Influence of Nutrient Levels on *Enterococcus* spp.’s Growth at the Inner Cabrillo Beach, Port of Los Angeles

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EXECUTIVE SUMMARY

The physicochemical parameters, including carbon concentration (COD), ammonium ions (NH$_4^+$), nitrite ions (NO$_2^-$), nitrate ions (NO$_3^-$), total nitrogen, total phosphorus, orthophosphate, temperature and precipitation, were investigated in this study along with Enterococcus spp. abundance. The data showed the highest Enterococcus spp. abundance was found at the marsh, open beach and dock, respectively. The Pearson correlation coefficient (r) indicated significant relationships between 1) COD concentrations and Enterococcus spp. abundance at the dock, 2) Ammonia concentrations at the dock and Enterococcus spp. abundance at the beach, 3) total nitrogen concentrations at the dock and Enterococcus spp. abundance at the beach. Also, statistically significant correlation coefficient was observed between COD levels from marsh and beach locations. These findings suggest the COD, NH$_4^+$ and total nitrogen at the dock site influence the growths of Enterococcus spp. at the dock and beach sites.
PROJECT GOALS, BACKGROUND & SCOPE OF WORK

**Goal of the project:** to determine physicochemical parameters, especially the nutrient levels, in runoff water from the Dominguez Channel, LA Harbor Watershed and beach water, which affect *Enterococcus* spp.’s growth at the Inner Cabrillo Beach, Port of Los Angeles.

**Background and Scope of Work**

The Port of Los Angeles with the assistance from other City of Los Angeles departments, has implemented a series of corrective actions at the Inner Cabrillo Beach (ICB) since the Los Angeles Harbor bacteria Total Maximum Daily Load, Inner Cabrillo Beach and Main Ship Channel was adopted in 2005. Since 2000, corrective actions have been implemented to reduce bacterial concentrations and improve water quality at ICB such as institutional programs (public education, beach sand maintenance and signage) and physical engineering improvement projects such as sanitary and storm drain system replacement/repairs, rock groin removal at the northern end of the beach, bird dropping removal pilot studies and permanent bird exclusion structures. Despite these efforts, concentration of indicator bacteria such as *Enterococcus* spp., total coliform, *Escherichia coli* occasionally exceed water quality objectives (WQO) at the two compliance monitoring sites, CB01(dock location) and CB02(beach location). In addition to these monitoring sites, a third site was implemented as of February 2014 to investigate the influence of nutrient levels discharged from the Dominguez Channel and the LA Harbor Watershed to the unpredictable *Enterococcus* spp. outbreak (marsh location).
Figure 1: Monitoring site: the Inner Cabrillo Beach, Port of Los Angeles
PROJECT APPROACH

Water Sample Collection. The water samples were collected at sites CB01, CB02 and CB03, twice a week. Water samples were collected in pre-autoclaved 1 gallon glass jars using gloves and a cooler for transport. Figure 2 displays sampling at the salt marsh location.

![Figure 2: Salt marsh sampling](image)

Physicochemical Analysis. Physicochemical parameters measured in this study included COD, ammonium ions (NH$_4^+$), nitrite ions (NO$_2^-$), nitrate ions (NO$_3^-$), total nitrogen, total phosphorus and orthophosphate using HACH DR900 spectrophotometer (HACH, Loveland, CO) according to manufacturer procedure. Temperature and precipitation data were obtained from USGS website.

Microbiological Analysis. Water samples of 50, 100 and 250 mL were filtered and cultured in Petri dishes containing Microbiological Culture Media and incubated for 2-days at 35 degrees Celsius. Figure 3 shows Enterococcus culturing and their growths.
Figure 3. *Enterococcus* spp. culturing
PROJECT OUTCOME

The highest concentration of *Enterococcus* spp. was observed for the marsh samples (watershed outlet). However, this could not conclude that Dominguez Channel and the LA Harbor Watershed runoff water was the source because of the high, diverse wildlife living at the marsh and tidal contributing to the marsh water quality. In addition, high relationship of *Enterococcus* spp. abundance at the dock and beach area was observed (Fig. 4A).

The significant correlations were found between

- Carbon concentrations (COD) and *Enterococcus* spp. abundance at dock
  (Fig. 4B) $r = 0.47$
- Ammonia/Ammonium concentrations at dock site and *Enterococcus* spp. abundance at beach (Fig. 4C) $r = 0.50$
- Total nitrogen concentrations at the dock site and *Enterococcus* spp. abundance at beach (Fig. 4D) $r = 0.46$

From the above, significant Pearson correlation coefficient indicated that carbon constituent highly affected the *Enterococcus* spp. abundance at the dock location, but not for other locations. Moreover, both ammonia/ammonium concentrations and total nitrogen influenced *Enterococcus* spp. abundance at the beach location. Hence, this project showed the evidence of carbon and nitrogen levels in the water samples that possibly enhanced *Enterococcus* spp. abundance.

Although a number of studies found the relationship between precipitation data and *Enterococcus* spp. abundance, there was no relationship between precipitation data and *Enterococcus* spp. abundance at dock and beach area, since there was little precipitation during the study period. *Enterococcus* spp. abundance at the marsh location always resulted in TNTC
Figure 4: Relationship between Enterococcus spp. abundance and significant physicochemical parameters A) Enterococcus abundance at dock and beach, B) carbon concentrations (COD) Enterococcus abundance at dock. Remark: all physicochemical parameters diluted 40 times
Figure 4: Relationship between *Enterococcus* spp. abundance and significant physicochemical parameters C) Ammonia/Ammonium ions concentrations and *Enterococcus* abundance at beach and D) total nitrogen concentrations and *Enterococcus* abundance at beach. Remark: all physicochemical parameters diluted 40 times
CONCLUSION AND REMARKS

- The highest *Enterococcus* spp. was observed at marsh area which was connected to the Dominguez Channel and the LA Harbor Watershed runoff, but it could not be concluded that the runoff water was their source.

- This project showed the evidence of carbon and nitrogen levels in the water samples that possibly enhanced *Enterococcus* spp. abundance. For example, the significant Pearson correlation coefficient indicated that carbon constituent highly affected the *Enterococcus* spp. abundance at the dock location, and both ammonia/ammonium concentrations and total nitrogen influenced *Enterococcus* spp. abundance at the beach location.

- There was no significant correlation found between precipitation data and *Enterococcus* spp. because of low precipitation rates during the study period.
REFERENCE

1. Port of Los Angeles, “Inner Cabrillo Beach 2012-2013 Source Identification Surveys”