Proposed Programs
Title    Maine Marine Environmental Monitoring Program
Sponsor  State of Maine
Department of Environmental Protection (DEP)
Department of Marine Resources (DMR)

Goals

"To examine the extent and effect of chemical contaminants and pollutants on marine and estuarine ecosystems...(and) to determine compliance with and attainment of water quality standards set by the legislature." (Doggett and Sowles, 1989. pp 41-42.)

Contaminants

To be decided. Chemical contaminants will be the primary focus.

Dates and Frequency of Sampling

The program was established by the Maine Legislature in 1988. Program development is currently underway. The proposed sampling schedule calls for extensive monitoring of the coast at a series of status and trends sites on a five year rotation. Intensive monitoring will be carried out intermittently at sites of particular concern. These sites will be sampled on a much more frequent basis. Diagnostic monitoring will be frequent and ongoing at sites of concern.

Sampling Stations

Twenty six status and trends sites are proposed for an initial extensive survey, the Kennebec/Androscoggin estuarine system is proposed as the first intensive study site, and Casco Bay as the first diagnostic study area.

Sampling and Analytical Procedures

Under development. Procedures are expected to follow those of other major programs for comparability where practical.

Reference


Discussion
Title  Great Bay Citizen Monitoring Program  
Sponsor  Sea Grant Extension  

Goals

To expand the existing spatial array of monitoring sites in Great Bay beyond the two stations now being monitored by the Jackson Estuarine Laboratory.

Contaminants

To be decided. Water will be the primary media, and physical parameters and traditional pollutants will be emphasized. Criteria will probably include salinity, temperature, pH, and dissolved oxygen. Nutrient analysis is also under consideration. Biological effects parameters may be included in the form of benthic population analysis.

Dates and Frequency of Sampling

The extent of the program and the starting dates are dependent on funding. Plans are to begin in the summer of 1989.

Sampling Stations

To be decided.

Sampling and Analytical Procedures

To be decided. Working in conjunction with the Jackson Estuarine Laboratory allows for some technical lab analysis if desired.

Reference

Information on the proposal is available through Sharon Meeker, Seagrant Extension, University of New Hampshire.

Discussion

A number of other citizen monitoring groups are in progress or proposed. See Midcoast Citizen Monitoring Program __, The North Shore Harbors Program, The Boston Harbor Monitoring Program (MAS and SWIM components), and Maquoit Bay Monitoring Program__. These programs are able to provide considerable information on local conditions in water bodies such as Great Bay.

Great Bay is the site of several other programs, mostly for
metals. See the Great Bay monitoring Program, Butyltin in Great Bay, and Metals in Great Bay and Jefferys Basin. The Jackson Estuarine Laboratory is currently conducting a monitoring program in Great Bay for which no information could be obtained.
Goals

To identify areas where shellfish sanitation problems exist, and to associate these with potential contamination sources.

Contaminants

To be decided. Emphasis will be on bacterial contamination. Fecal coliforms and dissolved oxygen are likely to be the primary criteria examined.

Dates and Frequency of Sampling

To be decided. With adequate funding, sampling will begin during the summer of 1989.

Sampling Stations

Two regions will be emphasized: the tidal regions of the St. George's River, and the Damariscotta River.

Sampling and Analytical Procedures

Samples will be collected and analyzed by citizen volunteer groups. The procedures of the International Shellfish Sanitation Commission will be followed. Laboratory facilities at local high schools will be modified to perform the analyses.

Reference

Information on this program can be obtained from Esperanza Stancioff University of Maine Cooperative Extension Service Rockland, Maine.

Discussion

A number of other citizen monitoring groups are in progress or proposed. See Great Bay Citizen Monitoring Program, The North Shore Harbors Program, The Boston Harbor Monitoring Program (MAS and SWIM components), and Maquoit Bay Monitoring Program. These programs are able to provide considerable information on local conditions in water bodies such as Great Bay.
This program will provide better definition of the water quality in these localities than can be provided by the Maine Shellfish Sanitation surveys. This may allow isolation of individual pollution sources, facilitating cleanup.
Chapter 1
Ongoing Programs

This section includes information on monitoring programs now operating in the Gulf of Maine study area.
Title Ocean Dumping Control Act (ODCA) Monitoring
Sponsor Canada Environmental Protection

Goals

To insure that disposal of waste at sea does not violate the terms of the Ocean Dumping Control Act. All types of waste are included in the terms of the Act, though disposal of dredge spoils are most common and of primary concern.

Contaminants

Materials to be discharged at sea, most commonly sediments from dredge sites, are analyzed for organohalogen compounds, Cd, Hg, n-hexane soluble hydrocarbons, radioactive materials and persistent plastics. Sediment physical properties are also analyzed. Information on biological parameters is available on some sites, for potential effects assessment.

Dates and Frequency of Sampling

Sampling began in 1976, though analysis prior to 1984 is not considered to be reliable. Sampling is intermittent, as dredging activities require. The program is ongoing.

Sampling Stations

Variable. Samples are taken in support of ODCA permit applications.

Sampling and Analytical Procedures

Threshold levels of organohalogens are established at 0.01 parts of the concentration shown to be toxic to sensitive marine organisms. Oil hydrocarbons are defined as those that are n-hexane soluble.

Reference


Discussion

The ODCA covers a range of contaminants in sediments. Of the ongoing programs, only the Benthic Surveillance and Mussel Watch components of the NS&T program analyze for chemical contaminants in sediments.
Specific information on dredge spoil monitoring in the U.S. was not located for this inventory, and this is included with the discussion of compliance monitoring programs in the NCPDI. One dredge spoil monitoring program in Penobscot Bay, Maine, is discussed on p__.
Title: Benthic Surveillance Project of the
The National Status and Trends Program for Marine
Environmental Quality (NS&T Benthic)

Sponsor: U.S. National Oceanic and Atmospheric Administration

Goals

"The National Status and Trends Program was initiated in 1984 to establish and maintain the information base required to quantify the current status and long term, temporal and spatial trends in concentrations of key contaminants and in biological indicators of contaminant effects on living resources in the Nation's coastal and estuarine environments." (NOAA, 1988 [a/b]. p31) This information is obtained through sampling and analysis of tissues and sediments from sites representative of local marine systems.

The NS&T program consists of two components, the benthic surveillance project, and the mussel watch project. The mussel watch is described separately on p. ___.

Contaminants

Samples of sediment and tissue are analyzed for 16 and 14 metals, respectively; aromatic hydrocarbons (see Table _); chlorinated pesticides (see Table _); and PCBs. Sediments are also examined for coprostanol and Clostridium perfringens spores as indicators of sewage contamination. Parameters examined by the benthic surveillance program are listed below by the matrix from which they are sampled, and the analytical method used (Table _).

Histopathological examinations are made of liver, kidney and gill sections of target fish species to determine potential biological effects of pollutants.

Sampling Dates and Frequency

The benthic surveillance program was instituted in 1984, and is ongoing. Sampling is done annually.

Sampling Stations

Benthic sediments and biota are sampled at approximately 50 sites nationally. Seven are within the Gulf of Maine. These are located at Machias Bay, Frenchman Bay, Penobscot Bay, Casco Bay, Merrimack River Mouth, Salem Harbor, and Boston Harbor.
### Organic compounds (aromatic hydrocarbons) analyzed in the National Status and Trends Program.

<table>
<thead>
<tr>
<th>Aromatic Hydrocarbon</th>
<th>CAS Number</th>
<th>Alternate Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acenaphthene</td>
<td>83-32-9</td>
<td>1,2-dihydroacenaphthalene</td>
</tr>
<tr>
<td>Anthracene</td>
<td>120-12-7</td>
<td>Paranaphthalene</td>
</tr>
<tr>
<td>Benz[a]anthracene</td>
<td>56-55-3</td>
<td>1,2-benzanthracene</td>
</tr>
<tr>
<td>Benzo[a]pyrene</td>
<td>50-32-8</td>
<td>3,4-benzpyrene</td>
</tr>
<tr>
<td>Benzo[e]pyrene</td>
<td>192-97-2</td>
<td>1,2-benzpyrene</td>
</tr>
<tr>
<td>Biphenyl</td>
<td>92-52-4</td>
<td>Diphenyl; phenylbenzene</td>
</tr>
<tr>
<td>Chrysene</td>
<td>218-01-9</td>
<td>1,2-benzphenanthrene</td>
</tr>
<tr>
<td>Dibenzanthracene</td>
<td>53-70-3</td>
<td>Dibenzo[a,h]anthracene</td>
</tr>
<tr>
<td>2,6-Dimethylnaphthalene</td>
<td>581-42-0</td>
<td></td>
</tr>
<tr>
<td>Fluoranthenes</td>
<td>206-44-0</td>
<td>1,2-(1,8-naphthalene)benzene</td>
</tr>
<tr>
<td>Fluorene</td>
<td>86-73-7</td>
<td>o-biphenylanemethane</td>
</tr>
<tr>
<td>1-Methylnaphthalene</td>
<td>90-12-0</td>
<td></td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>91-57-6</td>
<td></td>
</tr>
<tr>
<td>1-Methylphenanthrene</td>
<td>832-69-9</td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td>91-20-3</td>
<td></td>
</tr>
<tr>
<td>Perylene</td>
<td>198-55-0</td>
<td>Dibenzo[de,kl]anthracene</td>
</tr>
<tr>
<td>Phenanthrene</td>
<td>85-01-8</td>
<td></td>
</tr>
<tr>
<td>Pyrene</td>
<td>129-00-0</td>
<td>Benzo[def]phenanthrene</td>
</tr>
</tbody>
</table>
Table 2. Organic compounds (pesticides) analyzed in the National Status and Trends Program.

<table>
<thead>
<tr>
<th>Chlorinated Pesticide</th>
<th>CAS Number</th>
<th>Alternate Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aldrin</td>
<td>309-00-2</td>
<td>1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-dimethanonaphthalene</td>
</tr>
<tr>
<td>alpha-Chlordane (cis-chlordane)</td>
<td>5103-71-9</td>
<td>1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1h indene</td>
</tr>
<tr>
<td>2,4'-DDD (o,p'-TDE)</td>
<td>53-19-0</td>
<td>1-(4-chlorophenyl)ethyl]-benzene</td>
</tr>
<tr>
<td>4,4'-DDD (p,p'-TDE)</td>
<td>72-54-8</td>
<td>1,1-dichloro-2,2-bis(p-chlorophenylethene)</td>
</tr>
<tr>
<td>2,4'-DDE</td>
<td>3424-82-6</td>
<td>1-chloro-2-[2,2,2-trichloro-1-(4-chlorophenyl)ethyl] benzene</td>
</tr>
<tr>
<td>4,4'-DDE</td>
<td>72-55-9</td>
<td>1,1'-(dichloroethenylidene)-bis(4-chlorobenzene)</td>
</tr>
<tr>
<td>2,4'-DDT</td>
<td>789-02-6</td>
<td>1-chloro-2-[2,2,2-trichloro-1-(4-chlorophenyl)ethyl] benzene</td>
</tr>
<tr>
<td>4,4'-DDT</td>
<td>50-29-3</td>
<td>1,1'-(2,2,2-trichloro-ethylidene)bis[4-chlorobenzene]</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>60-57-1</td>
<td>3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphthalene</td>
</tr>
<tr>
<td>Heptachlor</td>
<td>76-44-8</td>
<td>1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>1024-57-4</td>
<td>1,4,5,6,7,8,8-heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindane</td>
</tr>
<tr>
<td>Hexachlorobenzene</td>
<td>118-74-1</td>
<td>gamma-hexachlorocyclohexane</td>
</tr>
<tr>
<td>Lindane (gamma-BHC)</td>
<td>58-89-9</td>
<td>1,1a,2,2,3,3a,4,5,5a,5b,6-dodecachlorooctahydro-1,3,4-methano-1h-cyclobutan-[c,d]-pentane</td>
</tr>
<tr>
<td>Mirex</td>
<td>2385-85-5</td>
<td>(1,2,3,4,5,6,7,8,8-nonachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1h indene</td>
</tr>
<tr>
<td>trans- Nonachlor</td>
<td>39765-80-5</td>
<td>—</td>
</tr>
</tbody>
</table>

24
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Matrix</th>
<th>Units</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organic Compounds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticides, PCBs</td>
<td>Tissue</td>
<td>ng/g</td>
<td>GC/ECD</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>Sediment</td>
<td>ng/g</td>
<td>GC/ECD</td>
<td>c</td>
</tr>
<tr>
<td>PAHs</td>
<td>Stomach contents</td>
<td>ng/g</td>
<td>GC/FID</td>
<td>c</td>
</tr>
<tr>
<td></td>
<td>Sediment</td>
<td>ng/g</td>
<td>GC/FID</td>
<td>c</td>
</tr>
<tr>
<td>Coprostanol</td>
<td>Sediment</td>
<td>ng/g</td>
<td>GC/FID</td>
<td>c</td>
</tr>
<tr>
<td><strong>Major and Trace Elements</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ag, As, Cd, Cr, Ni, Pb, Sb, Se, Sn</td>
<td>Tissue</td>
<td>ug/g</td>
<td>Graphite AA</td>
<td>d</td>
</tr>
<tr>
<td>Fe, Mn, Cu, Zn, Hg</td>
<td>Tissue</td>
<td>ug/g</td>
<td>Flame AA</td>
<td>d</td>
</tr>
<tr>
<td>Si, Al, Fe</td>
<td>Sediment</td>
<td>%</td>
<td>Flame AA</td>
<td>e</td>
</tr>
<tr>
<td>Cr, Zn, Mn</td>
<td>Sediment</td>
<td>ug/g</td>
<td>Flame AA</td>
<td>e</td>
</tr>
<tr>
<td>Se</td>
<td>Sediment</td>
<td>ug/g</td>
<td>Hydride AA</td>
<td>e</td>
</tr>
<tr>
<td>Ag, As, Cd, Cu, Ni, Pb, Sb, Sn, Hg</td>
<td>Sediment</td>
<td>ug/g</td>
<td>Graphite AA</td>
<td>e</td>
</tr>
<tr>
<td>C. perfringens</td>
<td>Sediment</td>
<td>spores/g</td>
<td>Plate count</td>
<td>f</td>
</tr>
</tbody>
</table>

---

a All contaminant units are dry weight.
b Confirmation of values near detection limit is made with GC/MS.
Each site consists of three sediment sampling stations separated by up to 5 km. The sites are located close to shore in or near major bays and estuaries. Trawls for winter flounder are taken as close as possible to sediment stations.

Stations are located so as to give an indicator of area environmental health, rather than to locate hot spots. Sites are chosen so as to be "representative of areas rather than only the site itself." (NOAA 1988 [a/b] p13) Therefore, regions of localized pollution, near point sources of pollution or near known dump sites have been avoided.

Sampling Procedures

Sediments samples "are obtained with a specially constructed box core device or a standard Smith-MacIntyre bottom grab." (Shigenaka and Lauenstein, 1988. pi) Surface skims are taken from these samples for organic analysis, while cores are taken from the samples for metal analysis.

Trawls for benthic vertebrates are taken at stations as near as practical to the sediment stations. Winter Flounder (Pseudopleuronectes americanus) are the primary target species in the Gulf of Maine.

Liver tissue is sampled from thirty fish at each station for analysis of chlorinated organic compounds and trace elements. Liver, kidney, and gill samples from these fish are sectioned for histopathological examination. Stomach contents and bile are sampled from a smaller number of individuals at each station, and analyzed for chlorinated organic compounds, aromatic hydrocarbons, and their metabolic products. The stomach contents are further analyzed to identify prey species. Finally, the age of the fish sampled is determined.

Analysis

Organics are analyzed using the procedures of MacLeod, et al (1985), and metals using unpublished manuals (National Marine Fisheries Service a, and National Marine Fisheries Service b). Sediment organic carbon is determined with a CHN analyzer. An overview of the analytical procedures used for each determination is given in Table_.

The NS&T Program maintains a specimen bank. Unworked samples are held in storage for retrospective analysis.

Quality Assurance/Quality Control

QA/QC features incorporated into the NS&T Program involve interlaboratory comparisons, blind sampling, and the development
of standard reference materials.

Reference

The NS&T data base is maintained by the Strategic Assessments Branch of NOAA. Summary reports are available periodically. Recent summary reports include NOAA 1987 a, NOAA 1987 b, and NOAA 1988 [a/b].

Discussion

The NS&T program provides a diversity of analyses in multiple media from throughout the U.S. allowing for assessment of contaminant trends over space and time. It also provides information on biological effects.

The NS&T program is based on groundwork laid by the initial phase of the NEMP. The NEMP also undertook benchmark studies in Penobscot and Casco Bays. Boston Harbor has been the site of numerous studies (see MCZM, 1989). Casco Bay, Penobscot Bay, Macias Bay and some of the other sites surveyed have been the sites of local studies. (See Metals in Northern NE Estuaries - Machias Bay and Penobscot Bay; Dredge Spoils in Penobscot Bay; the "Northern Gulf" Spill - Casco Bay; and the Merrimack River Project.)

The Mussel Watch component of the NS&T program is discussed below.
Title: The Mussel Watch Project of the National Status and Trends Program for Marine Environmental Quality (NS&T Mussel Watch)

Sponsor: U.S. National Oceanic and Atmospheric Administration

Goals

"It is expected that information from the National Status and Trends Program will provide a basis for setting priorities for management action and for documenting changes that may occur because of such actions." (NOAA, 1987 b. p2)

The Mussel watch is one component of the NS&T program. Bivalve mollusks are ubiquitous, sedentary, coastal, filter feeding organisms, and are used in this study as indicators of regional environmental quality.

Discussion of the Benthic Surveillance component of NS&T is found on p.?

Contaminants

Mollusk tissues are analyzed for the presence of pesticides, PCBs, PAHs, and 17 metals. Sediment samples are analyzed for the same parameters as well as coprostanol, a sewage indicator, and total organic carbon. See Tables _ & _ in the discussion of the Benthic Surveillance component of the NS&T program.

Dates and Frequency of Sampling

The mussel watch was initiated in 1986 and is ongoing. Samples are collected on an annual basis.

Sampling Stations

Of the 145 mussel watch stations throughout the United States, 6 are within the GOM. 4 are in Boston Harbor, and 2 are in Penobscot Bay.

Sites are selected so as to be free from the influence of individual point sources of pollution. The GOM sites are predominantly in regions, however, where pollution has been demonstrated.

Sampling Procedures

Samples of sediment are collected at each site with a Kynar-
coated, Young-modified Van Veen grab sampler, or with a stainless steel box corer. Separate surface skims are taken for the analysis of organics and of metals. Samples are frozen for transport.

Mussels (Mytilus edulis) are collected at all sites in New England. Samples are scrubbed in the field, and transported frozen in the shell.

Analysis

Procedures for analysis of organic chemicals in tissues and sediment follow MacLeod et al., 1985, as revised. Metal analyses are performed after the procedures of Battelle, 1986. Organic carbon is determined with a CHN analyzer. The techniques used in the mussel watch program are shown in table (C).

Quality Assurance/Quality Control

One objective of the NS&T program is to develop standard protocols for the handling and analysis of data. Specific programs include, interlaboratory comparisons, and development of Standard Reference Materials for tissues and sediments sampled by the program.

Reference

The NS&T data base is maintained by the Strategic Assessments branch of NOAA. Summaries are published periodically. Recent examples pertinent to the mussel watch include, NOAA 1987 a., and NOAA, 1988 [a/b].

Protocols for field sampling and analytical procedures respectively are Shigenaka, and Lauenstein, 1988, and MacLeod, et al., 1985.

Discussion

The wide range of contaminants for which the NS&T program analyzes and the synoptic sampling of mollusks and sediments are major strengths of this study. The regional coverage is limited by the small number of sites (6) sampled within the area, and the concentration of these in Boston Harbor and Penobscot Bay.

In the late 1970s a mussel watch program was instituted in the U.S.(see p?). This program operated for three years, and helped to establish the value of bivalves as indicators. The NS&T mussel watch component is modeled on this earlier program. The earlier U.S. mussel watch program examined many of the same parameters in the same species, though at a wider range of sites within the Gulf of Maine.
Table C. Analytical parameters for the Mussel Watch Project.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Matrix</th>
<th>Units</th>
<th>Method</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organic Compounds</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticides, PCBs</td>
<td>Sediment</td>
<td>ng/g</td>
<td>GC/ECD</td>
<td>b</td>
</tr>
<tr>
<td></td>
<td>Tissue</td>
<td>ng/g</td>
<td>GC/ECD</td>
<td>b</td>
</tr>
<tr>
<td>PAHs</td>
<td>Sediment</td>
<td>ng/g</td>
<td>GC/FID-MS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tissue</td>
<td>ng/g</td>
<td>GC/FID-MS</td>
<td></td>
</tr>
<tr>
<td>Coprostanol</td>
<td>Sediment</td>
<td>ng/g</td>
<td>GC/FID</td>
<td>b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Major and Trace Elements</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag,Cd,Cr,Ni,Pb,Tl</td>
<td>Sediment</td>
<td>μg/g</td>
<td>Graphite AA</td>
<td>c</td>
</tr>
<tr>
<td>Ag,Cd,Tl</td>
<td>Tissue</td>
<td>μg/g</td>
<td>Graphite AA</td>
<td>c</td>
</tr>
<tr>
<td>Cr,Ni,Pb</td>
<td>Tissue</td>
<td>μg/g</td>
<td>X-Ray Fluorescence</td>
<td>c</td>
</tr>
<tr>
<td>Mn,Cu,Zn</td>
<td>Sediment</td>
<td>μg/g</td>
<td>X-Ray Fluorescence</td>
<td>c</td>
</tr>
<tr>
<td>Mn,Cu,Zn</td>
<td>Tissue</td>
<td>μg/g</td>
<td>X-Ray Fluorescence</td>
<td>c</td>
</tr>
<tr>
<td>Hg</td>
<td>Sediment</td>
<td>μg/g</td>
<td>Cold vapor AA</td>
<td>c</td>
</tr>
<tr>
<td>Hg</td>
<td>Tissue</td>
<td>μg/g</td>
<td>Cold vapor AA</td>
<td>c</td>
</tr>
<tr>
<td>Si,Al,Fe</td>
<td>Sediment</td>
<td>%</td>
<td>Graphite AA/Flame AA</td>
<td>X-R Fluorescence</td>
</tr>
<tr>
<td>Si,Al,Fe</td>
<td>Tissue</td>
<td>μg/g</td>
<td>X-Ray Fluorescence</td>
<td>c</td>
</tr>
<tr>
<td>As,Sb,Se,Sn</td>
<td>Sediment</td>
<td>μg/g</td>
<td>X-R Fluorescence</td>
<td>c</td>
</tr>
<tr>
<td>As,Sb,Se,Sn</td>
<td>Tissue</td>
<td>μg/g</td>
<td>Neutron Activation</td>
<td>c</td>
</tr>
</tbody>
</table>

a All contaminant units are dry weight.
Many bivalve mollusks are common, ubiquitous and sedentary as adults. As filter feeders they can concentrate contaminants rapidly. For these reasons they are used widely as indicators of local contamination. Other programs determining contaminant levels in mollusks are listed in Table below.

The benthic surveillance component of NS&T follows the same procedures, and analyzes for most of the same contaminants. It is discussed above on p.?
<table>
<thead>
<tr>
<th>Species</th>
<th>Contaminant</th>
<th>Program</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Mussel Mytilus edulis</td>
<td>Metals</td>
<td>NS&amp;T Mussel Watch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Boston Harbor M P</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>US Mussel Watch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ME Estuaries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organics</td>
<td>NS&amp;T Mussel Watch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>NPMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>US Mussel Watch</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>OCs in Terns</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DDT in Shellfish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>PSP, Maine</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSP, Canada</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radio-nuclides</td>
<td>US Mussel Watch</td>
<td></td>
</tr>
<tr>
<td>SoftShell Clam Mya arenaria</td>
<td>Metals</td>
<td>ME EsTuaries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organics</td>
<td>NPMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Northern Gulf Spill</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DDT in Shellfish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>PSP, Maine</td>
<td></td>
</tr>
<tr>
<td>Sea Scallop Placopecten magellanicus</td>
<td>Metals</td>
<td>NEMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maritime Scallops</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eastern US Scallops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Organics</td>
<td>Georges Bank Benchmark</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DDT in Shellfish</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Traditional</td>
<td>PSP, Maine</td>
<td></td>
</tr>
<tr>
<td>Ocean Quahog Arctica islandica</td>
<td>Metals</td>
<td>GBMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>GBMP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Georges Bank Benchmark</td>
<td></td>
</tr>
<tr>
<td>Horse Mussel Modiolus modiolus</td>
<td>Organics</td>
<td>NPMP</td>
<td></td>
</tr>
<tr>
<td>Clam Mya Balthica</td>
<td>Metals</td>
<td>ME Estuaries</td>
<td></td>
</tr>
<tr>
<td>Periwinkle Littorina litorina</td>
<td>Metals</td>
<td>ME Estuaries</td>
<td></td>
</tr>
<tr>
<td>Gasropod Nucella lapillus</td>
<td>Metals</td>
<td>N E Snails</td>
<td></td>
</tr>
</tbody>
</table>
Title: Paralytic Shellfish Poisoning (PSP) Monitoring Program

Sponsor: Canada

Goals

To protect the public health from paralytic shellfish poisoning, caused by shellfish intoxicated by toxic dinoflagellate blooms.

Contaminants

Mollusc tissues are analyzed for the presence of Gonyaulax excavata.

Dates and Frequency of Sampling

The program has been ongoing since 1943. Intensity of monitoring effort increases during the peak of shellfish toxicity in the summer months.

Sampling Stations

[Prakash. Discussion not completed]

Sampling and Analytical Procedures

The mouse bioassay method has been used in nearly unaltered form since the inception of the program (AOAC, 1965).

Reference


Discussion

While PSP is a naturally occurring phenomenon, the work of White suggests that the pattern of occurrence is changing. If this change is related to anthropogenic influence, then PSP may be considered a biological effects indicator.

See also Paralytic Shellfish Poisoning Monitoring Program, Maine.
Title: Paralytic Shellfish Poisoning (PSP) Monitoring Program
Sponsor: Maine Department of Marine Resources

Goals

To protect the public health from paralytic shellfish poisoning caused by shellfish intoxicated by toxic dinoflagellate blooms.

Contaminants

Mollusc tissues are analyzed for the presence of Gonyaulax excavata. Mussels (*Mytilus edulis*), are the primary species analyzed, but clams (*Mya arenaria*) and other species are examined occasionally. Sediments are examined for the presence of resting spores of Gonyaulax.

Dates and Frequency of Sampling

The program was initiated in 1958. Sampling is carried out weekly from April until October. Sampling intensifies in areas where toxicity has been observed.

Sampling Stations

Twenty nine primary sampling stations are located along the Maine coast. These stations are determined based on historical experience as being reliable early indicators of intoxication. Once toxicity is observed, other sites are occupied in order to isolate the extent of the contamination.

Sampling and Analytical Procedures

Standard mouse bioassay procedures are followed (AOAC, 1965).

Reference

Hurst and Yentsch, 1981, and Shumway, et al. ????.

Discussion

While PSP is a naturally occurring phenomenon, the work of White suggests that the pattern of occurrence is changing. If this change is related to anthropogenic influence, then PSP may be considered a biological effects indicator.

See also Paralytic Shellfish Poisoning Monitoring Program, Canada.
Goals

To observe changes in the hydrographic and sedimentary conditions associated with changing use patterns in a body of inland marine water.

Contaminants

Water samples are analyzed for dissolved oxygen, salinity, absorbance, and ATP. Sediments are analyzed for redox potential. Phytoplankton samples were analyzed for species composition and abundance.

Dates and Frequency of Sampling

Sampling began in 1971 to investigate the impacts of a newly opened paper mill. This sampling continued through 1975. Sampling began again in 1985 with the increase in salmon aquaculture in the area. It has continued annually since.

Sampling Stations

The specific stations vary, but the core program consists of 30 sediment and water sampling stations.

Sampling and Analytical Procedures

Dissolved oxygen is determined by a modification of the Winkler method. Salinity is determined conductimetrically. ATP is prepared by filtration, boiling Tris buffer extraction, then analyzed by light integration (Wildish, et al. 1977).

Reference


Discussion
Goals

To assess current status, and future trends in the water quality of Boston Harbor, particularly in regards to the discharge of municipal waste as a contaminant source. The program consists of three parts: a near shore component, primarily concerned with traditional water quality parameters, run by the MAS, and Safe Water In Massachusetts (SWIM), a citizens group from Nahant; a harbor-wide survey for a wider range of variables run by the NEA; and a survey of benthic fauna on rocky substrate run by NEU. These separate but overlapping programs are considered together here.

Contaminants

Water, sediment, and tissue samples are taken and analyzed for a wide array of contaminants and effects indicators. See Table___. The primary emphasis is on traditional pollutants, though other parameters are also investigated.

Dates and Frequency of Sampling

MAS began a pilot project in Boston Harbor in 1986. This program was combined with efforts of the other two institutions in 1987 to form the current Boston Harbor Monitoring Program. Some aspects of the program are still under development. The program is intended to continue for at least ten years.

MAS and SWIM sample weekly for most variables. Benthic population samples are taken quarterly. Most samples taken by the NEA are taken monthly. NEU takes samples every two months.

Sampling Stations

The program has expanded considerably in its first years of operation. MAS collects samples at 25 intertidal or near shore subtidal sites to the south and through the central harbor areas. SWIM continues this sampling north through Broad Sound. NEA collects samples at ten sites throughout the harbor, many of these corresponding to sites used in previous NEA studies. NEU samples at six sites in the rocky subtidal zone at the north side of the harbor.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>MAS</th>
<th>SWIM</th>
<th>NEA</th>
<th>NEU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>Weekly</td>
<td>Weekly</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Ammonium</td>
<td>(P)</td>
<td>(P)</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Nitrates</td>
<td>(P)</td>
<td>(P)</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Nitrites</td>
<td>(P)</td>
<td>(P)</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Phosphate</td>
<td>(P)</td>
<td>(P)</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Fecal Coliform Bacteria</td>
<td>Bi-weekly (P)</td>
<td>Bi-weekly (P)</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Fecal Streptococci</td>
<td>Bi-weekly (P)</td>
<td>Bi-weekly (P)</td>
<td>Monthly</td>
<td></td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td></td>
<td></td>
<td>Annual</td>
</tr>
<tr>
<td>Histology</td>
<td></td>
<td></td>
<td></td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Pathology</td>
<td></td>
<td></td>
<td></td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Benthic Epifauna</td>
<td>Quarterly</td>
<td></td>
<td></td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Benthic Infauna</td>
<td></td>
<td></td>
<td></td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Plankton Populations</td>
<td></td>
<td></td>
<td>Semi-Annual</td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td></td>
<td></td>
<td>Monthly</td>
<td>Bi-monthly</td>
</tr>
<tr>
<td>Settling Rates &amp; Character</td>
<td></td>
<td></td>
<td></td>
<td>Bi-monthly</td>
</tr>
</tbody>
</table>

P - Proposed
Sampling and Analytical Procedures

MAS and SWIM collect water samples weekly and within 24 hours of rainfall measuring more than 1 inch. Water samples are taken at 2 m. intervals from the surface to the bottom, and analyzed on site for temperature and salinity with a YSI conductivity meter, and for dissolved oxygen with a YSI oxygen meter. Turbidity is analyzed with a secchi disk. Waterfowl population censuses have been added in order to include information on biological effects. Analysis for fecal coliform bacteria is proposed for addition to this program in the near future. Also, as opportunity permits, the program may begin sampling at sites further offshore.

MAS staff also collect sediment samples from subtidal sites with a Van Veen box corer, and intertidally with a hand corer. Sediments are sieved, and benthic macrofauna are identified and preserved for analysis of community structure.

NEA staff collect surface and bottom water samples monthly at ten sites for analysis of temperature, salinity, pH, nutrients, chlorophyll, bacteria, and suspended solids. Membrane filter techniques are used for analysis of bacteria. Procedures for other parameters are not discussed. 8 replicate ten minute plankton tows are taken at three of the stations twice each year. Major larval groups are enumerated, and samples are preserved.

Specimens of mussels (Mytilus edulus) and winter flounder (Pseudopleuronectes americanus) are also collected by NEA for metal and pathology analysis respectively. Mussels are taken from three of the NEA sites, and also from the Deer Island National Mussel Watch site. Tissues are digested, and analyzed by DC plasma spectroscopy for Cu, Cr, Cd, Hg, Mn, Ni, Pb, and Zn. Thirty to fifty winter flounder are collected annually at Deer Island for analysis of gross internal and external pathology, and histological evaluation for hepatocacinomas. About 100 lobsters (Homarus ??) are also analyzed annually for evidence of external shell disease, and black gill disease. Photographic records of pathologies are archived.

NEU divers sample subtidal rocky substrate. Algal and faunal densities and community structure are determined through photographs at transects and reproducible quadrats. Airlift suction samples are collected for analysis of the benthic infaunal community. Bivalves are taken for contaminant analysis and hematocyte studies. Settling panels at each site collect sediment and organisms which settle at the site for analysis of rates and constituents of suspended materials.

A benchmark study of contaminants in winter flounder tissues is proposed for May of 1989. Members of all cooperating groups,
and volunteer anglers from throughout the region are to collect 300-500 flounder from the harbor on a single day. These are to be the subject of extensive chemical analysis.

QA/QC

Temperature, salinity, and dissolved oxygen meters are calibrated no less than once each month. Analytical procedures are checked against samples of NBS standard tissue, and mussels from a clean water control site.

Reference

This program has not published results to date. This summary is primarily drawn from a memo; Hruby, Boyl, and Sebens, 1987. A copy of this memo was obtained from the Boston office of the Mass Audubon Society.

Discussion

Mussels are used as an indicator organism in this program. A number of other programs, most notably the mussel watches (p_ and P_), also utilize this species. One of the sampling sites for this program corresponds to a national mussel watch site. See Table_ (p_) for all programs using mollusks as indicators.

The procedures used by MAS ans SWIM are the same as those used in the North Shore Harbors program (p_).

Many of the sites sampled by the NEA are also used in previous studies by this group. This may provide background data on the site.

The work of NEU is similar to that done by the NEMP at the Pigeon Hill site.

The effects of contaminants are considered in this program.
Goals

This study utilizes marine birds as indicators of marine environmental quality, and assesses their usefulness as indicators. The monitoring program focuses on three species which feed in different regions, on different foods, reflecting contaminant levels in different components of the marine environment. The three primary species are the double-crested cormorant (Phalacrocorax auritus), the leach’s storm petrel (Oceanodroma leucorhoa), and the common puffin’ (Fratercula arctica).

The double-crested cormorant is a coastal piscivore, and as such it is likely to be most sensitive to contaminants found in runoff and other coastal sources of pollution. The leach’s storm petrel is a pelagic plankton feeder, feeding exclusively offshore even when breeding. As such it will be more indicative of the offshore surface microlayer conditions, possibly reflecting aerial inputs. The common puffin is a pelagic piscivore. It is likely to reflect more generalized oceanic pollution levels.

Most of the work to date has focussed on the eggs of these birds. Eggs concentrate OC compounds, but do not concentrate most metals. Recently tissue samples from adult or juvenile birds have been taken for analysis of metal content.

Contaminants

The focus of the study is organochlorine residues, primarily those in eggs. The 13 OCs for which analyses are conducted are listed below. Some eggs are also analyzed for Hg. In 1970 a survey of Pb and Cd levels in the kidney and liver of Double-crested Cormorants included one colony from within the GOM.

Organochlorine residues analyzed

<table>
<thead>
<tr>
<th>DDT</th>
<th>DDD</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDE</td>
<td>Dieldrin</td>
</tr>
<tr>
<td>Heptachlor epoxide</td>
<td>Mirex</td>
</tr>
<tr>
<td>Oxychlordane</td>
<td>Chlordane</td>
</tr>
<tr>
<td>Nonachlor</td>
<td>HCB</td>
</tr>
<tr>
<td>BHC (HCH)</td>
<td>Endrin</td>
</tr>
<tr>
<td>PCB</td>
<td></td>
</tr>
</tbody>
</table>

In 1988 a more detailed consideration of metals was added to
the program. Herring gulls (Larus argentatus), as well as adult birds of the three primary species, were collected for metal analysis. Analyses were conducted for Cd (kidney and liver), Pb (liver and bone) and Hg (kidney, liver, and feather). A summary of contaminant types by species, tissue type, site and year is found in table (D).

Sampling Dates and Frequency

GOM sites were included in this program in 1972. Eggs from three primary sites are collected every four years. Other samples are collected on an irregular basis. See Table(D). The project is ongoing and has been recently expanded with the inclusion of metal analysis.

Sampling Stations

Since the beginning of this study, seabirds and their eggs have been collected from 47 sites across coastal Atlantic Canada. Five of these sites are within the GOM region. Three sites within the GOM are currently active sampling stations.

Puffins are collected at Machias Seal Island, on the ME, NB border. Leach's Storm Petrels are collected at Kent Island, NB, and Double-crested Cormorants are collected at Manawagonish Island, NB. In addition to these primary sites, Double-crested Cormorants have also been taken at Boot Island, NS, Common Eider have been taken at Low Duck Island, NB, and Herring gulls have been collected at the Kent Island colony.

Sampling Procedures

Species, tissue sampled, and protocol used vary between years and sites. Egg collection procedure is the most standardized. In most cases fresh eggs are collected early in the nesting season. Nests are randomly selected from near the center of the colony, and where possible eggs are taken from the first clutch. Eggs are refrigerated until the contents can be removed to acetone and hexane cleaned glass jars and frozen till analysis. Individual birds are taken by shooting or netting for samples of other tissues. Whole specimens are wrapped in solvent rinsed aluminum foil or polyethylene and frozen.

Analysis

Samples are homogenized prior to analysis. OC procedures follow Reynolds and Cooper (1975) and Norstrom et al (1980). PCB levels are determined using capillary gas chromatography (Aroclor 1260 or 1:1 Aroclors 1254 and 1260)(Reynolds, 1971; Norstrom et al, 1978; Won and Norstrom, 1980). Samples for Hg analysis are prepared by wet digestion and analyzed by flameless atomic absorption spectrophotometry (AAS) (Fimreite and Reynolds, 1973).
## Seabird Samples Collected by Species, Colony, Contaminant Type, and Year

<table>
<thead>
<tr>
<th>Species</th>
<th>Colony</th>
<th>OC residues, eggs</th>
<th>Hg, eggs</th>
<th>Pb, Cd, tissue</th>
<th>Hg, tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double-crested Cormorant</td>
<td>Manawagonish Island</td>
<td>72, 76, 79, 80, 84, 88</td>
<td>72, 76, 80</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Boot Island</td>
<td>72, 76</td>
<td>72, 76, 80</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Leach's Storm Petrel</td>
<td>Kent Island</td>
<td>72, 76, 80, 84, 88</td>
<td>72, 76, 80</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Common Puffin</td>
<td>Machias Seal Island</td>
<td>72, 76, 80, 84, 88</td>
<td>72, 76, 80</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Herring Gull</td>
<td>Kent Island</td>
<td>88</td>
<td>88</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>Common Eider</td>
<td>Low Duck Island</td>
<td>72</td>
<td>72</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

42
Tissues for Pb and Cd analysis are freeze dried, ashed, acid/peroxide digested then analyzed by AAS. Either flame or flameless methods are used depending on concentration. See Noble and Elliott (1986).

Portions of the samples which have not been analyzed are stored to provide an archive of specimens for retrospective analysis.

Quality Assurance/Quality Control

NBS Standard Reference Material for Bovine Liver is utilized to standardize procedures. A review of the methodologies used was conducted in 1978. It showed that the vacuum oven drying procedure led to reproducible losses of DDT, DDD, HCB, and Oxychlordane. The procedures have been changed, and corrections have been added to the data base for pre 1978 data.

Reference

Data is included in the Canadian Registry of Toxic Chemicals (CRTC) data base. A summary of the results through 1985 has been published: Noble, D.G. and J.E. Elliott. (1986). Additional information on the recent metals testing program was supplied by J.E. Elliott (pers comm)

Discussion

This monitoring program provides a data base for observing large scale trends in contaminants to the marine system. Its value for observing localized phenomena is less clear, as the species studied range widely during the non breeding season, and so may collect contaminants far from the Gulf of Maine. Direct extension of this program to other regions of the Gulf of Maine would be difficult, as neither Leach's storm petrels nor puffins nest through the southern reaches of the gulf. Selection of other more locally representative species would minimize continuity with the existing data sets.

Seabirds of various species have been sampled from sites across the Gulf of Maine, but few of these are of the species monitored in this program. These projects, their locations, and the species studied are listed in Table (E).
<table>
<thead>
<tr>
<th>Species</th>
<th>Location</th>
<th>Study</th>
<th>Page</th>
<th>Tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Duck</td>
<td>Fatpot Island</td>
<td>Zitco</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Common Eider</td>
<td>Low Duck Island</td>
<td>CWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Common Eider</td>
<td>Bangs Island</td>
<td>USFWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Common Puffin</td>
<td>Machias Seal Island</td>
<td>CWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Common Tern</td>
<td>Nisbet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Double-crested Cormorant</td>
<td>Mangawagonish Isl.</td>
<td>CWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Boot Island</td>
<td>CWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Muscungus Bay</td>
<td>USFWS</td>
<td></td>
<td>Eggs, Brain, Conad, Heart</td>
</tr>
<tr>
<td></td>
<td>Duck Island</td>
<td>USFWS</td>
<td></td>
<td>Eggs, Brain, Conad, Heart</td>
</tr>
<tr>
<td></td>
<td>Hospital Island</td>
<td>Zitco</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Fatpot Island</td>
<td>Zitco</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Greater Black-backed Gull</td>
<td>Appledore Island</td>
<td>USFWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Greater Shearwater</td>
<td>SE Bay of Fundy</td>
<td>Gaskin</td>
<td></td>
<td>Fat, Liver, Muscle</td>
</tr>
<tr>
<td>Herring Gull</td>
<td>Ken Island</td>
<td>CWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Appledore Island</td>
<td>USFWS</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Hospital Island</td>
<td>Zitco</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td></td>
<td>Fatpot Island</td>
<td>Zitco</td>
<td></td>
<td>Eggs</td>
</tr>
<tr>
<td>Least Tern</td>
<td>Nisbet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sooty Shearwater</td>
<td>SE Bay of Fundy</td>
<td>Gaskin</td>
<td></td>
<td>Fat, Liver, Muscle</td>
</tr>
</tbody>
</table>
Title: Shellfish in Great Bay
Sponsor: U.S. Fish and Wildlife Service
N.H. Division of Public Health
N.H. Department of Fish and Game

Goals

To assess potential impacts of contaminants on shellfish and the potential risks to human consumers of shellfish.

Contaminants

Levels of metals and organic compounds were analyzed in shellfish tissues in 1988. The continuation of this program, and the addition of water and sediment sampling are proposed.

Dates and Frequency of Sampling

The pilot program was initiated in 1988. Annual sampling is proposed.

Sampling Stations

Mollusks are collected at 18 sites in Great Bay. Lobsters are collected at one station.

Sampling and Analytical Procedures

Soft shell clams, blue mussels, and lobsters are collected. Analytical procedures are unknown.

Reference

Discussion
Title: Hydrocarbon Accumulation in Marine Mammals

Sponsor: U.S. Minerals Management Service

Goals

This is one component of research on the effects of oil on marine mammals which has been instituted in support of offshore oil leasing in the US OCS. The purpose of this component is to determine background levels of hydrocarbons in marine mammal tissues, and to determine the extent of bioaccumulation of hydrocarbons by these animals.

Contaminants

Naphthalene concentration is determined from samples of tissue from various species of marine mammal. Naphthalene is used because of its persistence in the tissues of fish, the primary food of marine mammals, and because it is easily analyzed.

Dates and Frequency of Sampling

This work was instituted in 1979 and is ongoing. Samples are collected as opportunity allows.

Sampling Stations

Samples are collected by members of multi-institutional marine mammal stranding networks. They are collected opportunistically from animals which have become stranded along the coasts of the western North Atlantic, and Canadian Arctic Oceans.

Sampling and Analytical Procedures

Ultra violet spectrophotometric techniques are used to determine naphthalene concentrations in all tissues.

Quality Assurance/Quality Control

Variations between samples are consistent with the habitat and trophic level of the individual from which the sample is taken, but absolute levels seem unduly high. Attempts have been made to perfect the analytical technique so as to understand and minimize this problem.

Reference
A brief synopsis is available in Fritz (1985). Project progress reports are available. Geraci and St. Aubain (1982), and Geraci and St. Aubain (1985).

Discussion

The high absolute readings for contaminant levels has been recognized as a problem, and may be resolved. Multiple organizations are involved in the field sampling, making standardization of field methods difficult. Also, stranded specimens may not be either fresh or representative of the general population. Marine mammals of many species are highly migratory, and may accumulate contaminants far from the Gulf.

This study supplies one of the only available points of reference on contaminants in free ranging marine mammals. It capitalizes on the opportunities presented by strandings to study these marine predators.

Little work has been done using marine mammals. The only other marine mammal project in the Gulf is the work of Gaskin, which does not analyze for hydrocarbons.
Title Water Resources Data
Sponsor United States Geologic Survey

Goals

The United States Geologic Survey (USGS) instituted this study to develop a data base on the quality and availability of the freshwater resources of the United States. Stations are intended to represent overall water quality in the rivers of the US, not specifically to monitor any one activity or site. As river inputs are a major source of contaminants to the marine environment, and the last downstream sites at which records are taken are located near the head of the tide, these sites may provide information on the riverine inputs to the Gulf of Maine system.

Contaminants

Water samples are analyzed for physical parameters, nutrients, bacteria, metals, and radiochemicals. In the past, data on pesticides and hydrocarbons has been collected, but no such analysis is currently underway. Parameters currently being measured are listed in Table __ below.

Dates and Frequency of Sampling

Sites along some rivers have been sampled since the 1950s. Regular sampling has been in place in many locations since the early 1970s. Continuous monitoring devices provide a constant source of physical data for some points. Most other parameters are measured about four times each year.

Sampling Stations

A variety of physical and chemical parameters are measured in river waters at sites along major drainage basins. Different parameters are measured in different years at different sites. Those sites farthest downstream are generally located just above the head of tidal influence, and may be pertinent to the development of a marine monitoring program by providing information on river inputs.

Sampling and Analytical Procedures

Continuous digital readout instruments are used for
Table: Parameters analyzed by the USGS water database

<table>
<thead>
<tr>
<th>Category</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Parameters</td>
<td>Specific conductance, Ph, Air Temperature, Water Temperature, Turbidity,</td>
</tr>
<tr>
<td></td>
<td>Barometric Pressure, Dissolved Oxygen, Suspended Solids</td>
</tr>
<tr>
<td>Bacterial Parameters</td>
<td>Fecal Coliform, Strep Fecal</td>
</tr>
<tr>
<td>Nutrients</td>
<td>N (and NH4), P, Organic Carbon</td>
</tr>
<tr>
<td></td>
<td>Ca, Mg, Na, K, Cl, F, SO4, CaCO3, SiO2</td>
</tr>
<tr>
<td>Metals</td>
<td>Al, As, Ba, Be, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Hg, Mo, Ni, Se, Ag, Sr, V, Zn</td>
</tr>
<tr>
<td>Radiochemicals</td>
<td>Dissolved Radium, Dissolved Uranium, Gross Alpha Activity U-na,</td>
</tr>
<tr>
<td></td>
<td>Gross Beta Activity, Cs-137, Gross Beta Activity Y-90</td>
</tr>
</tbody>
</table>
measurements of flow, water levels, temperature, salinity and occasionally other variables at some sites. The type of machinery varies from site to site. Water quality samples are taken either from the centroid of flow or from a range of vertical samples to represent an average of water quality for the site.

Procedures for all types of sample collection, treatment, on site analysis, shipping and laboratory procedures are described in USGS Techniques for Water Resources Investigations publications.

Reference

Data are recorded in the National Water Data Storage and Retrieval System (WATSTORE) operated by USGS. Information on this system is available from

Chief Hydrologist
USGS
437 National Center
Reston VA

Annual reports are produced by individual states, and available through the National Technical Information Service, or through local USGS offices. See Bartlett, et al., 1988.

Discussion

This program does not attempt to monitor marine, or even estuarine systems. The data may be of use in determining inputs to the marine system, and for comparison with other sites located farther downstream.

This program is very similar to the NAQUADAT system in Canada. Coordinated data collection techniques have been developed for rivers which span the border.
Title National Water Quality Data Bank (NAQUADAT)

Sponsor

Goals

To observe trends in fresh water quality generally. It is not designed to identify local or regional conditions.

Contaminants

Water samples are analyzed for "a wide range of chemical, physical, and biological parameters." (Bird and Rapport, 1986) Included are nutrients, including nitrates, nitrites, and phosphorus. Occasional analysis for pesticides, PCBs and metals, including As, Cd, Hg, and Pb, are also conducted.

Dates and Frequency of Sampling

Sampling frequency varies. Monthly sample collection is most common. Data is available back to at least 1971. The program is ongoing.

Sampling Stations

All sampling stations are in fresh water, along rivers and streams of major drainage basins. The farthest downstream sites may give an indication of contaminant loading to the marine environment.

Sampling and Analytical Procedures

Unknown.

Reference

This discussion was derived from Bird and Rapport (1986).

Discussion

This program does not attempt to monitor marine, or even estuarine systems. The data may be of use in determining inputs to the marine system, and for comparison with other sites located farther downstream.

This program is very similar to the USGS Water Resources system in The United States. Coordinated data collection techniques have been developed for rivers which span the border.
The National Coastal Pollutant Discharge Inventory (NCPDI)

Sponsor U.S. National Oceanic and Atmospheric Administration

Goals

To produce a data base on the rates, distribution, and types of contamination in the coastal waters of the U.S. This database provides access to information on compliance monitoring programs.

Contaminants

Discharge quantities of 17 pollutants to the marine system are estimated. These include: biological oxygen demand; suspended solids; nitrogen; phosphorus; seven metals, As, Cd, Cr, Cu, Fe, Hg, Pb; petroleum hydrocarbons; PCBs; other chlorinated hydrocarbons; and fecal coliform bacteria. In addition the total volume of sludges and waste water are determined.

Dates and Frequency of Sampling

Figures are based on data collected at a variety of intervals. The data system dates to the mid 1980s, though it incorporates some pre-existing programs.

Sampling Stations

The inventory draws on many sources from many sites. Any industry required to submit National Pollutant Discharge Elimination System (NPDES), Discharge Monitoring Reports to the U.S. Environmental Protection Agency is included in this system.

Sampling and Analytical Procedures

Vary. EPA sets standards for those substances monitored under the NPDES.

Reference


The NCPDI data base is maintained by the Strategic Assessments Branch of NOAA. Data on the NPDES system is also available through the U.S. EPAs Storage and Retrieval of Water Quality Information (STORET) data base.
Discussion

This program is included here, though it is not properly a monitoring program, as it provides an access point for the enormous fund of information collected through compliance monitoring programs.

Compare with RIPS.
Title Regional Inventory of Pollution Sources (RIPS)
Sponsor A&WB of Environment Canada

Goals

To provide the data for calculation of contaminant loading to the marine system.

Contaminants

Those regulated by discharge permits.

Dates and Frequency of Sampling

Varies depending on permit requirements.

Sampling Stations

Any discharge which requires a permit.

Sampling and Analytical Procedures

Unknown

Reference

Reports of the inventory are not published regularly. Some industry sectors produce reports occasionally. This description is based on Barchard (1988).

Discussion

This is an inventory of industries, not primarily a data base of compliance monitoring information. Some data is available on discharges.

Compare with The National Coastal Pollutant Discharge Inventory, p__.
Goals

MARPMA surveys analyze parameters used for assessment and prediction of fish stocks. They are not primarily water quality surveys, but do provide some information on water quality. Opportunistic collection of tar and other marine debris during surface water sampling for fish larvae is a peripheral benefit of this survey.

Contaminants

Samples of hydrocarbon residue collected from surface water are collected, but not analyzed. Water samples are analyzed for dissolved oxygen, and primary productivity is determined.

Dates and Frequency of Sampling

The MARMAP program dates to 1972. During the NEMP, many MARMAP surveys were operated cooperatively with NEMP. The program is ongoing. Frequency varies, but two surveys each year is most common.

Sampling Stations

MARPMA cruises sample at multiple locations across the continental shelf as far north as Nova Scotia, and the entrance to the Bay of Fundy. About 90 stations are within the GOM study area. The extent of sampling varies from year to year.

Sampling and Analytical Procedures

Plankton samples are collected from seven depths, "C stock solution is added, and incubated for five hours in transmission tubes admitting light proportional to sampling depth. This radiocarbon-14 simulated in situ sunlight incubation technique is described in O'Reilly and Thomas (1983).

Water samples are taken at a range of depths from near bottom to near surface. Dissolved Oxygen is determined.

A standard neuston net is deployed to collect biological samples, primarily fish larvae. This gear also collects surface debris. This debris, including tar, is separated from the
biological samples and stored.

Reference

MARMAP data is maintained by the NMFS, Northeast Fisheries Center. Several sources of information are available pertinent to the different components of the program.


Hydrocarbons. The MARMAP program, and hydrocarbon information; Sherman, K., et al. (1973). Limited hydrocarbon analysis from non-GOM sites; Butler and Harris (1975). Samples are maintained by the National Marine Fisheries Service, Northeast Fisheries Center. Additional information concerning MARMAP hydrocarbon collection subsequent to 1972 has been provided by K. Sherman, NMFS (pers comm March 1989).

Discussion

While little has been done with the hydrocarbon information to date, it comprises a large fund of unprocessed samples of hydrocarbons from surface waters should the need, interest, and funding become available to analyze it.

See also the Surface Particulate Oil Pollution program, (p?) for other work dealing with pelagic tar samples.
Goals

To protect human health from bacterial contamination associated with shellfish.

Contaminants

Water is analyzed for the presence of coliform bacteria.

Dates and Frequency of Sampling

This program started in Canada in 1948. Procedures and timing have changed several times. Currently sampling occurs five times each year. The program is ongoing.

Sampling Stations

Survey sites are concentrated where problem areas are known or suspected.

Sampling and Analytical Procedures

Water samples are collected from within the tidal range as prescribed by the Interstate Shellfish Sanitation Conference. To the extent that it is practical to do so, samples are collected under conditions likely to maximize bacterial concentration. Analysis for coliforms (total and fecal) is performed. Analytical and quality assurance procedures followed are those approved by the Interstate Shellfish Sanitation Commission.

Reference


Discussion

All of the Gulf of Maine States, and the government of Canada follow the procedures developed by the Interstate Shellfish Sanitation Commission.
Goals

This program is designed to protect consumers of shellfish from health hazards associated with bacterial contamination.

Contaminants

Water samples are analyzed for coliform bacteria.

Dates and Frequency of Sampling

This survey was initiated in the 1940s. Significant changes occurred in the program in 1986, with the institution of new procedures.

Sampling frequency has changed throughout the life of the program. Samples are currently taken five times each year.

Sampling Stations

Samples are collected at about 1000 sites along the Maine coast. These are located at sites where shellfish harvesting is likely to occur. When resources do not allow all sites to be sampled, emphasis is placed on those sites likely to be clean enough for shellfishing.

Sampling and Analytical Procedures

Water samples are collected from within the tidal range as prescribed in the NSSP Manual of Operations (1986). To the extent that it is practical to do so, samples are collected under conditions likely to maximize bacterial concentration. Analytical techniques for coliforms (total and fecal) and quality assurance procedures followed are those of the American Public Health Association (1984).

Reference

American Public Health Association (1984), and National Shellfish Sanitation Program (1986). Data from a number of recent years has been computerized, and is accessible through the Department of Marine Resources.

Discussion

All of the Gulf of Maine States, and the government of
Canada follow the procedures developed by the Interstate Shellfish Sanitation Commission.
Goals

This program is designed to protect consumers of shellfish from health hazards associated with bacterial contamination.

Contaminants

Water samples are analyzed for coliform bacteria.

Dates and Frequency of Sampling

This survey was initiated in the 1940s. Significant changes occurred in the program in 1986, with the institution of new procedures.

Sampling frequency has changed throughout the life of the program. Samples are currently taken five times each year.

Sampling Stations

Samples are collected at sites where shellfish harvesting is likely to occur.

Sampling and Analytical Procedures

Water samples are collected from within the tidal range as prescribed in the NSSP Manual of Operations (1986). To the extent that it is practical to do so, samples are collected under conditions likely to maximize bacterial concentration. Analytical techniques for coliforms (total and fecal) and quality assurance procedures followed are those of the American Public Health Association (1984).

Reference

American Public Health Association (1984), and National Shellfish Sanitation Program (1986).

Discussion

All of the Gulf of Maine States, and the government of Canada follow the procedures developed by the Interstate Shellfish Sanitation Commission.
Goals

This program is designed to protect consumers of shellfish from health hazards associated with bacterial contamination.

Contaminants

Water samples are analyzed for coliform bacteria.

Dates and Frequency of Sampling

This survey was initiated in the 1940s. Significant changes occurred in the program in 1986, with the institution of new procedures.

Sampling frequency has changed throughout the life of the program. Samples are currently taken five times each year.

Sampling Stations

Samples are collected at sites where shellfish harvesting is likely to occur.

Sampling and Analytical Procedures

Water samples are collected from within the tidal range as prescribed in the NSSP Manual of Operations (1986). To the extent that it is practical to do so, samples are collected under conditions likely to maximize bacterial concentration. Analytical techniques for coliforms (total and fecal) and quality assurance procedures followed are those of the American Public Health Association (1984).

Reference

American Public Health Association (1984), and National Shellfish Sanitation Program (1986). Data from a number of recent years has been computerized, and is accessible through the Department of Marine Resources.

Discussion

All of the Gulf of Maine States, and the government of Canada follow the procedures developed by the Interstate Shellfish Sanitation Commission.
Title North Shore Monitoring Program
Sponsor Massachusetts Audubon Society

Goals

To use volunteer citizen effort to determine water quality trends and potential problem areas in five harbor areas in Massachusetts.

Contaminants

Water temperature, salinity, dissolved oxygen, and turbidity are determined. In addition, a census of waterfowl has recently been added to determine biological effects. Plans are underway to collect water samples for bacterial analysis and determination of chlorophyll.

Dates and Frequency of Sampling

A pilot project in Gloucester harbor was instituted in 1981. Salem, Beverly, and Marblehead harbors were added in 1987 and Manchester harbor in 1988. Samples are taken weekly in summer at all sites, and year round at some sites. Other sites are limited to bi-weekly in winter. All are ongoing. The intention is to compile at least ten years worth of data on each site.

Sampling Stations

A variety of sites in each of the five harbors are included in this program. All of the harbors are located on the northern coast of Massachusetts. Stations are located near shore. Samples are taken primarily from docks or piers.

Sampling and Analytical Procedures

Volunteers collect water samples which are tested on site. Temperature and salinity are determined with a YSI salinity, conductivity, temperature meter, and dissolved oxygen is determined with a YSI oxygen meter. Turbidity is determined with a secci disk.

Counts of seabirds from sites at or near sampling stations has been included in the program since 1986 as an indicator of biological effects.

Quality Assurance/Quality Control

A full time coordinator of volunteers is employed to train personnel. Instruments are calibrated monthly, or more often if
needed.

Reference

Data is compiled by Mass Audubon, North Shore. A brief description of this project and Mass Audubon's component of the Boston Harbor monitoring program was compiled in 1988, and is available from the Audubon Society.

Discussion

In open regions of the harbors, dissolved oxygen may not adequately represent water quality.

This program and the MA Audubon portion of the Boston Harbor program are the only studies utilizing waterfowl populations as effects indicators.

The portion of the Boston Harbor cooperative monitoring program which is run by MA Audubon is nearly identical to this program. Other coastal regions with local surveys of traditional pollutants include Maquoit Bay Maine, and Great Bay NH. Other citizen monitoring programs are proposed for Mid-coast Maine, and as an extension of the Great Bay study.
NOTE: This section diverges from the pattern established in the rest of this document. Rather than discussing a single program, it summarizes the efforts of 13 communities to monitor water quality within their borders.

Title Local Water Quality Monitoring Initiatives, Cape Cod
Sponsor Town Governments on Cape Cod

Goals

In order to supplement the information available to them from through state, provincial, and federal support, many communities take on water quality monitoring programs of their own. These vary considerably across the Gulf, and the communities of Cape Cod Massachusetts are used here as an example of the types of programs which are underway, and the types of information which are available on this one area of the Gulf.

The Cape Cod area is chosen because a detailed survey has already been conducted of the water quality programs in that area, not because the region is typical of the Gulf as a whole. As water quality problems are highly visible in the Cape Cod area, the region is likely to have a rate of community involvement higher than might be anticipated in many other regions of the Gulf.

Shellfish closures are of primary concern on Cape Cod, and programs are oriented toward isolating areas where closures may be necessary, from areas which can remain open, and identifying contaminant sources which might be responsible for these closures.

Contaminants

The parameters analyzed in monitoring programs, and the water quality studies available from 13 communities with frontage on the Gulf of Maine are outlined in Table 1. Most of the factors analyzed are traditional pollutants, or indications of physical changes. The recording of biotic factors by some communities may represent a measure of biological effects.

Dates and Frequency of Sampling

The Programs in Table 1 were active in 1988, most are ongoing.
### Local Water Quality Monitoring Studies on Cape Cod

<table>
<thead>
<tr>
<th>Town</th>
<th>Parameters Analyzed In Local Monitoring Programs</th>
<th>Local Water Quality Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C DO N T S Con B Other</td>
<td>201 Gov Town Univ Eng Unsp Repts</td>
</tr>
<tr>
<td>Bourne</td>
<td>T,F</td>
<td>x x x x x y</td>
</tr>
<tr>
<td>Sandwich</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barnstable</td>
<td>T,F   x x x x x x Phys</td>
<td>x x y</td>
</tr>
<tr>
<td>Yarmouth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dennis</td>
<td>T,F</td>
<td>x x x Plank</td>
</tr>
<tr>
<td>Harwich</td>
<td>T,F</td>
<td>x x x x x y</td>
</tr>
<tr>
<td>Brewster</td>
<td>T,F</td>
<td>x x x x x Chl, Tr, Plank, Phys</td>
</tr>
<tr>
<td>Chatham</td>
<td>T,F</td>
<td>x x x x x x y</td>
</tr>
<tr>
<td>Orleans</td>
<td>T,F</td>
<td>x x x x x x y</td>
</tr>
<tr>
<td>Eastham</td>
<td>T,F</td>
<td>x x x x x x y</td>
</tr>
<tr>
<td>Wellfleet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truro</td>
<td>F</td>
<td>x x x x x x y</td>
</tr>
<tr>
<td>Provincetown</td>
<td>T,F</td>
<td></td>
</tr>
</tbody>
</table>

- C-coliform bacteria
- T-total F-fecal
- DO: dissolved oxygen
- N-nitrogen
- T-temperature
- S-salinity
- Con-conductivity
- B-biota
- Phys-physical changes
- Plank-plankton
- Chl-chlorophyll
- Tr-transmitance
- 201-201 facilities grant
- Gov-federal/state/county study
- Town-town employee study
- Univ-university study
- Eng-private engineering firm
- Unsp-unspecified
- Repts-reports available
Sampling Stations

These vary from community to community.

Sampling and Analytical Procedures

These vary from community to community. Techniques for determination of coliform bacteria counts will generally follow the ISSC guidelines, as these are used by government agencies in their decision making.

Reference

Cape Cod Marine Water Quality Task Force (1988)

The studies listed in Table ? include reports to the towns. Where indicated these are available through the individual towns.

Discussion

Reports to communities contain a great wealth of information, especially on the location and potential sources of traditional pollutants. This information is oriented exclusively to the local perspective, and to local needs. This information could be of use in developing a Gulf-wide understanding if it can be integrated into the regional perspective, and made readily available to decision makers on the regional level.
Goals

To examine the connections between coastal land use and water quality in Maquoit Bay, Maine, with an emphasis on nutrients, and on input sources.

Contaminants

Water samples are analyzed for temperature, salinity and dissolved oxygen, nutrients, bacteria, chlorophyll a, and suspended organic material. Land use patterns are determined.

Dates and Frequency of Sampling

Water samples are collected weekly. The project was initiated in 1989 and is ongoing.

Sampling Stations

Samples are collected along transects of the Bay. Samples for bacterial and nutrient analysis are also taken from fresh water discharges into the Bay.

A similar and expanded program for Merrymeeting Bay is proposed for 1990.

Sampling and Analytical Procedures

This program is still under development, and procedures may vary from those described here. Temperature, dissolve oxygen, and salinity are analyzed with YSI meters. Fecal coliform bacteria are determined by membrane filter techniques, and nutrient analyses by standard techniques. Chlorophyll is determined fluorometrically.

Quality Assurance/Quality Control

Multiple determinations are performed on many of the samples.

Reference

This program is under development, and no synopsis is available. This discussion is based largely on a grant proposal, and on personal communication with Edward Laine, Bowdoin College, Brunswick, Maine.
Title: Acadia National Park Marine Monitoring Program
Sponsor: National Park Service

Goals

To establish a fund of archived samples for retrospective analysis in the event of future changes in sea level or an environmental incident.

Contaminants

All samples are archived. Identification of benthic species, and determination of wet weight biomass are the only analyses performed.

Dates and Frequency of Sampling

The program began in 1987. Samples are taken on an irregular schedule and will be taken a total of six times over a three year period. The Program is scheduled to end in 1989.

Sampling Stations

Four sites on Mound Desert Island, Maine are sampled. Two are high energy intertidal, and two are low energy intertidal flats.

Sampling and Analytical Procedures

The high energy sites are photographed from repeatable locations, and the distribution of faunal communities at the high tide mark are determined.

Sediment cores and macrofauna are taken at both the high and low tide extremes at the low energy sites. The sediment cores are archived, and the macrofauna is described, measured, weighed (wet) and preserved.

Reference

Leon Cammen, Bigelow Laboratory, Boothbay Harbor, Maine.

Discussion

A number of other programs keep specimen archives.
Chapter 2
Historic Programs

This section describes those programs which are no longer operating in the Gulf of Maine area.
Title  The Northeast Monitoring Program (NEMP)
Sponsor  U.S. National Oceanic and Atmospheric Administration

Goals

Recognizing the need for comprehensive monitoring of the marine environment in the northeast U.S., NOAA created the NEMP to synthesize existing monitoring effort within the agency, and to focus on regional needs. The emphasis of NEMP was protection of human health and safety, maintenance of ecosystem health, and development and evaluation of prototype monitoring tools and programs. NEMP programs extended over a broad geographic area, and included a wide range of projects in the early years, later concentrating on inshore regions and pollution trouble spots.

NEMP was a multifaceted program made up of a wide array of components. Projects included within the program, though disparate in some respects, will be considered together here.

Contaminants

Many variables were analyzed by NEMP programs. Water, sediment and tissue contamination were considered, as were biological effects indicators. Specific variables and the media from which they were analyzed are listed in Table ?. Not all variables were reported from each site. Analyses varied from one site, project or year to another.

Dates and Frequency of Sampling

The NEMP was established in 1979, incorporating several other programs which predated it. Major reductions in the program occurred in 1984. Formal operations ended in 1987, following a period of increasingly restricted budgets. Specific components changed dramatically during the life of the program.

Sampling Stations

NEMP surveyed 28 benthic stations on Georges Bank and the Gulf of Maine at least once each year between 1980 and 1984. Many of these same stations had been sampled previously as part of the Ocean Pulse project which was incorporated into NEMP. From 1984 to 1987, a smaller number of these stations were sampled in alternate years.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Water</th>
<th>Sediment</th>
<th>Tissue</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved Oxygen</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plankton</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary Productivity</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turbidity</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bacteria / Viral Indicators</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrients, Nitrogen</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ag</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cd</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cr</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Ni</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pb</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Zn</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>PAHs</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>PCBs</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>PHCs</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDT</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Grain Size</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Behavioral Modification</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Biochemical Abnormalities</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Community Structure</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Disease Incidence</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Genetic Abnormalities</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Physiological Abnormalities</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Species Abundance</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
NEMP benchmark studies were conducted in Casco, Penobscot, and Massachusetts/Cape Cod Bays, as well as in the deep Gulf of Maine. In these locations, a more detailed array of sites was established. The study of Penobscot Bay entailed 50 grab stations; Casco Bay, 56 grab stations; Mass Bay/Cape Cod Bay, 20 grab stations; Deep GOM, 31 grab stations.

Stations were established at Pigeon Hill, and Isles of Shoals for SCUBA surveys of benthic communities, and annual submersible surveys were conducted of the canyon areas of southern Georges Bank.

Sampling Procedures

NEMP components varied somewhat in the procedures followed. Offshore benthic sampling cruises involved grab sampling for sediments and benthic macrofauna, benchmark surveys generally involved intensive grab sampling in one year followed by sampling at a more limited number of sites in subsequent years. Sampling for other benthic species was done on an irregular basis using various types of commercial fishing gear.

Water

Analysis of most water quality parameters was limited in the northern sections of the NEMP study area. Dissolved oxygen and chlorophyll were determined. See MARMAP for a further discussion of this survey.

Sediment

Standard sediment stations consisted of 5 replicate grab samples taken with a Smith McIntyre grab sampler, though single grab stations were commonly taken for benchmark studies. Subsamples from the center of these grabs were taken for analysis of metals and organics, and frozen till analysis. Separate subsamples were taken for analysis of organic carbon, sediment grain size, and nitrogen content.

Tissue

Benthic infauna was collected from the sediment grabs. Standard procedures involved sorting of samples through a 0.5 mm sieve. Other benthic species were collected with commercial fishing gear. Muscle was the predominant tissue analyzed, though other soft tissues were used. Contaminant analyses were performed on specimens of American Dab, Haddock, Jonah Crab, Ocean Quahog, Sand lance, Sea Scallop, and Winter Flounder which were collected within the Gulf of Maine region (see table ?).
<table>
<thead>
<tr>
<th>Species</th>
<th>Tissue</th>
<th>Metals</th>
<th>PCB</th>
<th>PAH</th>
<th>PHC</th>
<th>DDT</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Dab (<em>Hippoglossoides plaesoides</em>)</td>
<td>Muscle</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haddock (<em>Melanogrammus aeglefinus</em>)</td>
<td>Muscle</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Jonah Crab (<em>Cancer irroraus</em>)</td>
<td>Soft tissue</td>
<td></td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean Quahog (<em>Arctica islandica</em>)</td>
<td>Whole</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sand Lance (<em>Ammodyes americanus or dubius</em>)</td>
<td>Whole</td>
<td></td>
<td>x</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea Scallop (<em>Placopecten magellanicus</em>)</td>
<td>Whole</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Muscle</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Viscera</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gonad</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gill</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter Flounder (<em>Pseudopleuronectes americanus</em>)</td>
<td>Muscle</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Effects

A primary goal of the NEMP was to determine the link between contaminants in the environment, and biological effects on individuals or populations. Measures of species abundance, behavioral change, and community structure were determined, and samples were collected for determination of biochemical, genetic, and physiological abnormalities, and indicators of disease.

Analysis

Sediment grain size was determined through standard sieve and pipette techniques, organic carbon was determined with a CHN analyzer. Metal and organic analysis were performed by the NMFS. Hydrocarbon analyses were performed according to the procedures of Grimmer and Bohnke (1979) using high pressure liquid chromatography and GC-MS. PCBs were determined according to the procedures of US EPA (1977). Metals were acid digested, and analyzed by air/acetylene flame atomic absorption spectrometry, according to procedures established by the US EPA (1976).

Benthic infauna was preserved, and identified to the lowest taxonomic level possible. Wet weight biomass was then determined.

Quality Assurance/ Quality Control

As the point of the program was to develop and test indicators of contamination in marine systems, QA/QC was very much in a feature of the program. Analyses were performed according to standard protocols, at centralized laboratory facilities, to increase comparability between sites. NBS standard reference materials were utilized in some cases for comparison.

Reference

A great many references exist on the NEMP. The best general source is Reid, et al (1987) which summarizes the most active years of the program. Other references include [.....the two annual reports...Pearce, on the entirety of the program, ...The Larsen reports on northern benchmarks...the Boehm reports on the southern benchmarks. GAS. ]

Discussion

The NEMP had a regional focus on the northeast, though this region covered far more area than the GOM. The variety of analysis on such a wide array of sites helped to establish baseline information for the region. The program initiated study on many biological effects indicators. The NEMP laid the groundwork from which the NS&T program was developed.
While having a regional focus, the NEMP work was predominantly in the New York Bight, Mid-Atlantic Bight regions, and not on the GOM. As the NEMP was an experimental program, and composed of many diverse parts, sampling and analysis were highly variable from year to year. The result is an uneven picture of the region. Analysis lagged behind collection of samples, so not all of the pertinent information has yet been obtained from the samples.
Title    Georges Bank Monitoring Program  
Sponsor Minerals Management Service  

Goals  
To monitor the environmental effects associated with oil and gas exploratory drilling in Georges Bank.  

Contaminants  
Concentrations of twelve metals, Al, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, V, and Zn, were determined in bottom sediments. Unspecified metals were also determined in benthic fauna. Aromatic hydrocarbons were also analyzed in sediments and benthic fauna. Benthic infaunal community structure was also analyzed.  

Dates and Frequency of Sampling  
Field sampling was initiated in 1982, and continued through 1986. It is not clear if any samples subsequent to 1983 have been analyzed.  

Sampling Stations  
Twenty one stations within the Gulf of Maine were sampled. Nineteen of these were on Georges Bank, while Two were in Deeper water just northeast of the Bank.  

Sampling and Analytical Procedures  
Hydrocarbon analysis was accomplished through UV/Flourescene methods, and confirmed by FID/G and GC/MS methods.  

Analytical procedures for metals were not available in the summary documents.  

Reference  
This work is summarized in MMS, 1987., MMS, 1986 a., and MMS, 1986 b. This discussion is based on these summaries. Final reports of the program include Bothner, et al., 1985., Payne et al., 1985., and Blake, et al., 1985.  

Discussion
This project examined metal concentrations in the sediments of estuaries impacted by different human activities.

Contaminants

Sediments were analyzed for 6 metals, Fe, Mn, Cu, Cr, Pb, & Zn, as well as total organic carbon and total phosphorus.

Sampling Dates and Frequency

All samples were collected during the spring of 1980.

Sampling Stations

Samples were collected from intertidal sites in six Gulf of Maine estuaries, Machias Bay, Maine, Penobscot River, Maine, Kennebec River, Maine, Saco River, Maine, and Seabrook, New Hampshire. The location of the stations within the estuary is not given.

Sampling and Analytical Procedures

A single box core was obtained from the intertidal region of each estuary. The core was divided into 2 cm sections, air dried, and weighed. Contaminant levels were determined separately for each 2 cm section to 13 cm depth. (At the Seabrook site measurements were made to 17 cm.)

Samples were acid leached, then analyzed. Cu, Pb, and Zn levels were determined using atomic absorption spectrophotometry, while Fe, and Mn levels were determined colorimetrically. The procedures used were those of Stookey (1979) and Armstrong, et al (1979). No analytical procedure for Cr is discussed.

Organic carbon was measured using the procedure of Gaudette, et al (1974), and phosphorus levels were determined using the technique of Aspila, et al (1976).

Reference

This data has not been published. Information is available through the University of New Hampshire Sea Grant office or
through Wm. Berry Lyons at the University of New Hampshire. A project completion report for the study is on file at the Seagrant office; Lyons, Armstrong, and Gaudette.

Discussion

This report provides baseline data on several estuarine systems. The contribution of this study to the development of any monitoring program is undermined by the lack of detailed information on sampling locations, especially as only one site from each estuary was sampled.

Machias Bay, and Penobscot Bay sediments are sampled by the NS&T program. Penobscot Bay sediments have also been surveyed by the NEMP.
Goals

To provide a broad characterization of key environmental aspects of the Georges Bank environment prior to exploratory drilling, and to identify unique and fragile areas of the Georges Bank system.

Contaminants

This wide ranging survey determined levels of hydrocarbons and trace metals in the sediments, water column, and biota. Table (?) lists sampling activities and contaminant types. Samples were analyzed for the aromatic and aliphatic hydrocarbons. Nine metals were determined: Ba, Cd, Cr, Cu, Fe, Ni, Pb, V, and Zn. Nutrients, productivity, dissolved oxygen, and other parameters were measured. Microbiological, and taxonomic studies were also accomplished.

Dates and Frequency of Sampling

Sampling was initiated with a shakedown cruise in 1976. Four cruises encompassing all seasons were completed during 1977.

Sampling Stations

Thirty seven of the stations were within the study area. All regions of Georges Bank and surrounding waters were represented. At ten of these stations water column and sediment samples were collected, at the remaining 27, only sediments were collected. Stations were concentrated in areas of potential oil leasing activity, or environmentally sensitive areas.

Sampling Procedures

Water samples were taken with a rosette sampler with an array of Go-Flo bottles. Samples were taken at 5m below the surface, and 5m above the bottom. Samples were analyzed for salinity, dissolved oxygen, micronutrients, suspended sediments, particulate metals, dissolved and particulate organic carbon, dissolved, particulate, and surface film hydrocarbons, chlorophyll a, ATP, bacterial counts, and other microbiologic analyses.
<table>
<thead>
<tr>
<th>SAMPLING ACTIVITY</th>
<th>STATION TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BOTTOM SEEDMENT</td>
</tr>
<tr>
<td>Water column</td>
<td></td>
</tr>
<tr>
<td>Rosette sampler</td>
<td></td>
</tr>
<tr>
<td>CTD/O</td>
<td>x</td>
</tr>
<tr>
<td>Transmissometry</td>
<td>x</td>
</tr>
<tr>
<td>Nephelometry</td>
<td>x</td>
</tr>
<tr>
<td>Salinity/dissolved oxygen</td>
<td>x</td>
</tr>
<tr>
<td>Micronutrients</td>
<td></td>
</tr>
<tr>
<td>Dissolved organic carbon</td>
<td>x</td>
</tr>
<tr>
<td>Particulate organic carbon</td>
<td>x</td>
</tr>
<tr>
<td>Particulate trace metals</td>
<td>x</td>
</tr>
<tr>
<td>Suspended sediments (USGS)</td>
<td>x</td>
</tr>
<tr>
<td>Bodman bottle: dissolved and particulate hydrocarbons</td>
<td>x</td>
</tr>
<tr>
<td>Brown-McGowan bongo system: zooplankton for trace metals, hydrocarbon, taxonomy</td>
<td>x</td>
</tr>
<tr>
<td>Sediment</td>
<td></td>
</tr>
<tr>
<td>Smith-McIntyre grab sampler: sediments for</td>
<td></td>
</tr>
<tr>
<td>Microbiology</td>
<td>x</td>
</tr>
<tr>
<td>Trace metals</td>
<td>x</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>x</td>
</tr>
<tr>
<td>Total organic carbon</td>
<td>x</td>
</tr>
<tr>
<td>Total organic nitrogen</td>
<td>x</td>
</tr>
<tr>
<td>Sediment analysis</td>
<td>x</td>
</tr>
<tr>
<td>Foraminifera</td>
<td>x</td>
</tr>
<tr>
<td>Infaunal taxonomy</td>
<td>x</td>
</tr>
<tr>
<td>Dredges/trawls</td>
<td></td>
</tr>
<tr>
<td>Epibenthic macrofauna for trace metals, hydrocarbons, histopathology, taxonomy</td>
<td>x</td>
</tr>
<tr>
<td>Macroinfauna for trace metals, hydrocarbons, histopathology, taxonomy</td>
<td>x</td>
</tr>
<tr>
<td>Benthos for trace metals, hydrocarbons, histopathology, taxonomy</td>
<td>x</td>
</tr>
<tr>
<td>Underwater photography</td>
<td>x</td>
</tr>
</tbody>
</table>
Plankton samples were taken concurrently with two bongo net systems, one for taxonomic and biomass analysis, and the other for chemical analysis.

Sediment samples were collected with a Smith-McIntyre grab sampler and analyzed for grain size, organic carbon, organic nitrogen, microbiological parameters, benthic macrofauna and microfauna, hydrocarbons, and metals.

A Blake trawl and an otter trawl were used for sampling of epibenthic macrofauna, and macrobenthi infauna. These were analyzed for histopathological abnormalities, metal and hydrocarbon concentration, and taxonomic characteristics.

Analytical Procedures

Hydrocarbons were separated into aromatic and aliphatic fractions by column chromatography, then analyzed by gas chromatography. Gas chromatography/mass spectrometry was also used.

Metal analysis utilized AAS procedures.

Organic Carbon and Nitrogen were determined with a CHN analyzer.

Full discussion of analytical procedures is included in ERCO, 1978.

QA/QC

Duplicate analyses were run on many samples. Detailed procedures for avoidance of contamination during sampling or analysis are included.

Reference


Discussion
Title: Heavy Metals in Maine Estuaries
Sponsor: Land and Water Resources Institute
University of Maine at Orono

Goals

To compare metal levels in relatively undeveloped estuarine systems, each impacted by a different type of anthropogenic input, including industrial effluent, agricultural runoff, untreated sewage, and mining effluent. Limited sampling at two other sites added to the spatial dimension of the study. This discussion combines two related studies, one on many facets of four estuaries, the other on more limited variables in two of the same estuaries and two different ones.

Contaminants

Samples of water, sediment and biota were analyzed for 10 metals, Ag, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, and Zn. Sediments were also analyzed for organic carbon. Only Cd was reported from the Damariscotta and Saco River sediments.

Dates

Samples were collected from Penobscot Bay, and the St Croix, Narraguagus, and Union rivers during 1975. Sediments from the last two sites, as well as the Damariscotta and Saco Rivers were analyzed separately. No dates were given for their collection.

Sampling Stations

Sampling stations were located in the St Croix, Narraguagus and Union River estuaries and the Goose Cove region of Penobscot Bay, as well as sediment only stations on the Damariscotta and Saco Rivers. Sites extended throughout the system from primarily fresh water, to open marine, and from both upstream, and downstream of major points of contaminant input.

Sampling Procedures

Water samples were collected from near surface and near bottom water at each site. 2 Five liter water samples were collected using a modified PVC Niskin bottle. A one liter subsample was vacuum filtered to separate suspended solids. Filters were stored in acid washed Petri dishes. Sediment cores were taken at each site by piston core or hand core. Cores were
transported and stored upright at bottom water temperature. Intertidal plants and animals were collected from shore sites adjacent to each station or transect. Samples of any available plant or animal type were taken, wrapped in plastic, and frozen till analysis.

Analysis

Sediment cores were frozen and split. Half of each core was archived. Portions from various depths were removed for further analysis. Sediments were dried, cooled and desiccated to determine organic carbon content. Particulates, sediments, and plant and animal tissues were dried, digested in nitric acid, heated and filtered. Metal content was determined by atomic absorption spectrophotometry for all metals except Hg for which cold vapor methods were used.

Procedures generally followed EPA protocols. Hg procedures followed Hatch and Ott (1968).

Quality Assurance/Quality Control

NBS SRMs and EPA standard sediments were routinely tested to assess reliability of the results. Duplicate analyses were run on some cores. Results of SRM analysis were compared with those from other laboratories using similar procedures.

Reference

Two completion reports for the major portion of this project are available. They present the procedures and summarize the results. Both are available through the Land Water Resources Institute, University of Maine. Fink et al (1976), and Fink et al (1980).

The Cadmium study in the Narraguagus, Union, Damariscotta, and Saco Rivers is reported separately. Mayer and Fink (1980).

Discussion

This study provides an historic reference point of considerable detail for these four estuaries.

Other studies involving metals in estuaries include.....
Goals

To utilize a sensitive detection technique to determine the distribution of methyl- and butyltin species through estuarine waters and sediments.

Contaminants

Both sediment and water samples were analyzed for four methyltin and three butyltin compounds.

Dates and Frequency of Sampling

Sampling dates were not specified. Results were published in 1986.

Sampling Stations

All samples were taken from the Great Bay estuary. The number of samples, the number of stations, and the location of those stations is unknown.

Sampling and Analytical Procedures

Water samples were collected in acid cleaned Pyrex bottles, and filtered immediately with acid cleaned filters. Samples were stored chilled, and darkened.

Sediment samples were collected with a Schipeck sampler, and the top 2 cm of sediment removed to polymethylpentene containers. Sediments were then freeze dried prior to analysis. Organic carbon was determined from the samples after the procedures of Gaudette, et al. (1974).

Analytical procedures involved atomic absorption spectometry using an electrodeless discharge lamp for tin. Details of the apparatus and procedures are available in Weber, et al. (1986).

QA/QC

Spiked sediment, sediment blanks, and reagents were analyzed using the same techniques.

Reference

Discussion

This study reveals the variations in concentration of the different species of tin present in this estuary. As the different species can have toxic effects which are orders of magnitude apart, this distinction is important in understanding the significance of this contaminant.

The lack of specific information on timing or specific location of sampling sites limits the utility of the study to a wider monitoring effort.

See also, butyltin in U.S. harbors, p (?), for another analysis of butyltin compounds from the same vicinity.
Title  Trace Metal Distributions in St. John Harbor Sediments

Investigator  S. Ray

Goals

This study was established to "determine the extent of anthropogenic input and to estimate the effects of dumping of dredged material in the outer harbor" at Saint John, New Brunswick. (Ray and MacKnight, 1984, p 12)

Contaminants

Sediment samples were analyzed for Cu, Zn, Pb, Cd, Mo, Ni, Mn, & Hg. Different stations received different analyses.

Sampling Dates and Frequency

Results were published in 1984, but do not contain any information on dates of sampling.

Sampling Stations

Samples were obtained from 145 sites, 78 from the inner harbor extending into Great Bay, and 67 from the outer harbor. Stations were concentrated in industrialized regions.

Sampling and Analytical Procedures

Sediments were sampled with a Van Veen grab. Samples were transported frozen in plastic containers. The silt/clay fraction of inner harbor sediments was separated prior to analysis.

Sediments were acid digested for analysis (inner harbor Ray and MacKnight 1984, outer harbor Loring and Rantala, 1977).

Hg was analyzed with a Pharmacia monitor by an automated variation of the procedure of Hatch and Ott (1968). All other species were measured with an atomic absorption spectrometer, CD, and Pb with the use of a graphite furnace, and the remainder by flame.

USGS reference marine sediment MAG-1 was analyzed using the described procedures. The results "were in good agreement with published values." (Ray and MacKnight, 1984, p 14)

Reference

Discussion

This study provides a detailed profile of this harbor and estuary as a basis for comparison with other estuaries within the Gulf of Maine system. The lack of information on the date of sampling is the primary weakness.
Goals

To identify levels, and investigate potential transport processes for metals in marine and estuarine sediments.

Contaminants

Sediment samples were analyzed for Cr, Cu, Fe, Mn, Pb, and Zn, and for grain size and organic carbon.

Dates and Frequency of Sampling

Unknown, the results were published in 1976 and 1979.

Sampling Stations

Sixty three gravity cores were taken from the Jeffreys Basin region, and _____ from the Great Bay estuary.

Sampling and Analytical Procedures

Sediment cores were taken with a stainless steel gravity corer, using acid washed polycarbonate liners. The cores were air dried, and the top 1 cm of sediment was removed and sieved to isolate the <80 mesh fraction. This was hot acid leached and filtered. Analysis was accomplished with an atomic absorption spectrophotometer

Organic carbon content was determined by the procedure of Gaudette, et al. (1974).

Reference

Armstrong, Hanson and Gaudette, (1976), and Lyons and Gaudette, (1979).

Discussion
Title    Metals in Dredge Spoils in Penobscot Bay  
Sponsor    U.S. Army Corps of Engineers  

Goals

To determine levels of metals in sediments before and after the disposal of dredge spoils.

Contaminants

Sediments were analyzed for seven metals, Cd, Cr, Cu, Hg, Ni, Pb, and Zn.

Dates and Frequency of Sampling

Not identified in CNA (1977).

Sampling Stations

Not identified in CNA (1977).

Sampling and Analytical Procedures

Not identified in CNA (1977).

Reference

Kyte (1974). This report was not available, and this summary was prepared from CNA (1977).

Discussion

This study provides an early reference point for a region sampled by several other programs, including NS&T, benthic and mussel watch components ( ), NEMP(metals?) ( ), Fink et al. ( ). Is this All?
Title: Argo Merchant Spill Monitoring

Goals

To assess the fates and effects of the 27,500 metric tons of number 6 fuel oil spilled when the tanker Argo Merchant ran aground.

Contaminants

All analyses were directed at the Number 6 fuel oil and its products. Most sampling was of the water and biota, (though some sediment samples were also taken).

Dates and Frequency of Sampling

The grounding occurred on December 15, 1976. Samples for monitoring purposes were collected for more than a month.

Sampling Stations

The grounding occurred on Nantucket Shoals, just outside of the study area. The oil moved to the south and east, moving across the corner of the region. Some samples were taken over much of Georges Bank.

Sampling and Analytical Procedures

The spill and surrounding environs were sampled extensively over a period of a month or more...[More in preparation]

QA/QC

Reference


Discussion
Northern Gulf Spill Monitoring

Goals

To observe the distribution and persistence of oil following a spill.

Contaminants

Hydrocarbons were analyzed in sediments and clams from the region of Casco Bay exposed to oil spilled by the tanker Northern Gulf. The characteristics of the spilled oil were used to isolate the effects of this oil from other hydrocarbons at the site.

Dates and Frequency of Sampling

The spill occurred in 1963. Samples were collected for analysis 11 years later in 1974.

Sampling Stations

Stations in areas known to have been impacted by the spill, and nearby uncontaminated sites were sampled.

Sampling and Analytical Procedures

Hydrocarbons in the sediments were analyzed by gas chromatography. The identity of the spilled oil was determined by comparison of the C14:C20 isoprenoid ratios in the chromatograms.

QA/QC

Reference

Mayo, et al. (1974). This document was not available in time for this discussion, which is therefore based on CNA (1977).

Discussion
Goals

To assess the Physical and chemical characteristics of water and sediment in the Bay of Fundy region. This information is pertinent to the effects of potential tidal power generation in the region.

Contaminants

A variety of water and sediment samples were analyzed to determine salinity, temperature, dissolved oxygen, ammonia, nitrite, nitrate, phosphate, silicate, dissolved and particulate organic carbon, particulate nitrogen, and chlorophyll.

Dates and Frequency of Sampling

The survey began in 1977 and ended in 1980. During that time samples were taken irregularly, but included all seasons, and all points of the tidal cycle.

Sampling Stations

Hundreds of sediment samples were collected from both the inner and the outer Bay. Water samples were taken primarily at 23 stations representing all areas of the Bay. The 7 stations in the inner reaches of the bay were sampled from anchor throughout the tidal cycle.

Sampling and Analytical Procedures

Samples were collected primarily from shipboard, though intertidal samples were also taken at some sites, some of these by helicopter.

Chemical analysis was conducted by the MEL and AOL. Procedural details were not obtained for this report.

Reference

The program is summarized in Kiezer, Gordon, and Hayes (1984).

Discussion

This program analyzed a range of parameters pertinent to an
understanding of nutrient cycling in the Bay of Fundy system. The analysis of data from across seasonal and tidal cycles may be important for understanding the implications of other, more limited sampling regimes in the Bay.
Title: Georges Bank Drilling Project
Technical and Scientific Studies Program
Sponsor: Texaco Canada Resources Ltd.

Goals

These studies were carried on in support of exploratory drilling proposals.

Contaminants

Most of the studies were laboratory experiments examining exposure effects, or were modelling exercises. Two studies contained features of interest. "Sediments and biological samples" were obtained in one study from the two sites where drilling is proposed, though the analysis to which these were subject is not known. Another of the studies determined the level of "heavy metals in various tissues of market sized lobsters."

Dates and Frequency of Sampling

Studies were carried out during 1987 and 1988.

Sampling Stations

Effort was concentrated near the two proposed drill sites on the Northeast Peak area of Georges Bank.

Sampling and Analytical Procedures

Unknown.

Reference

A summary document of this work has been produced, but could not be obtained for this inventory. Information contained here was obtained from a pre study synopsis, and from Tidmarsh, (1989).

Discussion
Title The National Pesticides Monitoring Program
Sponsor Multi-Agency Effort, Lead Agency, U.S. Environmental Protection Agency

Goals

To identify organochlorine pesticides in different components of the environment, and follow their trends over time.

Contaminants

Organochlorine residues in tissue were the primary focus of this program, though samples were occasionally analyzed for metals as well. DDT and its metabolites were the most consistently analyzed pesticides. Other OCs analyzed included aldrin, dieldrin, heptachlor, heptachlor epoxide, lindane, methoxychlor, oxychlordane, cis-chlordane, trans-nonachlor, endrin, HCB, mirex, toxaphene, and PCB (1260 or 1254).

Dates and Frequency of Sampling

The NPMP began in 1964 and increased substantially through the late 1960s and early 1970s. The fish and mollusk components ended in the late 1970s, and the program concluded with the end of waterfowl analysis in 1984. Sampling frequency varied from project to project, and year to year. Estuarine mollusks were sampled monthly for an eight year period at some sites. In contrast, these same sites were later sampled once after a 5-7 year lapse. Waterfowl sampling occurred about every four years.

Sampling Stations

These also varied considerably. Waterfowl were collected as they were submitted by hunters, their eggs were taken from randomly selected nests from throughout the Atlantic flyway. Six of the sites from which estuarine mollusks were sampled were within the GOM study area, all within the State of Maine. Fish were also collected, but from freshwater sites.

Sampling and Analytical Procedures

[In preparation]

QA/QC
Reference

Many sources are available on this program. These include:

Discussion

Program development was a primary goal of this effort, so protocols varied widely throughout the program, and over time.
To establish levels of metal concentration in commercially valuable species of marine algae. The threat to human health and the harvesting industry associated with bioaccumulation prompted this study.

Contaminants

Samples of sea water, and three species of seaweed were analyzed for seven metals, Cd, Cr, Cu, Fe, Pb, Zn, and Ni.

Dates and Frequency of Sampling

All collections were made during the summer of 1983.

Sampling Stations

One of the seven stations from which algae and water samples were collected was within the Gulf of Maine. This site was on Pumpkin Island in Lobster Bay, NS. As there was no major pollution sources locally, this served as a control site for the project.

Sampling Procedures

Four species of marine algae, Ascophyllum nodosum, Chondus crispus, Laminaria digitata, and L. longicruris, were collected from intertidal beds at Pumpkin Island. The samples were separated into morphologically homogeneous sub-samples.

A 500 ml sample of water was collected at the site from a depth of 10 cm.

Analysis

Plant samples were dried, ground, nitric acid digested, ashed, and analyzed for most metals by Inductively-Coupled Argon Plasma atomic emission spectrometric methods. A flameless atomic absorption spectrometric method was used for Cd analysis.

Water samples were analyzed by “chelation with ammonium pyrrolidine dithiocarbamate and extraction into methyl isobutyl ketone and aspiring organic extract directly into the flame (American Public Health Association 1980).” (Sharp et al 1988, p
Quality Assurance/Quality Control

National bureau of Standards Standard Reference Material 1571 Orchard Leaves was analyzed using the same methods.

Reference


Discussion

This paper discusses the need to examine seaweed quality in areas new to commercial harvesting "as well as monitoring of traditional areas." There is no indication, however, that the intention exists to utilize this work as the base for any such monitoring program.

Compare also to the deep water seaweeds component of NEMP.
Goals

This study correlates metal levels with an abnormal condition in a gastropod mollusc.

Contaminants

Specimens of snails, Nucella lapillus, were analyzed for the presence of 6 metals, Cr, Cd, Sn, Cu, Fe, and Zn. Observations were also recorded on the presence of abnormal, penis-bearing females in the population.

Dates

All samples were collected between July and October 1982.

Sampling Stations

Snails were collected from the intertidal zone at six sites, four of these within the Gulf of Maine region. These sites were located at Eastport, New Harbor, and Pemaquid Point, Maine, and at Manomet, Massachusetts.

Sampling and Analytical Procedures

Specimens were collected by hand, intertidally from each site. Specimens were dried, homogenized, and digested prior to analysis. Levels of all metals were determined by atomic absorption spectrometry. Cr, Cd, and Sn were analyzed by flameless methods with a graphite furnace. Cu, Fe, and Zn were determined using flame techniques.

Reference


Discussion

This is one of the few studies in the Gulf of Maine directly linking contaminant concentration with biological effect.

As no other research has been found from the GOM which utilizes this species, it is not clear how it compares with any ongoing programs. Several other programs use non-bivalve mollusks.
Goals

This research examined the relationship between metals in the marine environment and the decline in sea scallop, Placopecten magellanicus, stocks.

Contaminants

Levels of Cu, Zn, Cd, & Pb were determined in scallop tissues.

Sampling Dates and Frequency

All samples were collected between May and December 1981.

Sampling Stations

Nineteen sites throughout Atlantic Canada were sampled. Seven were within the Gulf of Maine study area.

Sampling and Analytical Procedures

Specimens were taken with a commercial scallop dredge. Size and age of specimens was determined. Most samples were frozen whole, and transported to laboratories for dissection. Scallops were separated into muscle, viscera, mantle, and gill tissue for separate analysis.

Tissues were freeze dried, powdered, homogenized and ashed prior to leaching in nitric acid. An atomic absorption spectrometer was used for the analysis. Cu and Zn were analyzed using flame method, while Cd and Pb were determined using a graphite furnace.

Quality Assurance/Quality Control

Precision and accuracy of instrumentation and method were checked using NBS Reference Material No. 1566 (oyster tissue).

Reference


Discussion

See also trace metals in scallops from the Eastern US (p?).
The mussel watch was set up to establish a strategy for monitoring coastal pollution on a national scale. It determined the value of coastal mollusks as indicators of environmental concentrations of pollutants.

Samples of mussels, *Mytilus edulus*, were analyzed for four categories of contaminants, trace metals, radio nuclides, chlorinated hydrocarbons, and petroleum hydrocarbons. Trace metals included Pb, Cd, Ag, Zn, Cu, and Ni. Some samples were also analyzed for Al, Fe, Mn and Sr in the third year. Radio nuclides determined include 238 Pu, 239+240 Pu, 137 Cs and 241 Am. Chlorinated hydrocarbons included DDE, DDD, and PCBs (1254 and 1260), and a range of petroleum hydrocarbon levels were determined.

The project continued for three years, from 1976 through 1978. Samples were collected annually from each site. While the program was not continued it has become the model for the mussel watch component of the NS&T program.

This project was part of a national effort. The initial year of sampling only included 6 GOM stations. 3 more were added in subsequent years. Of the 9 sampling stations in the Gulf of Maine, 5 in were in Maine, and 4 in Massachusetts. Sites ranged from rural to highly urbanized, and across a variety of shore types, but were not located near point sources of pollution.

Collection protocols are described in Goldberg, et al, (1978). Mussels of 5-8 cm length were taken at all of the stations within the Gulf of Maine. Whole mussels were packaged in plastic, frozen and shipped to one of three laboratory facilities.

An archive of sample material was instituted as part of this program.
Analysis

Three laboratories took part in the analysis. Different procedures were used at each laboratory. Data on radio nuclides was not comparable between laboratories, while the researchers considered the methods used for metal and organic analyses to yield comparable results. Goldberg et al, (1978) describe the intercalibration results from the laboratories.

Metals

Preparation involved drying and homogenizing tissue, and digesting in Nitric acid. One laboratory fully digested the sample to destruction of the tissue, while the other charred the partially digested sample, before further digesting it with peroxide. Full protocols are discussed in Goldberg, et al, (1983). An atomic absorption spectrophotometer was used in both labs. Flame was used exclusively at one lab, while a graphite furnace was used for all determinations except Zn in the second and third years at the other lab.

Radio nuclides

Farrington, et al (1983) describe the procedures used for RN analysis at the Woods Hole laboratory.

Chlorinated Hydrocarbons

Gas chromatographic techniques were used to determine the levels of DDT residues and PCBs. See Farrington, et al (1983).

Petroleum Hydrocarbons

Hydrocarbon analysis involved ethanol/potassium hydroxide digestion, followed by silica gel chromatography for initial separation of major fractions. These fractions were then analyzed by gas chromatography, and gas chromatography-mass spectrometry (Farrington, et al, 1983).

Quality Assurance/Quality Control

Procedures to avoid contamination of samples, and to calibrate instruments are described in the summaries, (Goldberg, et al, 1983, and Farrington, et al, 1983) as is information on interlaboratory comparison. (Goldberg, et al, 1978)

Reference

This study provides information on similar species and contaminants for the entire coast of the United States, providing a point of comparison for Gulf of Maine data against the rest of the country. Interlaboratory compatibility concerns are the primary difficulty in utilizing this information.

This study is similar to the mussel watch portion of the NS&T program. Many of the same contaminants are measured, though the NS&T program uses nationally standardized protocols. Direct comparison between the two mussel watch programs is made difficult as few of the sampling sites are the same.
Title Metals in Selected Seafood
Sponsor U.S. National Marine Fisheries Service

Goals

This study established data on overall metal contamination levels, and geographic trends in commonly consumed marine species.

Contaminants

Tissues from fish, crustacean, and mollusc were tested for Hg, Pb, Cd, Cr, and As.

Dates

This survey was conducted about 1975.

Sampling Stations

This survey was concerned with contaminant levels in fish at market, not on site, so no routine sampling regimen was followed. Samples were collected from all regions of the US, and identified by dates of collection, and general location. Some specimens were collected from the GOM region.

Sampling and Analytical Procedures

All are outlined in the reference on this study.

Reference

Zook, E.G., et al. (1976)

Discussion

This work provides a point of departure for discussions of metal contamination in US marine life. The limited amount of GOM data, and the market end emphasis of the sampling procedures all limit the utility of this study to the development of a monitoring program.
Title: OCs in Harbor Porpoise and Harbor Seals

Investigator: D. Gaskin

Goals

Tissue concentration of contaminants in the Harbor porpoise, *Phocena phocena*, were determined as part of an ecological study of the species. Similar data was collected on Harbor seals, *Phoca vitulina*, for comparison.

Contaminants

All tissues were analyzed for p,p\textsuperscript{'} DDE, o,p\textsuperscript{'} DDT, p,p\textsuperscript{'} DDD, and p,p\textsuperscript{'} DDT, dieldrin, PCBs (1254 and 1260) and mercury.

Dates and Frequency of Sampling

Collection of harbor porpoise spanned a three year period from 1969 to 1971. All harbor seal were collected in 1971.

Sampling Stations

All porpoise specimens were collected in the western North Atlantic, most in the Bay of Fundy. Seals were collected from haulout ledges at sites near Boothbay Harbor, ME, Grand Manan Island, NB, and Deer Island, NB.

Sampling and Analytical Procedures

73 Harbor porpoise were taken, and muscle, liver and blubber were extracted for analysis. These tissues and also brain samples were taken from 12 seals.

Samples for mercury analysis were acid digested, then processed by cold vapor atomic absorption spectrophotometry.

OC residues were extracted by hexane, and separated by flouracil column. Analyses were made by gas chromatography. In the porpoise samples, PCBs were not separately quantified, but were compared with the peaks for DDT. In the seal samples DDT and PCB groups were analyzed together and separately.

Reference

Gaskin and Frank (1972), Gaskin, Holdrinet, and Frank (1971), and Gaskin, et al (1973)
Discussion

No other study from the Gulf of Maine examines OC residues in marine mammals. Canadian studies of OCs in seals have been from waters farther to the north. See also p? for a discussion of hydrocarbon contamination in marine mammals.
Title Trace Metals in Scallops from the Eastern United States
Sponsor U.S. National Marine Fisheries Service
                 National Oceanic and Atmospheric Administration

Goals

This study established metal concentration levels in sea scallops, for comparison between regions of the US northeast coast.

Contaminants

Scallop tissues were analyzed for 8 trace metals, Ag, Cd, Cr, Cu, Hg, Ni, Pb, & Zn.

Sampling Dates and Frequency

The dates of sampling are not specified in the reference on this work which was published in 1978.

Sampling Stations

Samples were taken as part of the annual scallop stock assessment surveys of the NMFS. Samples for metal analysis were taken from selected tows throughout the Mid and North Atlantic coast. The dredge sites included 10 stations in the Georges Bank region, as this is one of the primary sites for scallop fishing.

Sampling Procedure

Samples were collected with a commercial scallop dredge. Specimens for analysis were separated immediately into adductor muscle, gonad, and remaining visceral mass. Samples were transported frozen. Different tissue types were analyzed separately.

Analysis

Hg was analyzed using the procedure of Greig, et. al. (1975) Pesticides Monitoring Journal, 9:15. All other elements were analyzed using the procedure of Greig et. al. (1975) Marine Pollution Bulletin 6:72.

Reference

Greig, et. al. (1978).

Discussion

Comparison with other sites is possible through the metals
in Canadian scallops project (p?). Other projects involving bivalve mollusks use coastal species.
Title Striped Bass from Nova Scotia rivers
Investigator S. Ray

Goals

To establish levels of Mercury and PCB in Striped bass, __, a commercially important marine predator showing evidence of population decline.

Contaminants

Muscle, kidney, liver, and gonad tissues were analyzed for Hg. Muscle and gonad tissues were also analyzed for PCBs.

Dates

No sampling dates were provided. The results were published in 1984.

Sampling Stations

Samples of striped bass tissue were collected from anglers and commercial fishermen working in two rivers, the Annapolis and the Shubenacadi, both in western Nova Scotia.

Sampling and Analytical Procedures

All samples were homogenized and acid digested. Hg was determined using the cold vapor, atomic absorption method of Hatch and Ott (1968). PCB analyses were conducted with flouracil column separation, and gas chromatography according to the procedures of the Environment Canada Analytical Methods Manual (1974).

Reference


Discussion

While these samples were collected in fresh or estuarine systems, striped bass spend enough of their lives in estuarine and marine environments that they may be considered reasonable indicators of marine environmental quality, though the possibility of contaminants being acquired from fresh waters must be considered. The lack of dates associated with these samples limits ability to compare them with other samples taken at other
times or locations.
Goals

This project examined several problems. It examined the relationship between contaminant levels in aquatic estuarine species, and the common tern, Sterna hirundo, a predator on these species. Further, the study looked at long term trends in contaminant levels to evaluate the value of terns as monitors of pesticide levels. Finally the relationship between contaminant levels and reproductive success was observed to assess the effects of pollution on the species.

Contaminants

Contaminant levels were determined in a variety of tissues and species, primarily from the eggs of common terns. The 10 OCs analyzed were DDE, TDE, DDT, dieldrin, heptachlor epoxide, HCB, PCBs(1254 & 1260), endrin, alpha-chlordane, and oxychlordane.

Dates and Frequency of Sampling

Egg samples were collected annually at one site within the Gulf of Maine, and occasionally at 6 other sites. Other species and tissues were sampled occasionally. Collection began in 1971 and continued through 1981. Studies of the tern population continues, but there is no longer any contaminant analysis.

Sampling Stations

Eggs of common terns were collected at 9 colonies in coastal MA. 7 of these, Snake Island, Plymouth, Yarmouth Jeremy’s Point, Nauset New Island, Tern Island, and Monomy Island, were within the Gulf of Maine study area. Little terns, Sterna albitrons, were also taken at one Nauset New Island. Fish and mollusks were taken intermittently from adjacent estuarine waters.

Sampling and Analytical Procedures

Freshly laid eggs were collected during the peak laying period. The first egg from each clutch was collected for consistency, as OC residues were shown to be higher in subsequent eggs. Occasionally later eggs, or eggs which failed to hatch were collected for comparison. Samples of Atlantic silversides, sea herring, and sand lance were netted, and mussels were taken by hand from areas near colonies.
All samples were wrapped in solvent rinsed aluminum foil and frozen till analyzed. Eggs were hard boiled, and the yolks removed for analysis.

Methods utilized followed Reynolds and Cooper (1975). Samples were homogenized, oven dried, and diethel ether: hexane extracted. Analysis was performed on an electron capture gas chromatograph.

Effects are examined in this study through comparison of residue levels in fresh, randomly selected eggs with those in eggs which failed to hatch, and through comparison of contaminant levels with breeding success rates.

Quality Assurance/Quality Control

10% of samples were confirmed using differential gas chromatography/ liquid phase. Reference materials were routinely included with the samples for comparison.

Reference

Nisbet, and Reynolds (1984)

Discussion

This work provides a ten year analysis of one species in one location, and is similar to that undertaken by the Canadian Wildlife Service. The same procedures were used at the same laboratory facility. Comparability is still problematic, however, as the CWS does not have a sampling site for terns within the GOM. See also all other bird related studies (Table ?).
Title  OC residues in eggs of Eiders and Gulls
Sponsor  Pawtuxent Wildlife Research Center
          United States Fish and Wildlife Service

Goals

To compare OC levels in Maine herring gulls with those measured in other sites, and to establish information on the levels in common eiders, and greater black-backed gulls.

Contaminants

Eggs of all species were tested for DDT residues (p,p'DDE, p,p'DDD, p,p'DDT) other Organochlorines (dieldrin, heptachlor, oxychlordane, cis-chlordane, toxaphene, HCB, mirex, trans-nonachlor) and PCBs (1254, and 1260), and eggshell thickness was determined.

Dates and Frequency of Sampling

All samples were collected in May of 1977.

Sampling Stations

Herring gull and greater black-backed gull eggs were collected from Appledore Island, ME, and common eider eggs were collected from Bangs Island, ME.

Sampling and Analytical Procedures

Egg contents were removed to chemically cleaned jars and frozen for storage. Samples were homogenized prior to extraction. "Extraction, sample cleanup and separation were as described by Cromartie et al (1975)." Analysis was accomplished with a gas chromatograph. 10% of the samples were confirmed by gas-liquid chromatography/mass spectrometry. Eggshell thickness was measured at the equator with a micrometer.

Reference

Szaro, Coon, and Kolbe (1979)

Discussion

See also CWS work. Eider eggs were sampled in that study in 1972.
Title: OCs in Food Items of Bald Eagles
Sponsor: U.S. Fish and Wildlife Service

Goals

To determine the paths through which OC residues were reaching Bald Eagles and contributing to their reproductive failure.

Contaminants

Fish and Gull tissues were analyzed for p,p'-DDT, p,p'-DDD, p,p'-DDT, PCBs, dieldrin, heptachlor epoxide, mirex, cis-chlordane, oxychlordane, cis-nonachlor, trans-nonachlor, and toxaphene.

Dates and Frequency of Sampling

Fish were obtained during the summer of 1966 and again in the fall of 1974. Herring gulls were also taken during the summer of 1966.

Sampling Stations

Fish were collected from near Deer Island N.B., Mt Desert Island, and Damariscotta Mills, ME., from the Penobscot river in ME., and from a sardine factory, where specific catch locations could not be determined.

Herring gulls were collected from Pemaquid Lake, Cutler, and the dumps at Bath and Eastport, ME.

Sampling and Analytical Procedures

Sea herring, common mackerel, alewife, yellow perch, and American eel were collected by netting, or obtained from commercial fishermen. Tissues were homogenized. Gulls were shot, skinned, and the feet, beak, wings, brain, liver, and gastrointestinal tract were removed before the remaining sample was homogenized.

Samples were hexane extracted, and separated on a Flouracil column, then a Silicar column. Analysis was accomplished through electron capture gas chromatography.

Ten percent of the samples were confirmed using GC/MS.

Reference

114

Discussion
Title Hydrocarbons in Aquatic Fauna
Investigator V. Zitco

Goals

To establish the degree of hydrocarbon contamination in fish and mollusc tissue in Canadian waters.

Contaminants

Fish and shellfish tissue was analyzed for aromatic hydrocarbons.

Dates

Samples were collected during 1972 and 1974.

Sampling Stations

Specimens were taken from many sites in Canada. GOM sites include the St. John river, St. Andrews, and Passamoquoddy Bay, NB.

Sampling and Analytical Procedure

Fish and mollusc specimens were collected in accordance with the procedures outlined in V. Zitco (1975). Ultra-violet and fluorescence spectrometry were used in the analysis following the procedures of the author. Emissions were compared with pyrene, crude oil, Bunker C fuel oil, and creosote oil. Most samples were below detection limits.

Reference


Discussion

This study provides baseline data on some species, though levels of most hydrocarbons were not detectable.
Title Organochlorine Residues in Shearwaters  
Investigator D. Gaskin

Goals

To determine the levels of OC residues in the tissues of two species of shearwaters. These seabirds are in the GOM exclusively to feed. Other GOM seabird studies have concentrated on nesting species.

Contaminants

Fat, liver, and muscle tissue of 20 greater and 6 sooty shearwaters, Puffinus griseus, and Puffinus gravis, were analyzed for p,p’DDT, p,p’DDE, p,p’DDE, dieldrin, HCB, mirex, oxychlordane, alpha chlordane, gamma chlordane, and PCBs (1254, and 1260).

Dates

All specimens were collected during August of 1974.

Sampling Stations

The shearwaters were collected at the Southeast entrance to the Bay of Fundy, near Long and Briar Islands, Nova Scotia.

Sampling and Analytical Procedures

Specimens were shot, and fat, liver and muscle tissue extracted. Samples were hexane extracted, separated on a flouracil column, and analyzed by gas chromatography.

Gas/liquid chromatography was used for confirmation of some of the samples.

Reference

Gaskin, Holdrinet, and Frank (1978).

Discussion

As southern hemisphere nesters, and highly migratory species, the shearwaters may be better indicators of overall ocean contamination than of local levels.
Title  Pesticide Levels in Cormorants
Sponsor  United States Fish and Wildlife Service

Goals

To determine the level of pesticide residue in a population of double-crested cormorants, Phalacrocorax auritus, which was reproducing successfully, for comparison with other sites where reproductive deficiencies were associated with pesticide contamination.

Contaminants

DDE, DDD, and DDT residue levels were determined in a variety of cormorant tissues.

Dates

All specimens were collected during the breeding season. Collection was carried out in Muscungus Bay during 1966 and at 2 sites during 1967.

Sampling Stations

Cormorant tissues and eggs were collected at a site in Muscungus Bay Maine and on Duck Island Maine.

Sampling and Analytical Procedures

Eggs were collected from nest sites, while adult or juvenile birds were shot on the islands before dispersal from the colonies. Brain, gonad, and heart tissues were analyzed.

Chromatography was conducted by the Pawtuxent Wildlife Research Center of the US Fish and Wildlife Service according to their procedures.

Reference


Discussion

While this study dates to the 1960s, it is included here as an historic reference from the Gulf of Maine on the cormorant, one of the species used in the CWS seabird studies. See also Table (?).
Goals

To determine the presence of DDT residues in shellfish from the Atlantic Provinces of Canada.

Contaminants

Tissues of shellfish were analyzed for p,p' DDT, p,p' DDD, and p,p' DDE.

Dates and Frequency of Sampling

All samples were collected in October of 1967.

Sampling Stations

The only station within the GOM was at St. Andrews, N.B.

Sampling and Analytical Procedures

Mussels (Mytilus edulis), scallops (Placopecten magellanicus), and clams (Mya arenaria) were collected from commercial catches near the study station. Specimens were frozen.

Whole body samples were homogenized for analysis. Analysis was by gas-liquid chromatography after the procedures of Duffy and O'Connell (1968).

Samples were confirmed using two gas chromatographic columns, and/or by thin layer chromatography.

Reference

Sprague and Duffy (1971).

Discussion
Title  Butyltin In U.S. Harbors
Sponsor  U.S. Navy

Goals

This study established baseline levels of butyltin in regions near U.S. Naval operations prior to tributyltin (TBT) use by the Navy.

Contaminants

TBT concentrations were determined in water samples.

Dates and Frequency of Sampling

All samples in the GOM were taken in October of 1985. While "the Navy plans to monitor major harbors in which it operates to evaluate changes in butyltin concentration" (Grovhoug, et al. 1986. p1283), Naval Shipyards personnel in Portsmouth are unaware of any planned, or ongoing monitoring program.

Sampling Stations

Portsmouth N.H. was the only GOM site. Eight samples were taken near Naval facilities, seven near commercial or recreational boating facilities, and nine near ecologically sensitive areas.

Sampling and Analytical Procedures

Water samples were collected 0.5 m below the surface, and stored chilled in polycarbonate containers. Samples were analyzed using hydride derivatization/atomic absorption to produce volatile tin species, and modified hydrogen flame atomic absorption spectrophotometry for detection, after Valkirs, et al. (1985).

Quality Assurance/Quality Control

National Bureau of Standards has verified the accuracy of this procedure for detecting TBT.

Reference

Grovhoug, et al. (1986).

Discussion

The only other TBT study found for this inventory was also
located in the Portsmouth area, see p (?).
Title  
Surface Particulate Oil Pollution

Sponsor  
Bedford Institute of Oceanography

Goals

To quantify the extent and distribution of oils in marine surface waters.

Contaminants

Tars collected from surface waters were extracted to determine the total weight of tar in each sample.

Dates

Samples from the Bay of Fundy were collected in 1971, and samples from Cape Cod in 1972.

Sampling Stations

Neuston tows were taken from platforms of opportunity throughout the northwest Atlantic. Of 874 surface samples collected, only 5 were within the GOM study area. Three were collected from the Bay of Fundy, and two off of Cape Cod, MA.

Sampling and Analytical Procedure

A modified Sameoto and Jaroszinski neuston sampler was towed for 1 nautical mile at each site at a speed of 5-7 knots. Samples were frozen.

Tar portions were dissolved in Carbon tetrachloride, then evaporated. The residue was then n-hexane extracted, centrifuged, and the hexane insoluble portion benzene extracted. The sum of the hexane and benzene soluble portions was reported as the total tar.

Reference


Discussion

Little of this information is from within the GOM. Samples, while quantified by weight were otherwise subjected to very limited analysis. Compare with the MARMAP survey (p ?).
Programs not yet included into the tables.
Title  Merrimack River Input into Massachusetts Bay
Sponsor  Massachusetts Institute of Technology Sea Grant Program

Goals

To identify the fate of water leaving the Merrimack River, and of the metals contained in that water. To determine the potential input of contaminants to Massachusetts Bay from the Merrimack River.

Contaminants

Salinity is determined as a means of identifying the plume from the Merrimack River, and to follow the dynamics of that plume. Analysis of water samples for metals is in progress.

Dates and Frequency of Sampling

All samples were collected during June of 1988.

Sampling Stations

160 water samples were collected from 56 stations from the mouth of the Merrimack River into the northern reaches of Massachusetts Bay.

Sampling and Analytical Procedures

Unknown.

Quality Assurance/Quality Control

As the concentration of pollutants is quite low, "special techniques were required to prevent the addition of trace metals during collection and analysis. In addition, replicate samples were obtained at selected locations to assist in guaranteeing the precision and accuracy of results." (Anon, 1989. p. 4.)

Reference


Discussion
Title: Metals in Boston Harbor  
Sponsor: R.J. White Jr.

Goals  
To examine the distribution of metals within the sediments of Boston Harbor.

Contaminants  
Sediments were analyzed for seven metals, Cd, Cr, Cu, Hg, Ni, Pb, and Zn.

Dates and Frequency of Sampling  
Not identified in CNA (1977).

Sampling Stations  
Over 150 core samples were collected from sites throughout inner and outer Boston Harbor.

Sampling and Analytical Procedures  
Sediment cores were taken at each site. Subsamples from each were acid/peroxide digested, dried, and ashed. Analysis was by flame AAS. Subsamples for mercury analysis were dried and aqua regia digested. Analysis was by cold vapor AAS.

Reference  
White (1972), as summarized by CNA (1977).

Discussion  
This study provides extensive background data on the distribution of metals within Boston Harbor, an area heavily studied since.
Title    Metals in Sediments and Water in Boston Harbor
Sponsor  The Commonwealth of Massachusetts

Goals

Contaminants

Water samples were analyzed for dissolved and particulate concentrations of six metals, Cd, Cr, Cu, Ni, Pb, and Zn. Sediments were analyzed for the same metals as well as Co, Hg, and V.

Dates and Frequency of Sampling

Not identified in CNA (1977).

Sampling Stations

Water was collected at 8 inner harbor, and 18 outer harbor sites, and sediments at, 4 inner harbor and 52 outer harbor sites.

Sampling and Analytical Procedures

Water was filtered through an acid-leached glass fiber filter to remove particulates. The particulate matter was then acid extracted. Dissolved metals were extracted with ammonium pyrrolidinecarbodithionate (APDC) and methyl-isobutyl ketone (MIBK). Analysis was conducted by flame AAS.

Sediment cores were taken and frozen. Subsamples for analysis were removed from each 10 cm depth. These subsamples were acid digested, filtered, and analyzed by Flame AAS. Hg analysis utilized cold vapor AAS.

Reference


Discussion

An early reference on Boston Harbor. Includes water and sediment information.
Title Contaminated Materials in Massachusetts Bay
Sponsor Commonwealth of Massachusetts

Goals

Contaminants

Sediments were analyzed for seven metals, Cd, Cr, Cu, Pb, Hg, Ni, and Zn.

Dates and Frequency of Sampling

Unknown.

Sampling Stations

Samples were collected at four sites along the North Shore of Massachusetts, the North Channel in Boston, Broad Sound, Marblehead Channel, and Salem Channel, and also at 32 station in Massachusetts Bay between Cape Ann and Cape Cod.

Sampling and Analytical Procedures

Cores were frozen for shipment and storage. Subsamples were taken from each 10 cm. of depth. These were acid digested and filtered. Analysis was by plasma emission spectrometry.

Reference

This work was reported by CNA (1977).

Discussion

This study expands the spatial array of baseline information on metal contamination from Boston into the Mass. Bay area.
Title: Contaminated Materials in Massachusetts Bay  
Sponsor: Commonwealth of Massachusetts

Goals

Contaminants

Sediments were analyzed for seven metals: Cd, Cr, Cu, Pb, Hg, Ni, and Zn.

Dates and Frequency of Sampling

Unknown.

Sampling Stations

Samples were collected at four sites along the North Shore of Massachusetts, the North Channel in Boston, Broad Sound, Marblehead Channel, and Salem Channel, and also at 32 stations in Massachusetts Bay between Cape Ann and Cape Cod.

Sampling and Analytical Procedures

Cores were frozen for shipment and storage. Subsamples were taken from each 10 cm. of depth. These were acid digested and filtered. Analysis was by plasma emission spectrometry.

Reference

This work was reported by CNA (1977).

Discussion

This study expands the spatial array of baseline information on metal contamination from Boston into the Mass. Bay area.