

Newport Coast ASBS Mussel Bioaccumulation Study

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Introduction

In 2006, the cities of Newport Beach and Laguna Beach initiated a program designed to assess the impacts of urban runoff, harbor contamination, stormwater runoff, and public trampling and scavenging activities on rocky intertidal communities living within the Newport Coast Area of Special Biological Significance (ASBS) and the Heisler Park ASBS. As part of this program, potential bioaccumulation of contaminants of concern were investigated using outplanted blue mussels (*Mytilus galloprovincialis*) at several locations within the Newport Coast ASBS and also in the entrance channel to Newport Harbor.



Key Issues

In a previous study, Buck Gully effluent exceeded water quality standards for concentrations of cadmium and copper, two metals known to bioaccumulate in animal tissues (WESTON, 2006). Because blue mussels have a propensity to rapidly bioaccumulate contaminants from their environment through actively filtering up to 50 liters of water per day, they are widely used as a sensitive water quality monitoring tool in assessing local concentrations of water-borne contaminants. Additionally, blue mussels can also be used as sentinels for the health of the ASBS since elevated contaminants detected in their tissues may not only be representative of water quality issues, but may also indicate potential toxicity in other animals (e.g., shore birds, crabs, snails, and sea stars) that may depend upon mussels for a significant portion of their diet.

Study Design

Vexar cages containing approximately 25 mussels per cage were installed within the intertidal zone at several sites within the Newport Coast ASBS. The study design's goal was to evaluate if contaminants entering the ASBS via effluent from Buck Gully were bioaccumulating within the ASBS's filter feeding community. Two sites, located at the mouth of Buck Gully (one intertidal and one subtidal), were selected to examine impacts from dry and wet weather runoff entering the ASBS via Buck Gully. Two additional sites located to the north of Buck Gully and to the south of Buck Gully examined the extent of the influence of Buck Gully effluent upon the intertidal filter feeding community.

A fifth site, located in the entrance channel to Newport Harbor, was selected to evaluate the level of contamination present in mussels feeding within Harbor waters and to compare against tissue concentrations of mussels residing within the intertidal waters of the Newport Coast ASBS.

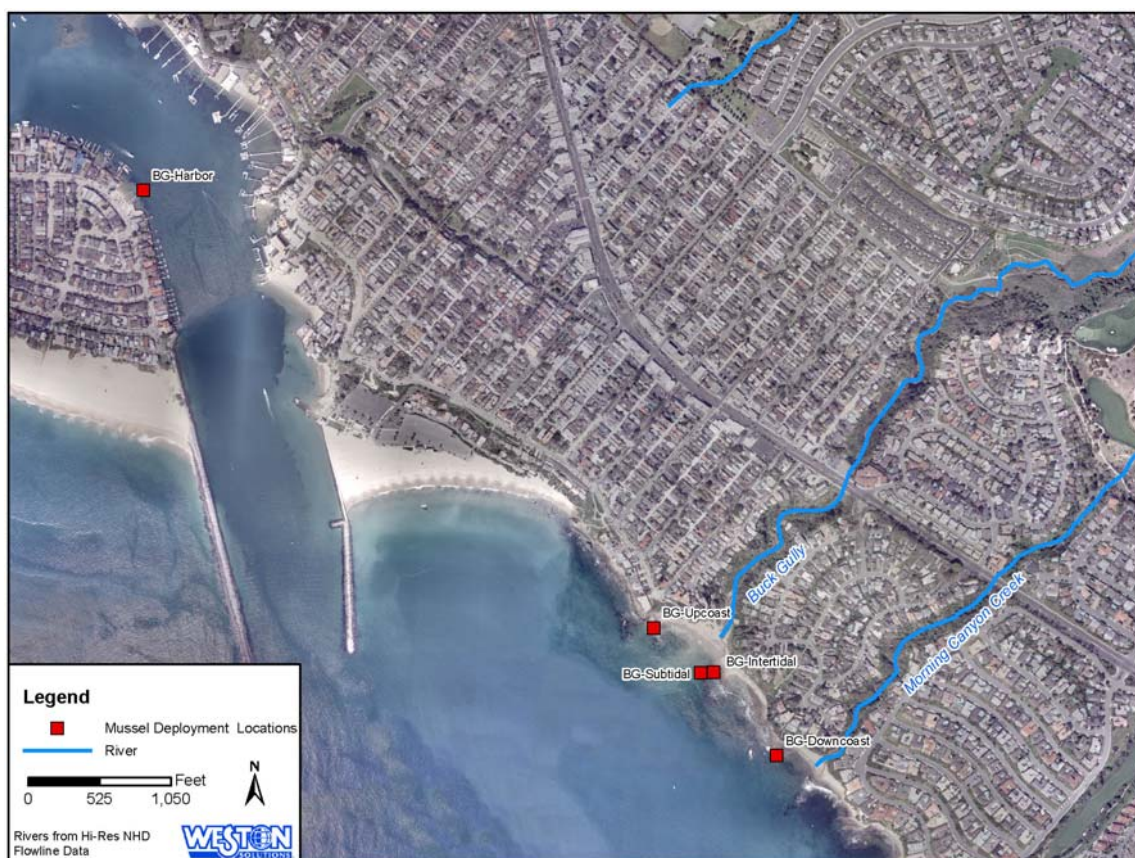


Figure 1. Mussel Outplant Locations

In addition to analyzing tissues of outplanted blue mussels for conventional contaminants (e.g., metals, pesticides, PAHs, PCBs, and pyrethroids) tissues were also analyzed for human viruses, coliphages, domoic acid, fecal indicator bacteria and species of *Vibrio* bacteria. Tissue contaminant levels in mussels from each station and to unexposed mussels were statistically compared, and contaminant concentrations found to be significantly elevated were compared to published residue-effects values using the USACE Environmental Residue Effects Database (ERED). ERED is a compilation of data taken from the scientific studies in which biological effects (e.g., reduced survival and growth) were measured in conjunction with tissue contaminant concentrations. Currently, the database is limited to those instances where biological effects observed in an organism are linked to one contaminant of concern within its tissues.

Reference toxicant testing using copper sulfate was performed in accordance with EPA Method 600/4-79-020 to determine the overall health and sensitivity of mussels prior to and subsequent to field exposures of three-month and six-month durations.

Results

Summarized results of tissue analyses are presented in Table 1. Only 4,4'-DDE and several metals (arsenic, cadmium, copper, lead, manganese, nickel, and zinc) were found to bioaccumulate significantly in outplanted mussels; however, concentrations of all accumulated contaminants were well below concentrations that have been shown to cause biological effects (Table 1). Mussel cages deployed in January 2007 were dislodged from all sites, and no mussels were recovered. In June 2007, mussels were re-deployed at the same locations and later retrieved from three intertidal locations and one harbor location after three-month and six-month field exposures. No mussels were recovered from the Site BG-Subtidal due to sand burial of the cages.

Table 1. Summary of Tissue Results in Mussels Deployed within the Newport Coast ASBS and Newport Harbor

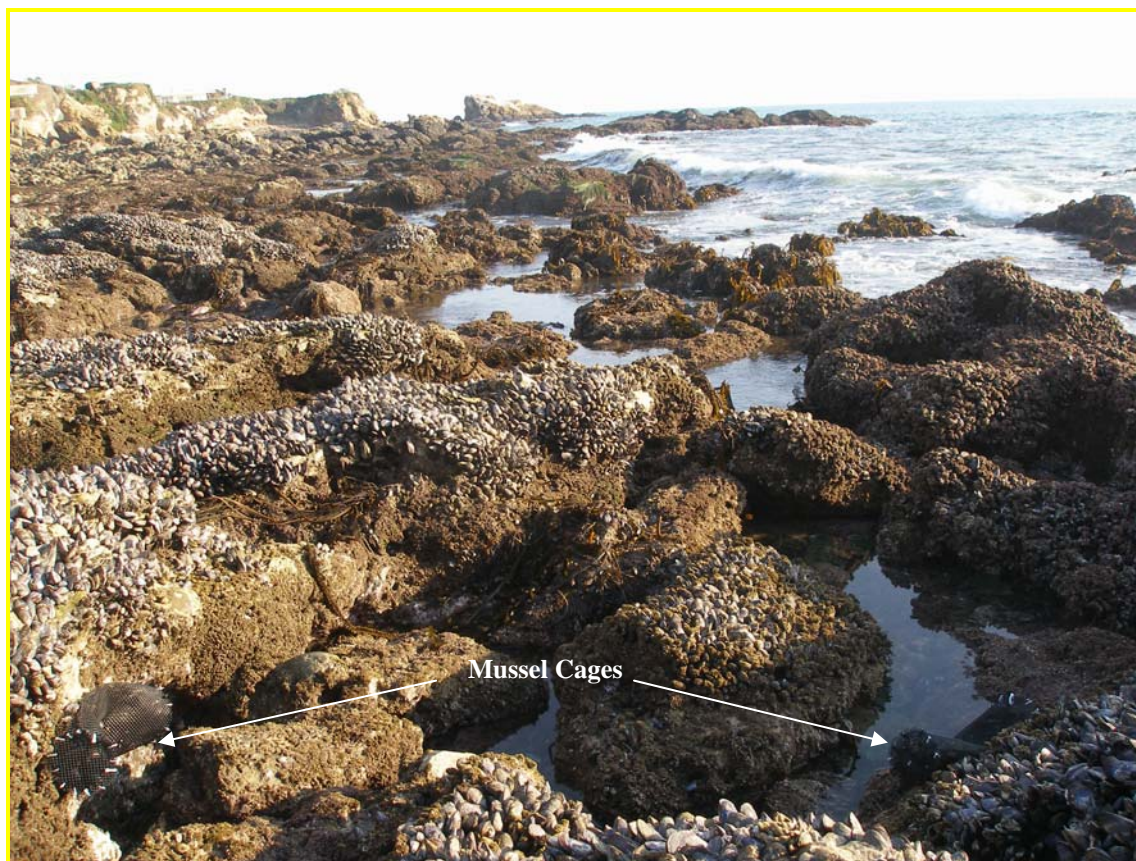
Analyte	BG-Intertidal	BG-Upcoast	BG-Downcoast	BG-Harbor	Comparison to ERED Database
PAHs	Detected in trace amounts	Detected in trace amounts	Detected in trace amounts	Detected in trace amounts	Concentrations across all sites were three to four orders of magnitude below effect levels.
Metals	Low concentrations of As, Cd, Cu, Pb, Mn, Ni, and Zn were detected	Low concentrations of As, Cd, Cu, Pb, Mn, Ni, and Zn were detected	Low concentrations of As, Cd, Cu, Pb, Mn, Ni, and Zn were detected	Low concentrations of As, Cd, Cu, Pb, Mn, Ni, and Zn were detected	All detected concentrations were three or more times lower than published NOED* values for relevant species.
PCBs	Not detected	Not detected	Not detected	Not detected	No data for relevant species
OP Pesticides	Not detected	Not detected	Not detected	Not detected	No data for relevant species
Synthetic Pyrethroids	Not detected	Not detected	Not detected	Not detected	No data for relevant species
Chlorinated Pesticides	4,4'-DDE detected in three-month exposures	4,4'-DDE detected in three-month exposures	4,4'-DDE detected in three-month and six-month exposures	4,4'-DDE detected in three-month and six-month exposures	Highest concentration of 4,4'-DDE detected in mussel tissue was 3.4 times lower than listed NOED for survival in zebra mussels (750 ug/kg)

*NOED refers to no observed-effect dose and is defined as the dose at which a test chemical does not cause an effect that is statistically different from the control.

Concentrations of fecal coliform and total coliform bacteria in mussels deployed for three-month and six-month field exposures were lower than pre-exposure mussel concentrations. *Vibrio spp.*, coliphage, and adenoviruses were infrequently detected in mussel tissues. Newport Harbor and BG-Intertidal had low amounts of fecal waste contamination. Domoic acid in mussel tissues (less than 0.2 parts per million) was significantly lower than the California Department of Public Health standard.

Summary of Findings for Mussel Bioaccumulation Study

Results of this study within the Newport Coast ASBS indicated that contaminants contained in Buck Gully runoff did not bioaccumulate in outplanted mussels to concentrations that have been shown to cause significant biological effects, regardless of the duration of exposure (e.g., three-month or six-month exposures). A summary of conclusions from the Mussel Bioaccumulation Study is provided below:



- Reference toxicant test results indicated that the sensitivity of the larvae spawned from adults (i.e., those exposed to water at BG-Intertidal, BG-Harbor, BG-Downcoast, and BG-Upcoast station locations) and exposed to copper sulfate was similar to that of larvae of unexposed adult mussels.
- Composited mussel tissues from individual deployment sites were not statistically different from other deployment sites.
- A composite of tissue from mussels deployed within the Newport Coast ASBS near the mouth of Buck Gully (i.e., BG-Upcoast, BG-Downcoast, and BG-Intertidal) was statistically elevated for 4,4'-DDE, barium, cobalt, iron, and manganese.
- Mussels collected in October 2007 after a three-month field exposure, contained a statistically higher percentage of lipids and higher total DDTs (4,4'-DDE was the only DDT product detected) than mussels collected in February 2008 after a six-month field exposure. However, concentrations of 4,4'-DDE were at least three times lower than concentrations in mussels where no biological effects were observed.

- Total PAHs were statistically higher in mussels collected after a six-month field exposure than in mussels that were not field exposed. Percent lipids were also statistically higher in Newport Coast ASBS mussels versus Newport Harbor mussels, indicating that increased concentrations of PAHs were associated with increased lipid content and associated contaminant capacity. In addition, concentrations of PAHs in mussels were at least four times lower than those concentrations shown to cause biological effects.
- Cadmium, selenium, and total PAHs were the only analytes statistically elevated in Newport ASBS mussels in comparison to Newport Beach Mussel Watch mussels. Concentrations of cadmium and total PAHs in Newport Coast ASBS mussels, however, were two or more orders of magnitude below levels in which chronic effects would be expected (McCarty and MacKay, 1993). No relevant data were available on the effects of selenium in closely related marine organisms.
- No PCB congeners, organophosphorus pesticides, or chlorinated pesticides, with the exception of 4,4'DDE, were detected in mussel tissue across all sites.
- Concentrations of fecal coliform and total coliform bacteria in mussels prior to deployment in the field were above concentrations in mussel tissues subjected to three-month and six-month field exposures.
- *Vibrio spp.*, coliphage, and adenoviruses were infrequently detected in the mussel samples suggesting that abnormal pollution from land runoff is not occurring to a significant extent. Two of the sampling sites (Newport Harbor and BG-Intertidal) indicated low amounts of fecal waste contamination. Domoic acid in mussel tissues was significantly lower than the state standard, suggesting that harmful algal blooms had not recently occurred in this area.

Literature Cited

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