Bacteriological Monitoring Studies to Identify Sources of Fecal Pollution at Baby Beach, Dana Point Harbor, California

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ABSTRACT (#738)

Baby Beach, at Dana Point Harbor, CA has had a history of impaired water quality resulting in frequent beach postings and closures due to high fecal indicator bacteria concentrations, especially *Enterococcus* spp. Numerous Best Management Practices (BMPs) to reduce bacterial levels have been implemented, yet the postings continue. Weekly bacteriological monitoring data indicate a general decline in concentrations of fecal and total coliform bacteria from 1999-2002, suggesting some benefit of current BMPs such as storm drain plugs and netting to discourage bird nesting. However, enterococci concentrations increased during the same period. Bacterial monitoring studies to identify potential sources of indicator bacteria such as storm drains, birds, and sediments were conducted. The study objective was to assess groundwater, storm drains, seagulls, sediments, and increased boating and beach bathing activities as sources of fecal indicator bacteria.

Coastal sediments/sands may serve as a reservoir of fecal indicator bacteria from multiple sources including animal and human feces and plants. Sediment/sands can filter bacteria present in water and also provide protection from sunlight and predation (5). Sediments can also provide organic nutrients that enhance bacterial accumulation, persistence and/or regrowth. Bacteria in sediments may affect levels in the overlying water. Storm drains can be significant sources of bacteria, nutrients and sediments that pollute receiving waters. Thus, densities of fecal indicator bacteria (total coliforms, fecal coliforms, *E. coli* and enterococci) in sediment and water samples collected along transects at nearshore sites and neighboring storm drain outfall area were determined using the membrane filtration method (1). *Enterococcus* species in water and sediments were determined using different identification methods, including API 20 STREP (Biomérieux), MicroScan® (Dade-Behring) and conventional biochemical testing. The bacteriological investigations conducted suggest that bacteria laden sediments, storm drains and seagull stools are major sources of fecal indicator bacterial pollution at Baby Beach.

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I. ABSTRACT

Baby Beach, at Dana Point Harbor, CA has had a history of impaired water quality resulting in frequent beach postings and closures due to high fecal indicator bacteria concentrations, especially *Enterococcus* spp. Numerous Best Management Practices (BMPs) to reduce bacterial levels have been implemented, yet the postings continue. Weekly bacteriological monitoring data indicate a general decline in concentrations of fecal and total coliform bacteria from 1999-2002, suggesting some benefit of current BMPs such as storm drain plugs and netting to discourage bird nesting. However, enterococci concentrations increased during the same period. Bacterial monitoring studies to identify potential sources of indicator bacteria such as storm drains, birds, and sediments were conducted. The study objective was to assess groundwater, storm drains, seagulls, sediments, and increased boating and beach bathing activities as sources of fecal indicator bacteria.

Coastal sediments/sands may serve as a reservoir of fecal indicator bacteria from multiple sources including animal and human feces and plants. Sediment/sands can filter bacteria present in water and also provide protection from sunlight and predation (5). The organic nutrients in sediment enhance persistence and/or regrowth to levels that may exceed standards in the overlying water. In addition to being significant sources of bacteria, storm drains may also contribute sediments. Thus, densities of fecal indicator bacteria (total coliforms, fecal coliforms, *E. coli* and enterococci) in sediment and water samples collected along transects at nearshore sites and neighboring storm drain outfall area were determined using the membrane filtration method (1). *Enterococcus* species in water and sediments were determined using different identification methods, including API 20 STREP (Biomérieux), MicroScan® (Dade-Behring) and conventional biochemical testing. The bacteriological investigations conducted suggest that bacteria laden sediments, storm drains and seagull stools are major sources of fecal indicator bacterial pollution at Baby Beach.

II. INTRODUCTION

Baby Beach is located in an urbanized harbor and is widely used by families with toddlers and young children because it is shallow and protected from strong surf. Weekly monitoring of fecal indicator bacteria (total and fecal coliforms and enterococci), used to assess beach water quality, indicate that the nearshore beach area is more frequently contaminated than the offshore sites in the harbor.

Finding fecal sources of contamination is complex since some species of coliform bacteria and enterococci that are normally present in the gastrointestinal tract of humans and animals can also be found in plants and soil and survive for prolonged periods. Some species of enterococci can survive on dry surfaces (i.e. fabrics and plastics) for up to 4 months (4,6). Thus, the levels of both "environmental" and fecally derived indicator bacteria in water may be more reflective of persistence or propagation in sediments/sand. Therefore, the presence of indicator bacteria in water is not always associated with fecal pollution. Since the 30-day log mean standards for total coliforms, fecal coliforms and enterococci per 100 ml ocean water are 1,000, 200 and 35 respectively, it is possible that the high levels bacteria in sediments could affect concentrations of the overlying water at Baby Beach.

To gain a better understanding of the sources and significance of indicator bacterial levels at Baby Beach and to recommend BMPs, spatial and speciation differences of enterococci isolates obtained from marine water were compared to those from sediments, seagulls, and water in storm drains. Since previous studies showed that high levels of indicators was correlated with fine sediments (2, 3), sediment particle sizes were also compared with indicator densities to examine the possible relationship of bacterial levels to sediments with higher proportions of silt and clay.

III. SAMPLE COLLECTION & ANALYSIS

Collect water sample using 100 ml bottle attached to pole

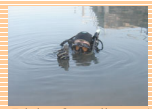
Water

Seagull Stool

Resuspend stool in PBS

Filter sample through membrane

Sediment



Diving for sediment (up to 7ft. depths)

Baby Beach and Dana Pont Harbor

Sonicate 10g sediment for 30s

Dry sediment @ 105°C

Culture & enumerate **Enterococci** on membrane using mEI agar

Sub-culture onto blood agar

Speciate isolate

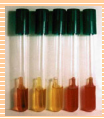
Culture and enumerate total and fecal coliforms and *E. coli* on membranes

Total Coliforms

Fecal Coliforms

E. coli

Biochemical tests for carbohydrate utilization,growth, tolerance andother chemicalreactions



API 20 Strep: Rapid method for carbohydrate utilization and enzyme reactions

MicroScan: Rapid, automated identification & antimicrobial susceptibility testing

High bacterial counts may result in beach postings

Separate sediments by particle size using sieves

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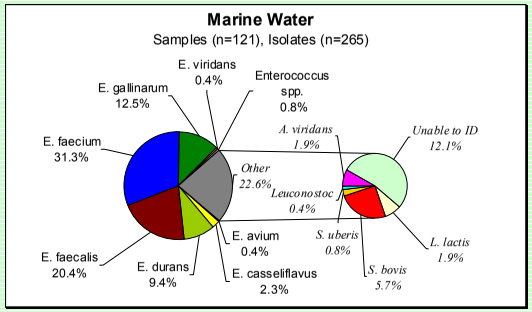
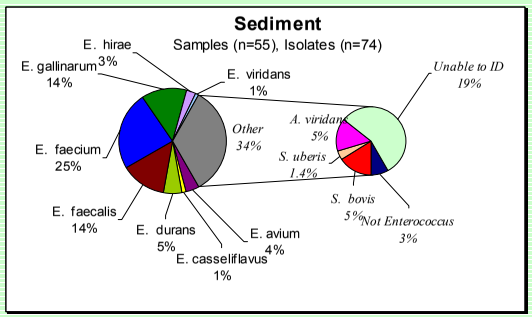
IV. RESULTS & DISCUSSION

Figure 1. Speciation of enterococci from marine water, sediments, and Seagull stool.





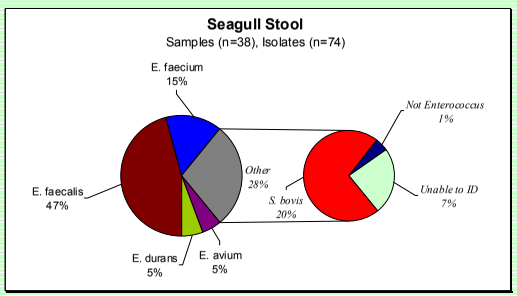


Figure 2. Sediment Transect Studies

The highest levels of enterococci and total coliforms were most frequently found in sediments proximal to the west end storm drain. The levels ranged from below detection limit (<90 CFU) to 200,000 CFU/10g sediment. *E. coli* was generally below detection limit. A direct correlation between levels of fecal indicator bacteria with sediment particle size was not found. High densities of bacteria were also found in fine and coarse sediments directly below the storm drain and from beach sand which may have been contaminated with seagull droppings. Up to 1.4 x 10^7/g enterococci were found in seagull stools.

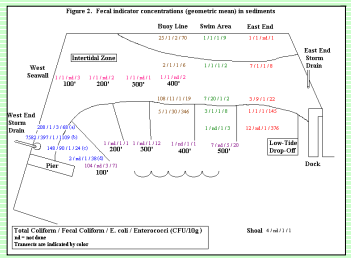


Figure 3. Special Studies

Circulation Study
A two-day circulation study was conducted to determine the amount of mixing in nearshore waters as compared to other areas in the harbor. The results indicated that flow conditions can hold surface waters and perhaps bacteria in the vicinity of Baby Beach, possibly contributing further to the high incidence of postings.

Water sampling for Boat Sewage Discharge Study

Boat Sewage Discharge Study
There was no obvious relationship between high boat use days and bacterial contamination. However, bacterial levels in water increased when there were large waves and swell along the outer breakwater possibly due to resuspended sediments.

West End Storm Drain
The west end storm drain was found to be a contributor of significant bacterial levels to sediment up to 50 ft. from the mouth of drain (Figure 2). Groundwater well studies confirmed that bacteria were not migrating through groundwater from the storm drains or sewer.
The distribution of enterococci species was similar in both marine water and sediments collected from nearshore and storm drain sites (Figure 1). The distribution pattern found in seagull stools was different, however some species found in seagulls were also found in water and sediments. The enterococci species distribution was also different in fresh water vs. marine water and sediments (data not shown). Up to 20% of the isolates from mEI may be species other than enterococci that may or may not reflect fecal contamination.

East End Storm Drain

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V. CONCLUSIONS

- The fecal indicator bacterial levels found in beach and storm drain water, sediments and seagull droppings indicate that they are significant sources of bacteria to Baby Beach as compared to boating and swimming activities. The bacteria may be localized to the beach area due to the geography/topography, design, and poor water circulation of the harbor.
- Concentrations as high as 2 x 10^5 CFU/10g of total coliforms and in particular, enterococci, were found in sediments, indicating that they may accumulate and persist in sediments, particularly those impacted by storm drain runoff and inadequate circulation of water.
- The distribution of enterococci species in sediments was similar to that of the overlying marine water, suggesting that coastal sediments may be an important reservoir of these organisms.
- The API 20 Strep and MicroScan identification systems were found to be generally reliable for identification of *E. faecalis* from environmental sources. However, for complete and accurate identification of other species of enterococci, we recommend the following supplemental testing in addition to API 20 S: gram stain, pigment, motility, catalase, and growth studies at 45ºC and 6.5% NaCl. Based on these identification methods, *E. faecium,* found in humans, animals and plants, was the most prevalent species in marine and sediment samples. *E. casseliflavus,* usually found in the environment, was the most prevalent species in storm drain water. *E. faecalis,* predominant in humans but also found in animals and plants, was the most common species found in seagull stools.
- Further studies are needed to assess seasonality of these results, the use of molecular typing techniques for specific source identification, and the reliability of fecal indicators of measures of beach pollution.

VI. REFERENCES

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