Section 5 - Information Sources & Literature Cited

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Acknowledgements

This multidisciplinary study drew on the efforts and talents of many people at the Las Virgenes Municipal Water District (LVMWD). Staff worked long hours to collect, compile and analyze over 35 years of water quality data from the Malibu Creek watershed and produce this report within the six-month deadline specified in regulatory requirements. The JPA acknowledges their dedication and efforts, as well as those of other district staff who helped cover other duties of the project team at critical junctures.

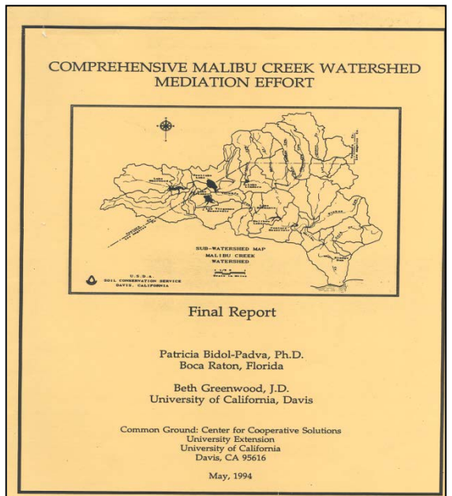
We also thank:

T. Reeder (Santa Ana RWQCB) for alerting us to historical phosphate mines in Orange County within the Monterey Formation (M Fm.) and M Fm. impacts in Newport Bay and Orange County coastal streams, S. Jasinski (USGS) for information on phosphate mining in Santa Barbara county, J. Izbicki (US Geological Survey) for sharing major ion data from the lower watershed and commonsense advice on metals testing in rock samples, and Alyssa Orton (CISU) and V. Scott (Viewpoint School) for assistance field sampling, and to Geolabs geologist C. Swift for sharing his knowledge of local M Fm. rock literally foot by foot at the Westlake Regional Recreation Facility grading site. We also thank the staff and volunteers of the Resource Conservation District of the Santa Monica Mountains for their surveys of steelhead trout and water quality, and the Los Angeles County Flood Control District and Dept. of Public Works and National Park Service, Santa Monica Mountain National Recreation Area for sharing data. A special note of thanks to M. Abramson, A. Lipman, K. Jontz and the Heal the Bay Stream Team® for over a decade of volunteer sampling in the Malibu Creek watershed and nearby coastal streams. Their efforts, since joined by the National Park Service, provided much of the data from the watershed's undeveloped areas. M. Potapova generously shared major ion data compiled for over 1,100 US streams from the U. S. Geological Survey National Water Quality Assessment Program (NAWQA), which highlighted the unique mineral character of Malibu Creek and its northern tributaries in relation to other U.S. streams. Dr. R. Ingersoll (UCLA) alerted us to recent findings on the tectonic and geologic setting of the Santa Monica Mountains and southern California. Early feedback on our geological findings and recommendations for further testing were provided following presentations to the Coast Geological Society and the Orange County chapter of the Groundwater Resources Association. We apologize to anyone we have overlooked who assisted with the production of this report or the data it contains.

About this revision: This report was originally submitted to the Los Angeles Regional Water Quality Control Board on March 31st , 2011. This June 24, 2011 revision corrects typographic and print layout errors overlooked in the earlier report, and corrects a statement in the earlier report on p. 29 where we originally stated that sulfate and specific conductance (SC) are tightly correlated when the data are grouped by region. This statement was too general. As shown in the figure associated with this statement, sulfate and SC levels in two of Malibu Creek's northern tributaries (Cheeseboro Creek and upper Las Virgenes Creek) vary much more than either Malibu Creek or any of its other tributary streams where we had data. We apologize for the oversight. It does not change any other finding or conclusions described in the original report. We welcome feedback from readers for use in any future revisions of the report, including additional data. See page 97.

The report's principal authors were Dr. Randal Orton, Janice Dougall, and Jacqy Gamble.

Malibu Creek Watershed Management -- A small sample of major studies within the watershed and important comparative works in other watersheds


COMPREHENSIVE MALIBU CREEK WATERSHED MEDIATION EFFORT

SUB-WATERSHED MAP MALIBU CREEK WATERSHED

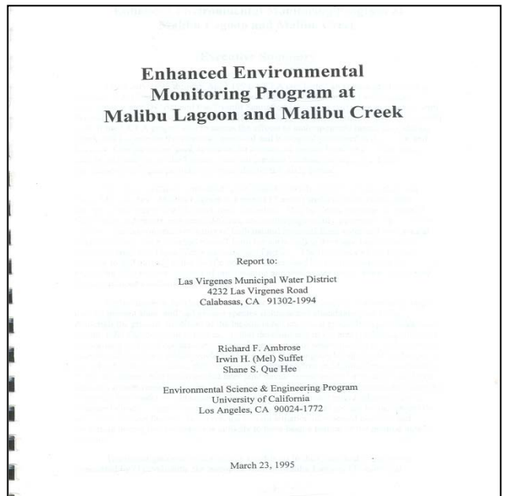
Final Report

Patricia Bidol-Padva, Ph.D.
Boca Raton, Florida

Beth Greenwood, J.D.
University of California, Davis

Common Ground: Center for Cooperative Solutions
University Extension
University of California
Davis, CA 95616

May, 1994


Enhanced Environmental Monitoring Program at Malibu Lagoon and Malibu Creek

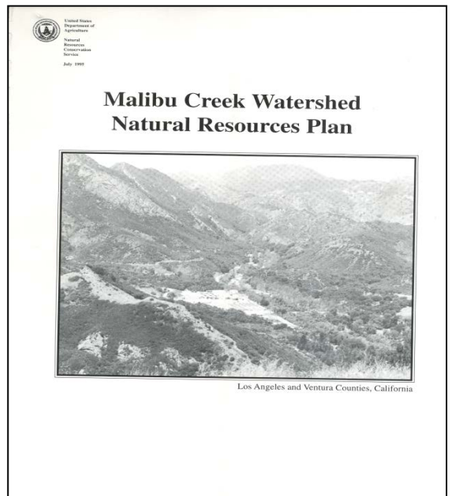
Report to:

Las Virgenes Municipal Water District
4232 Las Virgenes Road
Calabasas, CA 91302-1994

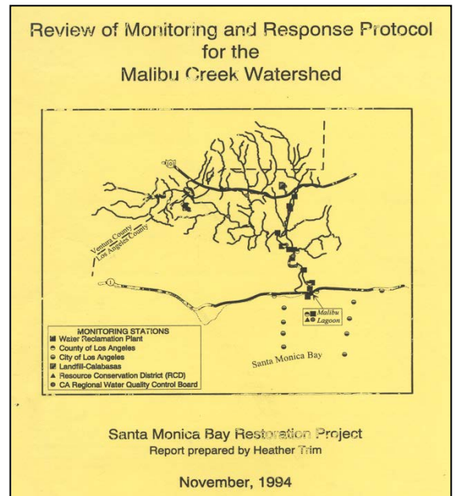
Richard F. Ambrose
Irwin H. (Mel) Suffet
Shane S. Que Hee

Environmental Science & Engineering Program
University of California
Los Angeles, CA 90024-1772

March 23, 1995


Malibu Creek Watershed Natural Resources Plan

Los Angeles and Ventura Counties, California


Review of Monitoring and Response Protocol for the Malibu Creek Watershed

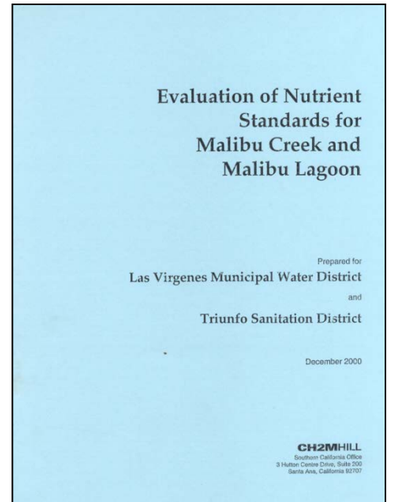
MONITORING STATIONS
Water Reclamation Plant
County of Los Angeles
City of Los Angeles
Landfill-Calabasas
Resource Conservation District (RCD)
CA Regional Water Quality Control Board

Malibu Lagoon

Santa Monica Bay

Santa Monica Bay Restoration Project
Report prepared by Heather Trim

November, 1994


Evaluation of Nutrient Standards for Malibu Creek and Malibu Lagoon

Prepared for
Las Virgenes Municipal Water District
and
Triunfo Sanitation District

December 2000

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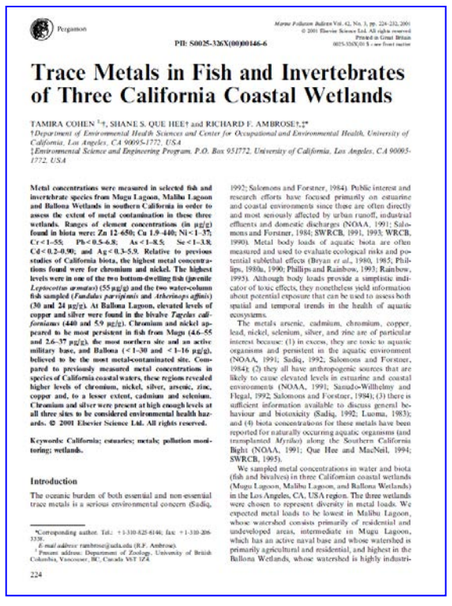
Southern California Office
3 Hutton Centre Drive, Suite 200
Santa Ana, California 92707


Pergamon

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Trace Metals in Fish and Invertebrates of Three California Coastal Wetlands

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Metal concentrations were measured in selected fish and invertebrate species from Mugu Lagoon, Malibu Lagoon and Ballona Wetlands in southern California in order to assess the extent of metal contamination in these three wetlands. Ranges of element concentrations (in μg/g) found in biota were: Zn 12–650; Cu 1.9–440; Ni < 1–37; Cr < 1–55; Pb < 0.5–6.8; As < 1–8.5; Se < 1–3.8; Cd < 0.2–0.90; and Ag < 0.3–5.9. Relative to previous studies of California biota, the highest metal concentrations found were for chromium and nickel. The highest levels were in one of the two bottom-dwelling fish (juvenile *Leptocottus armatus*) (55 μg/g) and the two water-column fish sampled (*Fundulus parvipinis* and *Atherinops affinis*) (30 and 24 μg/g). At Ballona Lagoon, elevated levels of copper and silver were found in the bivalve *Tagelus californianus* (440 and 5.9 μg/g). Chromium and nickel appeared to be most persistent in fish from Mugu (4.6–55 and 2.6–37 μg/g), the most northern site and an active military base, and Ballona (< 1–30 and < 1–16 μg/g), believed to be the most metal-contaminated site. Compared to previously measured metal concentrations in species of California coastal waters, these regions revealed higher levels of chromium, nickel, silver, arsenic, zinc, copper and, to a lesser extent, cadmium and selenium. Chromium and silver were present at high enough levels at all three sites to be considered environmental health hazards. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: California; estuaries; metals; pollution monitoring; wetlands.

Introduction

The oceanic burden of both essential and non-essential trace metals is a serious environmental concern (Sadiq, 1992; Salomons and Forstner, 1984). Public interest and research efforts have focused primarily on estuarine and coastal environments since these are often directly and most seriously affected by urban runoff, industrial effluents and domestic discharges (NOAA, 1991; Salomons and Forstner, 1984; SWRCB, 1991, 1993; WRCB, 1990). Metal body loads of aquatic biota are often measured and used to evaluate ecological risks and potential sublethal effects (Bryan *et al.*, 1980, 1985; Phillips, 1980a, 1990; Phillips and Rainbow, 1993; Rainbow, 1995). Although body loads provide a simplistic indicator of toxic effects, they nonetheless yield information about potential exposure that can be used to assess both spatial and temporal trends in the health of aquatic ecosystems.

The metals arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver, and zinc are of particular interest because: (1) in excess, they are toxic to aquatic organisms and persistent in the aquatic environment (NOAA, 1991; Sadiq, 1992; Salomons and Forstner, 1984); (2) they all have anthropogenic sources that are likely to cause elevated levels in estuarine and coastal environments (NOAA, 1991; Sanudo-Wilhelmy and Flegal, 1992; Salomons and Forstner, 1984); (3) there is sufficient information available to discuss general behaviour and biotoxicity (Sadiq, 1992; Luoma, 1983); and (4) biota concentrations for these metals have been reported for naturally occurring aquatic organisms (and transplanted *Mytilus*) along the Southern California Bight (NOAA, 1991; Que Hee and MacNeil, 1994; SWRCB, 1993).

We sampled metal concentrations in water and biota (fish and bivalves) in three Californian coastal wetlands (Mugu Lagoon, Malibu Lagoon, and Ballona Wetlands) in the Los Angeles, CA, USA region. The three wetlands were chosen to represent diversity in metal loads. We expected metal loads to be lowest in Malibu Lagoon, whose watershed consists primarily of residential and undeveloped areas, intermediate in Mugu Lagoon, which has an active naval base and whose watershed is primarily agricultural and residential, and highest in the Ballona Wetlands, whose watershed is highly industri-

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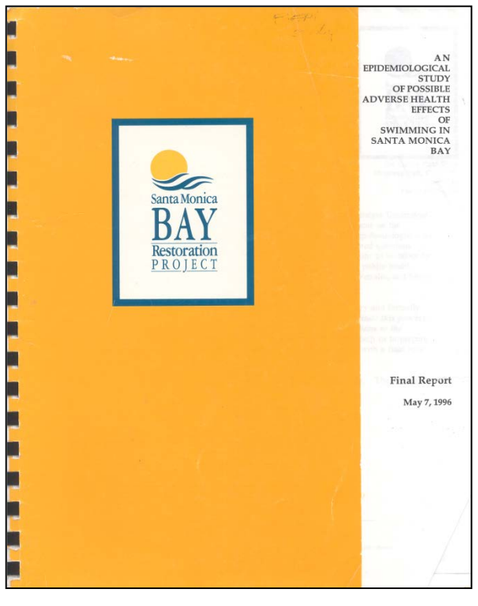
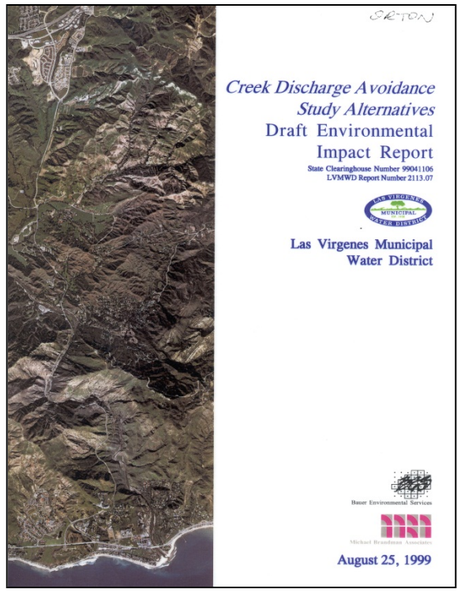

AN EPIDEMIOLOGICAL STUDY OF POSSIBLE ADVERSE HEALTH EFFECTS OF SWIMMING IN SANTA MONICA BAY

Santa Monica BAY Restoration PROJECT

Final Report

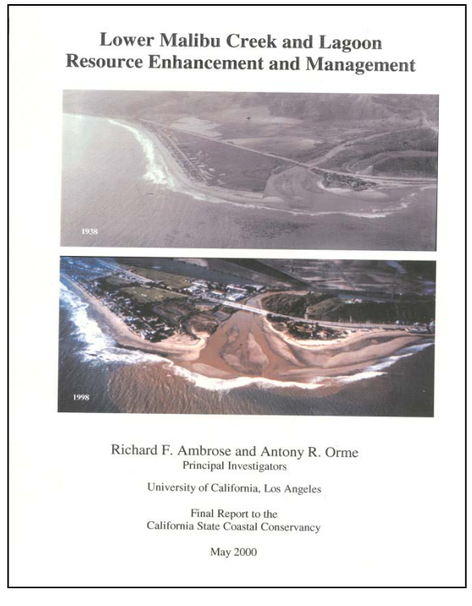
May 7, 1996


Creek Discharge Avoidance Study Alternatives
Draft Environmental Impact Report

State Clearinghouse Number 99041106
LVMWD Report Number 2113.07

Las Virgenes Municipal Water District

August 25, 1999


Lower Malibu Creek and Lagoon Resource Enhancement and Management

1938

1998

Richard F. Ambrose and Antony R. Orme
Principal Investigators

University of California, Los Angeles

Final Report to the
California State Coastal Conservancy

May 2000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Downstream effects of mountaintop coal mining: comparing biological conditions using family- and genus-level macroinvertebrate bioassessment tools

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Abstract. Surface coal mining with valley fills has impaired the aquatic life in numerous streams in the Central Appalachian Mountains. We characterized macroinvertebrate communities from riffles in 37 small West Virginia streams (10 unmined and 27 mined sites with valley fills) sampled in the spring index period (March–May) and compared the assessment results using family- and genus-level taxonomic data. Specific conductance was used to categorize levels of mining disturbance in mined watersheds as low (<500 μS/cm), medium (500–1000 μS/cm), or high (>1000 μS/cm). Four lines of evidence indicate that mining activities impair biological condition of streams: shift in species assemblages, loss of Ephemeroptera taxa, changes in individual metrics and indices, and differences in water chemistry. Results were consistent whether family- or genus-level data were used. In both family- and genus-level nonmetric multidimensional scaling (NMS) ordinations, mined sites were significantly separated from unmined sites, indicating that shifts in community structure were caused by mining. Several Ephemeroptera genera (e.g., *Ephemerella*, *Eeporus*, *Drunella*) and their families (Ephemerellidae, Heptageniidae) were correlated most strongly with the primary NMS axis ($r > 0.59$ for these genera; $r > 0.78$ for these families). These same Ephemeroptera were absent and, thus, eliminated from most of the mined sites. Total Ephemeroptera richness and relative abundance both declined with increasing mining disturbance. Several other metrics, such as richness, composition, tolerance, and diversity, clearly discriminated unmined vs mined sites. Most family-level metrics performed well and approximated the strength of genus-based metrics. A genus-based multimetric index (MMI) rated more mined sites as impaired than did the family-based MMI. Water-quality variables related to mining were more strongly correlated to NMS axis-1 scores, metrics, and MMIs than were sedimentation and riparian habitat scores. Generally, the correlations between the genus-level MMI and water-quality variables were stronger than the correlations between the family-level MMI and those variables. Our results show that mining activity has had subtle to severe impacts on benthic macroinvertebrate communities and that the biological condition most strongly correlates with a gradient of ionic strength.

Key words: bioassessment, coal mining, macroinvertebrates, specific conductance, Ephemeroptera, multimetric index, taxonomic resolution.

Many studies have shown that coal mining activities negatively affect stream biota in nearly all parts of the globe (e.g., Lewis 1973a, b; Scullion and Edwards 1980, Winterbourn and McDiffett 1996, Garcia-Criado et al. 1999, Kennedy et al. 2003). Acidic coal mine drainage (pH < 6) and associated water-quality degradation have been studied the most extensively of all effects (e.g., Herlihy et al. 1990, Maltby and Booth 1991, Winterbourn and McDiffett 1996, Verb and Vis 2000, Cherry et al. 2001, DeNicola and Stapleton 2002, Freund and Petty 2007). In the northern Appalachians and Allegheny Plateau, certain coal strata have higher S content than other strata and tend to cause acidic mine drainage. Some coal mining activities routinely produce acidic mine drainage, but mountaintop mining (MTM) in the steep terrain of the Central Appalachian coalfields of Kentucky, Virginia, and West Virginia generally results in alkaline mine drainage

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