PROJECT OBJECTIVES:

To biologically and chemically evaluate the present status of an estuary currently used for recreational purposes and as receiving waters for effluent from a sewage treatment plant; within two years, effluent flow in the same area from a new plant will approach a 10-20 fold increase.

To determine the suitability of various micro- or macro-organisms as indices of the presence of effluent.

ACHIEVEMENT OF OBJECTIVES:

The problem of coastal sewage pollution was studied by examining comparatively two coves on the Connecticut shoreline. Mumford Cove has received approximately 0.25-0.5 MGD of chlorinated sewage effluent for 25 years; an adjacent body of water (Palmer Cove) receives no gross input of organic matter and served as a control area. The current status of water quality in both coves was assessed in respect to their multiuse nature and the projected impact on Mumford Cove of eventual increased effluent flow of 5-6 MGD from an enlarged sewage treatment plant now under construction. The data accumulated have been evaluated with regard for local and State concern relative to the area in question. Consequently, current plans now include an offshore outfall, rather than discharge into Mumford Cove.

RESEARCH PROCEDURES USED:

The study was based on sampling of selected biological, chemical and physical characteristics over a 21 month period (September, 1970 through May, 1972). Three stations were sampled in each cove (1,M,4 in Mumford Cove; 5,P,8 in Palmer Cove; Fig. 1) at approximately two week intervals.

Volume of effluent discharge and rainfall data for the study period were obtained from Town of Groton records. Field measurements included salinity, dissolved oxygen (D.O.), and temperature. The latter two were determined using portable, battery-operated gear. Laboratory analyses included D.O. (azido modification of the Winkler method), standard 5-day B.O.D., orthophosphate O-Po4; stannous chloride method), and nitrate-nitrogen (NO3-N; UV spectrophotometric method). All procedures were those recommended by APHA et al. (1965). Once during each season, continuous recordings of temperature and D.O. were made at corresponding locations in each cove over a several day period. The recorders were placed at shore points as close as possible to the established cove stations. During each season, recorders were placed simultaneously near stations 1 and 8, then moved to M and P, and positioned finally at stations 4 and 5.
For bacteriology, water samples were collected in sterile screwcapped bottles, iced, and processed immediately upon return to the laboratory. All samples were taken at mid-depth. "Total" counts were made on Difco Marine Agar (MA) and Difco Plate Count Agar (PCA) prepared with distilled water. The spread plate technique (Buck and Cleverdon, 1960) was utilized with incubation at 2, 25, and 35°C for PCA and 2, 20, and 25°C for MA. Total and fecal coliforms and fecal streptococci were enumerated by the membrane filter method (Millipore Corporation, 1972).

Both creeks entering the coves were sampled for total and fecal coliforms at selected sites in August and October, 1971, and May 1972.

One liter samples for phytoplankton enumeration were collected in Van Dorn bottles and preserved with distilled water, ethanol, and formalin solution (63:1). Samples were concentrated using a Foresi continuous flow centrifuge and counted using a Sedgwick-Rafter cell. Identification was limited to four major groupings (greens, diatoms, blue-greens, and flagellates) with dominant organisms identified to genus.

In June and August, 1971, water samples were taken from stations 1 (Mumford Cove) and 8 (Palmer Cove) and enriched with nitrate, phosphate, nitrate plus phosphate, and sewage effluent in varying concentration up to 20 fold the current flow.

Bottom sediment samples were collected with a Peterson Grab, measured for volume and washed through 5.6, 2.0 and 1.0 mm mesh screens and preserved with buffered formalin for subsequent identification of macroinvertebrate populations.

CONCLUSIONS:

Table 1 summarizes the range of physical and chemical parameters recorded at the sampling stations. Normal seasonal and dilution effects on all variables studied were noted at mid-cove (M and P) and outer (4 and 5) stations. The upper stations (1 and 8) showed the most variable results; the greatest extremes were noted at Station 1 (effluent discharge area), particularly BOD, nitrate, and phosphate. Although few total and fecal coliforms were found in the sewage plant effluent, the creeks feeding both coves occasionally showed very high counts of all these groups (e.g., > 200,000 total coliforms/100 ml) especially following periods of heavy rainfall. "Total" bacterial counts at different incubation temperatures showed no distinct trends; variations were ascribed to salinity and seasonal variations.

Phytoplankton numbers were greatest at the upper stations and decreased seaward. The outer and mid-cove stations were dominated by diatoms while Stations 1 and 8 frequently exhibited large numbers (up to 27,000/ml) of flagellates resembling Paridinium, Dinophysis, and Prorocentrum. These organisms, associated with eutrophic waters, were seen only rarely at the other stations and could represent a potential nuisance or toxicity phenomenon if increased enrichment were to enlarge their area of occurrence in either cove.

Enrichment studies showed a pronounced effect of nitrate, phosphate, nitrate plus phosphate, and sewage effluent addition on resident algal populations. The most dramatic results were seen with Mumford Cove water; dense green mats developed in test flasks and included unicellular and filamentous green algae, filamentous blue-greens, and several diatoms, noticeably Scenedesmus. Palmer Cove water showed heavy growth of blue-green algae and diatoms only when 10-20 fold concentration of sewage effluent was added.
Particulate matter and increased turbidity were noted frequently at Station 1 (effluent). Extensive periodic growths of macroalgae were evident at both Station 1 (Ulva lactuca) and Station 8 (Enteromorpha sp.).

In general, the benthic invertebrates found in both Mumford and Palmer Coves were indicative of typical coastal estuaries and did not suggest the existence of gross pollution conditions.

The data indicate that, while the current low flow of sewage effluent from the Town of Groton plant has not had a significant, obvious deteriorative effect on the entire body of Mumford Cove, the upper end of the cove which receives the effluent does offer the potential for significant eutrophic effects if the projected flow increase enters the cove at the existing location. The greater flow of fresh water alone could produce serious ecological consequences, considering the existing hydrologic conditions (Anon., 1971); Buckingham and Gilardi, 1971). Possible biological and chemical increases and alterations are seen as further deleterious effects of increased effluent volume.

PUBLICATIONS:


REFERENCES:


ACKNOWLEDGEMENT:

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ABSTRACT:

A chemical and biological study is described for a Connecticut estuary receiving 0.25-0.5 MGD of treated sewage effluent prior to construction of a secondary treatment plant with a projected flow of 5-6 MGD. An adjacent, unpolluted cove was used as a control. Three stations in each estuary were
sampled bi-weekly from Sept. 1970 to June 1972. Analyses included temperature, salinity, dissolved oxygen, B.O.D., nitrate, and phosphate. Counts were made of total bacteria, total and fecal coliforms, fecal streptococci, phytoplankton and benthic invertebrates.

Results indicated that nitrate, phosphate, and D.O. levels at the current outfall area at the head of the receiving cove are high enough to suggest that the increased flow of fresh water and nutrients into the saline cove may produce adverse effects in terms of stimulating the growth of existing populations of flagellated phytoplankters. While only the effluent mixing area is affected at present, the greatly increased effluent volume projected for the cove will influence a larger area as a function of wind, tides, and other factors. The directive by the State of Connecticut Department of Environmental Protection to extend the new outfall area approximately one mile seaward into Fishers Island Sound is considered prudent.

KEYWORDS:

   Estuary*
   Sewage effluent*
   Pollution*
   Nitrate
   Phosphate
   B.O.D
   Coliforms
   Fecal Streptococci
   Phytoplankton*
   Benthic Invertebrates*
FIG. 1. Sampling stations in Mumford and Palmer Coves, Groton, Conn.
<table>
<thead>
<tr>
<th></th>
<th>Temp. (°C)</th>
<th>Salinity (‰)</th>
<th>D.O. (mg/L)</th>
<th>PO₄ (mg/L)</th>
<th>NO₃-N (mg/L)</th>
<th>BOD (mg/L)</th>
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</thead>
<tbody>
<tr>
<td><strong>Mumford Cove</strong></td>
<td></td>
<td></td>
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<tr>
<td>Sta. 1</td>
<td>0.6-24.6</td>
<td>0-29</td>
<td>3.3-13.0</td>
<td>0.04-12.25</td>
<td>0.24-5.3</td>
<td>0.6-12.3</td>
</tr>
<tr>
<td>Sta. M</td>
<td>1.1-20.0</td>
<td>12-30</td>
<td>5.7-11.7</td>
<td>0.0-0.20</td>
<td>0.12-0.95</td>
<td>0.1-2.6</td>
</tr>
<tr>
<td>Sta. 4</td>
<td>0.9-19.6</td>
<td>24-30</td>
<td>6.3-11.4</td>
<td>0.0-0.15</td>
<td>0.13-0.98</td>
<td>0.2-2.5</td>
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<tr>
<td><strong>Palmor Cove</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Sta. 5</td>
<td>-0.6-22.0</td>
<td>0.6-30</td>
<td>5.6-12.3</td>
<td>0-0.12</td>
<td>0-0.91</td>
<td>0.5-2.8</td>
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<tr>
<td>Sta. P</td>
<td>1.0-23.0</td>
<td>15-30</td>
<td>5.0-12.7</td>
<td>0-0.12</td>
<td>0.11-0.97</td>
<td>0.3-3.6</td>
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<tr>
<td>Sta. 8</td>
<td>0.4-25.6</td>
<td>0-27</td>
<td>2.8-15.7</td>
<td>0-0.14</td>
<td>0.11-1.68</td>
<td>0.3-7.1</td>
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