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M E M O R A N D U M
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To: Jim Krull, District Supervisor

From: Jerry Thielen, Environmentalist

Subject: Burley Lagoon Bacteriological Survey

INTRODUCTION

Burley Lagoon near Tacoma, Washington, is a prime growing area for Pacific oysters (*Crassostrea gigas*) that has been partially closed to commercial harvesting. Western Oyster Company (sole operator in the lagoon) is prohibited from harvesting in certain areas due to excessively high fecal coliform (FC) bacteria found in oyster tissue samples (Figure 1). The Department of Social and Health Services (DSHS) first observed fecal contamination in Burley Lagoon oysters during summer 1978 through their statewide monitoring of shellfish growing areas. When DSHS detects a noticeable increase in bacterial counts, intensive monitoring is conducted to verify the problem. This was the case in Burley Lagoon. DSHS made the final closure in September 1978 after detecting a buildup of fecal coliform levels exceeding 700 times the state market standard of 230 organisms/100 grams of oyster flesh.

DSHS also conducted an intensive door-to-door survey during the fall of 1978 which documented a number of failing septic systems and other sources (livestock, waterfowl, "public beach", etc.) polluting the lagoon's drainage basin. Both raw sewage and sewage effluent (visible signs of sewage contamination) were found to be discharging directly to the lagoon or feeder streams. Although DSHS identified a number of sources of fecal contamination around the lagoon, the agency did not feel that these were having a great enough impact to account for the high fecal levels detected in the oysters tested.

In February of 1979 the Department of Ecology (DOE) was requested by DSHS to conduct a bacteriological investigation to further identify possible sources of fecal contamination in Burley Lagoon. Because a period of five months had elapsed since the DSHS closure, the first objective of the DOE investigation was to determine current fecal coliform levels in Burley Lagoon. Objective two was to determine the impact of any sources of pollution identified and make recommendations.

DESCRIPTION OF STUDY AREA

Burley Lagoon is located in southern Puget Sound at the head of Carr Inlet (Figure 1). It is a narrow, flat-bottomed estuary measuring approximately two miles long by one-quarter mile wide, with a surface area of 370 acres. Except for a narrow passage to Henderson Bay, the lagoon is enclosed by a long, narrow sand spit that runs along its southern end. The shoreline is characterized by vacation cabins, permanent residences, and a small shopping center. The main freshwater sources are from Burley and Purdy Creeks, located at the northern end and mouth of the lagoon, respectively. In addition, the lagoon receives a substantial amount of runoff from intermittant flowing streams during periods of heavy rainfall.

METHODS

Sampling was conducted one (1) hour prior to low slack tide on March 5, 1979. Surface samples were collected for the water quality analysis.

Twenty stations were established within the study area (Figure 1). For all stations, the following five physical and chemical parameters were measured: fecal coliforms (org./100 ml); dissolved oxygen (mg/l) by Winkler method; pH (s.u.); temperature (°C); and specific conductance (μmhos/cm). Approximate salinity values were calculated from specific conductance values. In addition, oyster and sediment samples were collected at four stations (A through D).

A second sample run was made on March 28, 1979, at which time sediment and oyster samples only were collected from an area just south of the island (Figure 1). The purpose was to measure bacterial levels in the various sediment types.

DSHS conducted all fecal coliform analyses on the oyster tissue samples to assure uniformity with previous data. The remaining samples were split between DOE and DSHS laboratories. All samples were packed in ice and shipped to the appropriate lab for analysis.

Fecal coliform samples were collected from the water column using 200 ml sterile bottles and the standard "grab" technique. Approximately 150 grams of sediment per station was collected using a sterile scoop and whirl-pack plastic bag. Oyster samples were collected as per DSHS sampling procedures, as to size and condition of oysters. One (1) oyster sample comprised taking twelve (12) oysters from a station and compositing the meat tissue into one "blended" sample. A 100-gram subsample then was analyzed for FC bacteria. The Most Probable Number Test was used by both labs to analyze for fecal coliforms. Identical

procedures (Standard Methods for the Examination of Seawater and Shellfish, 1970) and media were used in the determination of both the presumptive and confirmed tests (Lauryl Tryptose Broth and E.C. Medium, respectively).

RESULTS

Water

Fecal coliform levels exceeded the state's water quality standard at all ten stations in Burley Lagoon (Class AA), at the time of the survey (Tables 1 and 2).

Table 1. Median Fecal Coliform Densities for Ten Stations in Burley Lagoon and Corresponding AA Water Quality Standards.

Class AA Standards Marine Waters	Burley Lagoon Average March 5, 1979
14 organisms/100 ml (median value)	280 organisms/100 ml (median value)
Not more than 10 percent exceeding 43 organisms/100 ml	90 percent exceeding 43 organisms/100 ml

Likewise, of seven streams sampled, three exceeded the state water quality standard for Class AA freshwater of 50 organisms/100 ml (Table 2). Of the remaining four streams, three were on the borderline in terms of the standard (Stations 1, 7, and 9). Of the stations that exceeded state standard, the unnamed tributary on the west side of the upper lagoon (Station 6) had the highest fecal coliform count at 7,000 organisms/100 ml. Although it is estimated that this unnamed stream accounts for less than 15 percent of the total freshwater inflow, it appears to be a significant coliform source. It drains an area which has a relatively large duck rearing pen. Both this creek and Burley Creek (Station 5) would appear to have their greatest effect upon the water quality of the lagoon when the lagoon is at low slack tide. At this time, dilution by the salt water is at a minimum and freshwater influence at a maximum.

The bacteriological condition of Henderson Bay (source of marine water) appeared to be generally good. Fecal coliform levels at Stations 11 and

12 were found to be less than 2 organisms/100 ml and 33 organisms/100 ml, respectively. The third station (#15), however, had a value of 230 organisms/100 ml, far above the standard of 14/100 ml. It appears that the count at this station is influenced by McCormack Creek (Station 14) and the Burley Lagoon discharge during ebb tide. The fecal coliform count at Station 14 (McCormack Creek) was 170 organisms/100 ml.

Dissolved oxygen and pH were found to be within limits for class AA waters. Aesthetics, although a relative type of parameter, was also found to be within limits for Burley Lagoon, i.e., no visible signs of sewage contamination such as sewage sludge were noticeable.

Oysters and Sediment

Oysters from the four sampling beds were found to be within the 230 organisms/100 gram standard for fecal coliform bacteria. Station D, which had the highest level of coliforms in the water column, had the lowest oyster tissue level (78 organisms/100 grams). Station B had the highest tissue count at 170 organisms/100 grams and a fairly high water column count at 230 col./100 ml. The type of sediment collected for analysis from the oyster beds was of a sandy, rocky composition. Analysis showed very low levels of fecal coliform organisms indicating no growth or accumulation of bacteria in these sediments at the time of the survey (Table 2).

Paired samples taken from mid-lagoon south of the island during the March 28 survey showed the important influence that sediment type has on fecal coliform levels in both the oysters and sediment. Fecal coliform levels were generally higher in sediment that was primarily mud (lower beach area), as opposed to the sandy, rocky upper beach area (Figure 1). Correspondingly, fecal coliform levels in oysters growing on the lower beach showed a ten-fold increase over those taken from the upper beach.

DISCUSSION

The water quality of Burley Lagoon is determined by existing conditions within its drainage basin. Burley and Purdy Creeks, Henderson Bay, and numerous seasonal streams all have varying degrees of influence on the lagoon's water quality. These appear to be affected by a variety of point and non-point fecal sources as determined in late 1978 by DSHS (Cox, 1978).

High fecal counts at Stations 3, 4, and 8 were apparently due to the levels of bacteria found in Burley Creek and the unnamed stream, Station 6 (Figure 1). At low slack tide, the northern half of the lagoon is completely devoid of salt waters. At this time freshwater influence is at a maximum and the quality of that freshwater is of vital importance to the lagoon's water quality.

Although the lagoon flushes almost completely on each tidal cycle (Kelley, 1963), there is evidence that a possible "sink" develops during ebb tide near the mouth of the lagoon and McCormack Creek. Fecals may build up here and are flushed back into the lagoon during flood tide. The high counts at Stations 16 and bed "D" seem to substantiate this theory.

CONCLUSIONS AND RECOMMENDATIONS

Although results of this survey show that fecal levels in Burley oysters were within the market standard of 230 organisms/100 grams, this in no way indicates that there are no longer problems in the lagoon. It is evident that lagoon oysters are capable of exceeding marketable limits for fecal coliforms based on the fact that there is a significant concentration of fecal coliform bacteria in the water column.

Previous work on Burley Lagoon oysters by Vasconcelos (1969) showed that fecal coliform bacteria had the greatest accumulation in oysters relative to the water, during the summer months when corresponding levels in the water were at their lowest. The least accumulation was observed during the winter when fecal coliform levels in the water column were high. An average accumulation rate of 20 times greater than ambient waters was documented over a year, with rates as high as 88 times observed. The higher accumulation with respect to the water is apparently due to the increased physiological activity of the oysters, brought about by increased ambient temperatures. Thus, under the right environmental conditions (warm temperatures or warm temperatures with rainfall), fecal coliform levels could exceed marketable limits in Burley Lagoon oysters. This could occur at any time of year with the greatest probability during the warmer months.

However, the fact that oyster samples were within market standards during the survey suggests possible alternatives to DSHS management. Survey work by DOE and Vasconcelos (1969) clearly shows that conditions can and do change within an area over a period of time, not only in terms of long-term effects, but from season to season. This should give DSHS another management tool in the decision-making process concerning the closing and re-opening of oyster beds throughout the state. It may be that oysters can be harvested from the closed area during some periods when fecal bacterial levels in the tissues are low. Any harvest operations would need to be closely monitored.

Fecal coliform contamination of Burley Lagoon appears to be caused mainly by nonpoint sources, from both Pierce and Kitsap Counties. Nonpoint pollution appears to be the main contributor of fecal coliforms to the lagoon (Cox, 1978), and both the state and local health agencies share in the responsiblity for controlling this source. Because of the complex problems associated with fecal contamination in the lagoon in terms of land use, it is imperative that representatives from agencies concerned (DOE, DSHS, and Pierce and Kitsap Counties) meet to develop an intra-agency plan for resolving bacterial problems in Burley Lagoon.

JT:cp

Attachments

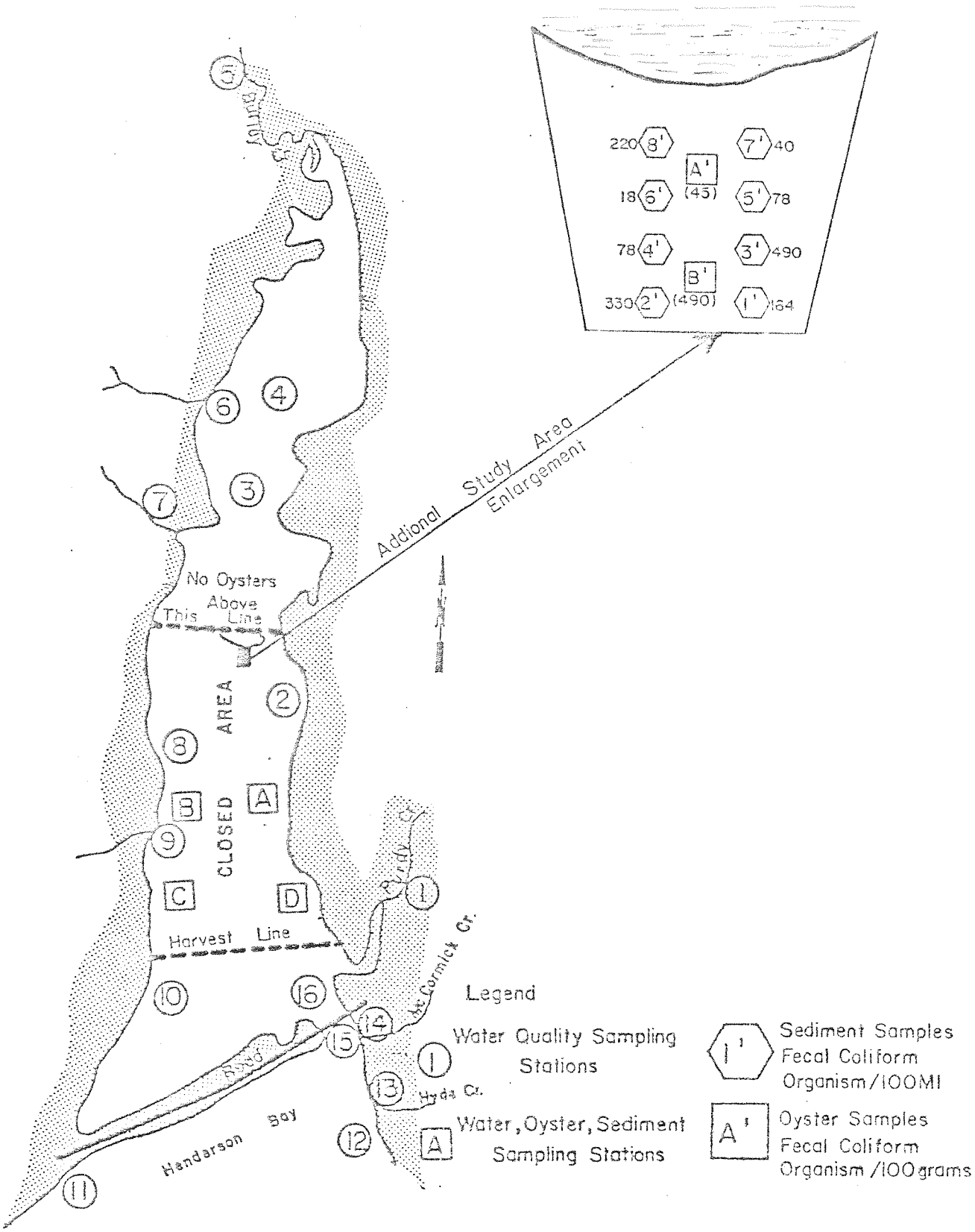

Figure 1 Bacteriological Sampling Stations
Burley Lagoon, Washington

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