

Example SURE Proposal: Marine Sciences

Southern California contains many remarkable oceanographic features. Here in San Diego, some of the most noticeable are the bays and estuaries that line the coast. Not only are these estuaries noticeable, but they “are among the most biologically productive environments on Earth” (Burton and Thurman, 2001). Estuaries are feeding grounds and nursery sites for a number of organisms and may be important habitats for migratory species. However, their important role in the biosphere could be undermined by anthropogenic pollutants and contaminants that enter the estuary via runoff, which is greatly intensified in metropolitan areas like San Diego.

One way to examine the influence of anthropogenic pollution on coastal systems is by studying potential effects of estuarine sediments on benthic communities. Where this relationship has been studied in different parts of the world, grain size distribution of sediment has been identified as a factor affecting benthic community abundance and composition. In addition to grain size, communities also may be affected by concentrations of heavy metals in the sediments (Chapman and Wang, 2001; Guerra- Garcia and Garcia-Gomez, 2004; Mucha et al., 2005).

High concentrations of heavy metals were found to be prevalent in sediment with high silt and clay content from an estuary in Northern Africa (Guerra-Garcia and Garcia-Gomez, 2004). These high concentrations of metals are known to affect benthic macrofauna, macroscopic organisms that live within the sediment matrix or at the sediment-water interface. Another study in the Douro Estuary in Portugal also revealed a relationship between high silt and clay content in the sediment, high heavy metal concentrations, and the distribution of benthic macrofauna (Mucha et al., 2005).

In San Diego, it is known that Mission Bay’s sediments contain many contaminants, including the heavy metals copper, lead, zinc, and cadmium (Kaufmann, 2004). All four of these heavy metals can be toxic in high concentrations but may alter the activity of benthic macrofauna even at low concentrations (Clark, 2001). In the eastern section of Mission Bay, near the entrance of Tecolote Creek, high concentrations of copper and zinc have been detected in the sediment (Kaufmann, 2004). However, the relationship between sediment composition, including heavy metals, and the distribution of benthic macrofauna has not yet been investigated in Mission Bay.

I plan to examine the relationship between sediment composition and benthic macrofauna in Mission Bay. In particular, I will address three questions. 1) What is the distribution of copper, lead, cadmium and zinc in sediments throughout Mission Bay? 2) What is the distribution of benthic macrofaunal abundance and diversity throughout Mission Bay? 3) How do sediment grain size distribution and metal concentration relate to the benthic macrofaunal community structure in Mission Bay?

Six sites within Mission Bay will be sampled during two monthly sampling events during the summer of 2006. Three sites will be located near the inlets of major creeks (Rose Canyon Creek, Tecolote Creek, Cudahy Creek), two will be in the larger embayments of the bay (Sail Bay, Fiesta Bay), and one reference site will be located near the mouth of the bay in an area off Ventura Point that is well flushed by tides. These sampling sites will be chosen to represent major regions of Mission Bay as well as areas likely to be influenced by runoff.

Benthic samples from each of the six study sites will be collected using a grab sampler deployed from a small boat owned by USD’s Marine Science and Environmental Studies department. From each sample, sediment grain size distribution will be analyzed in the laboratory with a Laser Particle Sorter. Sediment also will be analyzed for concentrations of cadmium, lead, copper, and zinc, using an Atomic Absorption Mass Spectrometer. If time permits, samples of sediment will be sieved into separate size fractions, and atomic absorption analysis will be conducted on each fraction to examine metal concentration in relation to sediment grain size class.

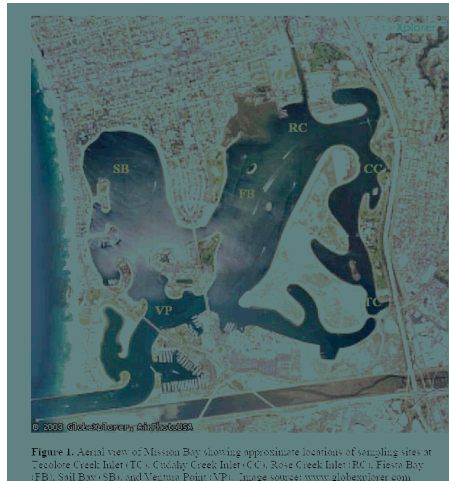


Figure 1. Aerial view of Mission Bay showing approximate locations of sampling sites at Teal Creek Inlet (TC), Crescent Creek Inlet (CC), Rose Creek Inlet (RC), Ferry Bay (FB), Sail Bay (SB), and Virginia Point (VP). Image source: www.globespotter.com

A second grab sample at each station will be collected and wet sieved on board the boat through a 1mm mesh sieve. The macrofauna retained in the sieve will be preserved in formaldehyde for later examination. In the lab, macrofauna will be counted, sorted, and identified under a stereo microscope. Species abundance and diversity will be calculated, and those results will be compared to the distribution of sediment grain size and heavy metals to examine relationships between sediment characteristics and macrofaunal community composition.

My proposed project is important for a number of reasons. First, this research will provide insight into the relationship between sediment contamination and benthic macrofaunal distribution in Mission Bay. Elevated levels of some heavy metals have been detected in sediments from Mission Bay, but whether the concentrations of those metals are correlated with variation in the benthic community has not yet been determined. Second, sediment-bound heavy metals can enter the food web, as benthic macrofauna may be eaten by larger animals, including fish and birds. The concentration and distribution of heavy metals in Mission Bay will allow people to evaluate the potential risks to birds, fish, and even humans, since some people catch fish in parts of the bay. Finally, heavy metals in the bay should be most concentrated in the sediments near their source. Identifying areas of particularly high heavy metal concentrations could help to identify areas that might benefit from increased efforts to control runoff and the input of pollutants into Mission Bay.

References:

Burton, E.A. and Harold V. Thurman. (2001). Introductory Oceanography: Ninth Edition. New Jersey: Prentice Hall.

Clark, R.B. (2001). Marine Pollution: Fifth Edition. Oxford: Oxford University Press.

Chapman, P.M. and F. Wang. (2001). *Assessing Sediment Contamination in Estuaries*. Environmental Toxicology and Chemistry, 20: 3-22.

Guerra-Garcia, J.M. and J. C. Garcia-Gomez. (2004). *Polychaete Assemblages and Sediment Pollution in a Harbor with Two Opposing Entrances*. Helgoland Marine Research: 58.183-191.

Kaufmann, R.S. (2004). *Mission Bay Water and Sediment Testing Project*. Final Report, City of San Diego. <http://www.sandiego.edu/~kaufmann/missionbay.html>

Mucha, A. P. M. Teresa S.D. Vanconcelos, Adriana A. Bordalo. (2005). *Spatial and Seasonal Variations of Macrobenthic Communities and Metal Concentration in Douro Estuary*. Marine Environmental Research 60: 531-550.