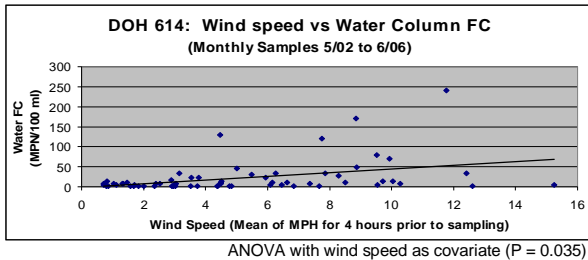


Fecal Coliforms (FC) on Intertidal Sediment Create Summer Critical Periods for Indicator Bacteria around Western Washington

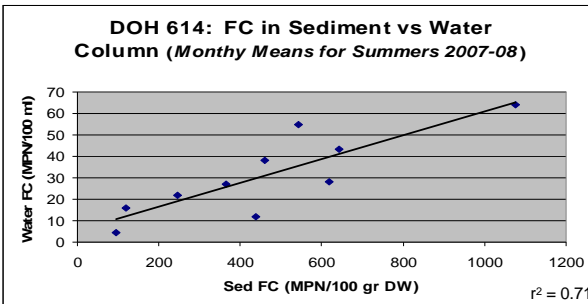
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Introduction: FC residing on intertidal sediment in upper Oakland Bay form a secondary source of indicator bacteria. Under windy conditions, they re-suspend into the water column. The effect is most pronounced in the summer. This phenomena has restricted shellfish harvest since 2006.

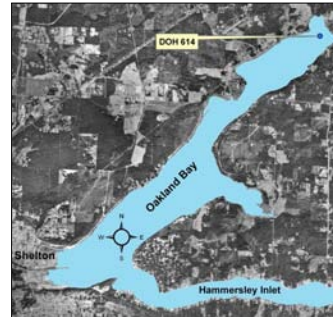
The geographic orientation and fetch of Oakland Bay exacerbates the problem. It is parallel to predominate winds which can enhance the scour of waves during flood tides.



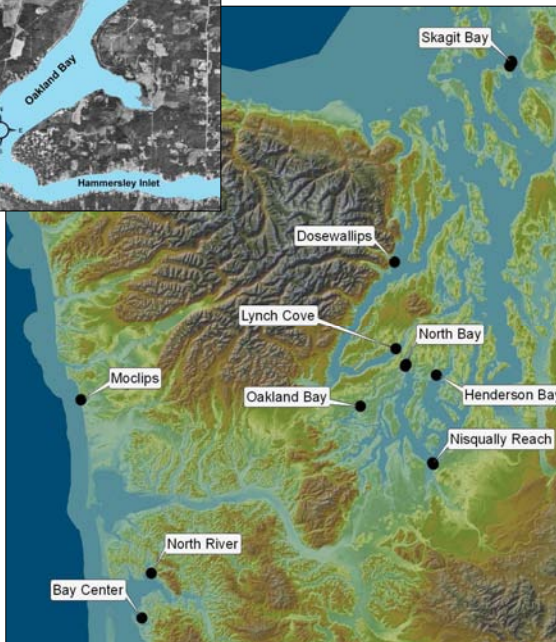
The FC population on the sediment surface increases from May through September, holds steady until December, and then declines again. The higher the summer FC concentration on the sediment surface, the higher the water column FC.



These results were duplicated in a TMDL model developed for Oakland Bay by DOE—a regression between wind speed and FC levels was ten times better at predicting observed FC concentrations in the marine water than using tributary loading alone.



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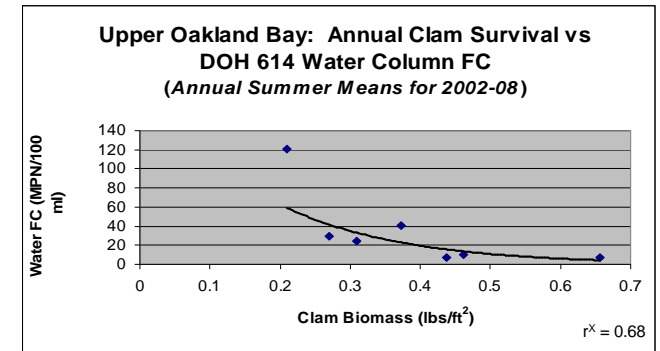
Location of Sites with a Summer Critical Period for FC

Recent Results: a review of the DOH Shellfish Program water quality database established the location of shellfish beds around Western Washington with similar conditions. About 1200 sampling stations were screened. The earliest data was from 1988.

Ten sites (see map) were identified where both 1) the summer geomeans exceeded the fall-winter-spring means by at least 5 cfu, and 2) the summer geomeans exceeded the 14/43 NSSP standard for safe shellfish harvest.

Conceptual Model: Rozen and Belkin (2001)² found that when supplied with sufficient organic nutrients, *E. coli* can grow in seawater almost as well as rich lab media. In Oakland Bay, nutrients may propagate through benthic fluxing and seasonal patterns of plankton growth and marine snow deposition to support substantial FC populations on sediment July-December. One season of data suggests a positive intra-annual correlation between daily concentrations of inorganic nitrogen species in the water column and sediment FC.

Inter-annually, one variable source of nutrients is shellfish mortality. A comparison of 7 years of shellfish survival data in the upper bay with summer mean water column FC concentrations identified an inverse correlation between the two variables.



Discussion: the conceptual model suggests there are links between nutrient and FC concentrations. Shellfish mortality may be one pathway. Further research combined with a model of the influence of wind and wave action may better explain intra- and inter-annual variation in observed summer FC concentrations around Western Washington.

Conclusion: cleaning-up FC-laden sediment is a necessary intervention point to protect summer shellfish harvest. Whether to focus on primary FC sources, nutrient loading/fluxing, sediment transport mechanisms, or other strategies is the subject of ongoing research in Oakland Bay. The results may be applicable at the other nine sites around Western Washington.

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² Rozen, Y and S Belkin. 2001. Survival of enteric bacteria in seawater. *FEMS Microbiology Reviews* 25:513-29.