WATER QUALITY IN THE SANTA MONICA BAY WATERSHED

UNDER THE
SURFACE WATER AMBIENT MONITORING PROGRAM
FISCAL YEAR 2001-2002

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EXECUTIVE SUMMARY

California's Surface Water Ambient Monitoring Program (SWAMP) is a comprehensive monitoring program designed to assess the quality of the beneficial uses of the State's water resources. SWAMP activities include surveying each hydrologic unit in the State at least once every five years; using consistent sampling methods, analytical procedures, data quality objectives, and centralized reporting requirements; analyzing spatial and temporal trends in water quality statewide; and evaluating waterbodies based on water quality standards and available data. Two types of monitoring are conducted under SWAMP: ambient monitoring, in which waters are surveyed without bias to known impairment, and site-specific monitoring, in which problem sites or clean sites (reference sites) are characterized.

The Los Angeles Regional Water Quality Control Board (LARWQCB) has developed an ambient monitoring program that obtains site-specific information while still encompassing regional ambient monitoring goals. Ultimately, this data will allow the LARWQCB to answer the following questions:

- What is the percentage of streams in a watershed or the region that support their beneficial uses (e.g., water contact recreation, cold freshwater habitat, etc.?)
- Is the percent of streams in a watershed or the region that support their beneficial uses increasing or decreasing over time?

In 2003-2004, the Santa Monica Bay (SMB) Watershed Management Area (WMA) was sampled. The SMB WMA is 414 $miles^2$ and encompasses a high diversity in geological and hydrological characteristics, habitat features, and human activities. The WMA includes downtown Los Angeles, small, urban watersheds, and several large watersheds, such as the Malibu Creek and Ballona Creek watersheds. Urbanization has had a significant impact on the riparian and wetland resources of the watershed, primarily through filling, alteration of flows, and decrease in water quality. Existing and potential beneficial use impairment problems in the watershed fall into two major categories: human health risk, and natural habitat (wildlife) degradation. Prior to this study, various reaches of this watershed had been 303(d) listed for beach closures, swimming restrictions, shellfish harvesting advisories, enteric viruses, pathogens, bacteria, algae, eutrophication, unnatural scum/foam, ammonia, odors, low dissolved oxygen (DO) and/or organic enrichment, trash, mercury, lead, cadmium, copper, nickel, silver, arsenic, zinc, selenium, tributyl tin, toxicity, benthic community effects, fish consumption advisories, sediment toxicity, PAHs, DDT, pesticides, PCBs, dieldrin, chlordane, exotic vegetation, habitat alteration, hydromodification, reduced tidal flushing, debris, chloride, and specific conductance. The main goal of the sampling in the SMB WMA was to obtain an overall view of the health of the watershed. Additionally, the monitoring plan was been designed to provide information on potential reference sites in the watershed, and beneficial use attainment or non-attainment.

Sixty-one sites distributed among the approximately 30 coastal sub-watersheds of the SMB WMA were selected for sampling. In most cases, two stations were sampled in each sub-watershed. Sampling was completed at 59 sites; two sites were dry during sampling events. Sampling was conducted during the spring seasons of 2003 and 2004. Sampling at all stations included field measurements (conductivity, DO, pH, salinity, temperature, turbidity, and current speed), conventional water column chemistry (alkalinity, ammonia-N, boron, chloride, chlorophyll a, conductivity, dissolved oxygen, fluoride, hardness, nitrate-N, nitrite-N, orthophosphate, sulfate, total dissolved solids (TDS), temperature, total Kjeldahl nitrogen (TKN), total phosphorous (P), and turbidity) and bacteriology. Bioassessment was conducted at 39 sites and enzyme-linked immunosorbent assay (ELISA) analyses for chlorpyrifos and diazinon were conducted at 37 sites. During spring 2003, a subset of 20 stations was sampled for water column toxicity, dissolved metals, and organophosphate chemistry, and another subset of 5 stations was sampled for dissolved metals only. Additionally, 2 lower sub-watershed stations located near gas stations were tested for MTBE.

A number of water quality concerns were indicated in the SMB WMA. DO was < 90% saturation at 34 sites during at least one sampling event. pH was > 8.5 at 9 sites. Basin Plan objectives for conventional constituents do not exist for many of the small urban watersheds of the SMB WMA, but concentrations of several constituents exceeded other suggested thresholds. Boron exceeded the California Department of Health Services (DHS) action level for drinking water of 1.0 mg l^{-1} at 5 sites, chloride exceeded USEPA criteria for protection of aquatic life at 13 sites, chlorophyll a exceeded the USEPA suggested threshold value for reference conditions in level III (Xeric West) ecoregion 6 of 2.39 µg l^{-1} at 14 sites, and fluoride exceeded the California Public Health Goal for drinking water for toxicity to humans of 1.0 mg l^{-1} at 6 sites. Sulfate and TDS concentrations exceeded California Secondary MCLs at most sites; sulfate and TDS concentrations from Las Virgenes Canyon Creek exceeded Basin Plan objectives. All nitrate-N + nitrite-N values were below the Basin Plan MCL of 10.0 mg l^{-1}, but many total N values exceeded the USEPA level III ecoregion 6 suggested threshold value for reference conditions of 0.518 mg l^{-1}. Orthophosphate-P and total P exceeded the USEPA recommended limits of 0.10 mg l^{-1} at many sites, and total P at most sites exceeded the USEPA level III ecoregion 6 suggested threshold value for reference conditions of 0.03 mg l^{-1}.

E. coli and fecal coliform exceeded freshwater single sample limits at sites throughout the SMB WMA, and Enterococcus and total coliform exceeded marine single sample limits at one brackish station. We were not able to compare Enterococcus or total coliform to the freshwater geometric means or log means presented in the Basin Plan because those criteria are based on calculations requiring at least 4 samples.

The metals sampled were aluminum, arsenic, cadmium, chromium, copper, lead, manganese, nickel, selenium, silver and zinc. With the following exceptions, all concentrations were below Basin Plan objectives or criteria for toxicity to aquatic life: manganese at 9 sites exceeded the California secondary MCL, and at three of those sites, concentrations exceeded the California DHS action level for drinking water; nickel at two sites exceeded a California Toxics Rule (CTR) criterion; and selenium at 7 sites exceeded National Toxics Rule (NTR) criteria for aquatic life.

With the exception of chorpyrifos and diazinon, no other organic compounds were detected. Chlorpyrifos and diazinon each exceeded the California Department of Fish and Game (CDFG) criteria for toxicity to aquatic life at 3 sites.

Acute and chronic water column toxicity were detected at 6 sites in the SMB WMA. Five of these sites were each in the lower portion of their respective sub-watersheds. Likely causes of toxicity cannot be identified from the data. Benthic IBI scores ranged from 4 to 78 and represented four condition categories ranging from Very Poor to Good. No scores were in the Very Good category. Condition varied throughout the SMB WMA. Inconsistent patterns in physical habitat, water chemistry, and toxicity data prevent the conclusion of which factors contribute to degraded biotic condition.

There were no discernible patterns between years for any of the parameters, but there were differences between upper and lower sites within individual watersheds. However, differences were not consistent among watersheds. In several watersheds, more water quality problems were indicated in the lower portions, while in other watersheds conditions were similar among sites. However, in some cases the upper and lower sites were located very close together and may not truly represent the upper and lower portions of the watershed. The ability to compare conditions in the upper versus lower portions of watersheds and make generalizations about spatial patterns in water quality within watersheds is limited by the lack of consistent sampling among sites within a watershed.

SWAMP program goals and specific goals for monitoring in the SMB WMA were met. An overall view of the condition of the watershed has been provided, and this information can be used to identify potential reference sites and determine beneficial use attainment or non-attainment. However, the deterministic sampling design used in the SMB WMA study does not have the statistical power necessary for making conclusions with regard to the watershed as a whole. The results of this study cannot contribute to answering the questions the LARWQCB originally posed regarding the percentage of streams in the watershed or region that support beneficial uses, and how that percentage is changing over time. Additionally, the original study design for the SMB WMA called for locating two sites in a sub-watershed, one site in the upper watershed and the other in the lower watershed near its intersection with Pacific Coast Highway. However, due to the ability to find sites with running water and access, sites designated “Upper” were not always in the true upper portion of the watershed, and in some cases were located in close proximity to the “Lower” sites. Thus, not all paired Upper and Lower sites in this study represent a true comparison of the characteristics of the upper and lower portions of the watersheds. However, this may be virtually impossible due to the ephemeral nature of southern California streams. Lastly, in the future, a more complete view of this watershed, or others, could be gained if the triad approach was used at every site and if water chemistry included all the available analyses.

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LIST OF ABBREVIATIONS

%R	Percent Recovery
AB	Assembly Bill
ABL	California Department of Fish and Game Aquatic Bioassessment Laboratory
B-IBI	Benthic Index of Biotic Integrity
CCC	Criterion Continuous Concentration
CDFG	California Department of Fish and Game
CFCP	Coastal Fish Contaminants Project
CMC	Criterion Maximum Concentration
CRM	Certified Reference Material
CTR	California Toxics Rule
CWA	Clean Water Act
DFG-WPCL	California Department of Fish and Game-Fish & Wildlife Water Pollution Control Laboratory
DHS	Department of Health Services
DNQ	Detected Not Quantified
DO	Dissolved Oxygen
ELISA	Enzyme-Linked Immunosorbent Assay
FDQ	Field Blind Duplicate
FIA	Flow Injection Analysis
LARWQCB	Los Angeles Regional Water Quality Control Board
LCM	Laboratory Control Material
LCS	Laboratory Control Spike
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MLML-TM	Moss Landing Marine Laboratories Trace Metals Laboratory
MPSL-DFG	California Department of Fish and Game-Marine Pollution Studies Laboratory
MS	Matrix Spike
MSD	Matrix Spike Duplicate
N	Nitrogen
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
OP	Organophosphate Pesticide
P	Phosphorus
QA/QC	Quality Assurance/ Quality Control
QAMP	Quality Assurance Management Plan
RL	Reporting Limit
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
SFL	Sierra Foothills Laboratory, Inc.
SMB	Santa Monica Bay
SMWP	State Mussel Watch Program
SOP	Standard Operating Procedure

SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TSMP	Toxic Substances Monitoring Program
TTP	Toxicity Testing Program
UCD-GC	University of California, Davis-Granite Canyon Marine Laboratory
USACE	US Army Corps of Engineers
USEPA	US Environmental Protection Agency
VOC	Volatile Organic Compound
WMA	Watershed Management Area
WMI	Watershed Management Initiative

Units

l	liter
ml	milliliter
µl	microliter
g	gram
mg	milligram
µg	microgram
ng	nanogram
kg	kilogram
ppt	part per thousand
ppm	part per million
ppb	part per billion

Equivalents

1 ppt	1 mg/g
1 ppm	1 mg/kg, 1 µg/g, 1 mg/l
1 ppb	1 µg/kg, 1 ng/g, 1 µg/l

1 INTRODUCTION

1.1 Overview of the Surface Water Ambient Monitoring Program (SWAMP) in California

The quality of surface waters in the state of California is provided for by the Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA). These acts require implementation of efforts intended to protect and restore the integrity of surface waters. However, current monitoring and assessment capability at the State Water Resources Control Board (SWRCB) is limited and tends to be focused on specific program needs. This has led to a fragmentation of monitoring efforts resulting in gaps in needed information and a lack of integrated analyses. A solution to this problem was presented in California Assembly Bill (AB) 982 (Water Code Section 13192; Statutes of 1999), which required the SWRCB to prepare a proposal for a comprehensive surface water quality monitoring program. This ambient monitoring would be independent of individual water quality programs and would provide a measure of (1) the overall quality of water resources and (2) the overall effectiveness of Regional Water Quality Control Boards' (RWQCB) prevention, regulatory, and remedial actions. When fully implemented, AB 982 will help to alleviate the fragmented water quality issues within the State.

The SWRCB Report to the Legislature from November 2000 entitled "Proposal for a Comprehensive Ambient Surface Water Quality Monitoring Program" (November 2000 Legislative Report) proposed to restructure existing water quality monitoring programs into a new program, the Surface Water Ambient Monitoring Program (SWAMP). The proposal focused on a number of programmatic objectives designed to assess the quality of the beneficial uses of the State's water resources. Some of these objectives are satisfied with the information produced by existing monitoring efforts within the SWRCB and other agencies. Each of the SWRCB and RWQCB's existing monitoring programs, e.g., the State Mussel Watch Program (SMWP), the Toxic Substances Monitoring Program (TSMP), the Toxicity Testing Program (TTP), Coastal Fish Contaminants Project (CFCP), and fish/shellfish contamination studies, have been incorporated to the extent and manner possible into SWAMP to ensure a coordinated approach without duplication. SWAMP also coordinates with other programs implemented in the State to assure that the ambient monitoring efforts are not duplicated.

When fully implemented, SWAMP will cover four activities:

- Comprehensive environmental monitoring focused on providing information necessary to effectively manage the State's water resources. Each hydrologic unit will be surveyed at least once every five years and all waters will be included without bias to known impairment;
- Consistency in sampling methods, analytical procedures, data quality objectives, and centralized reporting requirements;
- Analysis of spatial and temporal trends in water quality statewide; and
- Development of a Water Quality Control Policy and consistent implementation of the CWA section 303 (d) procedures for listing and delisting of waterbodies based

on water quality standards and available data. SWAMP data can also be used in the bi-annual water quality reports to the United States Environmental Protection Agency (USEPA) required by section 305 (b) of the CWA.

These activities contribute to the goals or expected end-products of SWAMP:

- Creation of an ambient monitoring program that addresses all hydrologic units of the State at least one time every five years using consistent and objective monitoring, sampling and analytical methods; consistent data quality assurance protocols; and centralized data management;
- Documentation of ambient water quality conditions in potentially clean and polluted areas;
- Identification of specific water quality problems preventing the SWRCB, RWQCBs, and the public from realizing beneficial uses of water in targeted watersheds; and
- Data to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of waters of the State.

However, funding is not currently available to implement SWAMP fully. As a result, SWAMP primarily focuses on the site-specific needs of each RWQCB. The RWQCBs were charged with establishing monitoring priorities for the water bodies within their jurisdictions. Efforts primarily focused on site-specific monitoring to better characterize problem sites or clean locations (reference sites) to meet each RWQCB's needs for 303(d) listing, Total Maximum Daily Load (TMDL) development, and other core regulatory programs. During this first phase, RWQCBs were able to use SWAMP resources to address high priority water quality issues in their region, while following SWAMP protocols to ensure statewide data comparability. When additional funding is available in the future, activities designed to achieve the overall goal of developing a statewide picture of the status and trends of the quality of California's surface water resources will be initiated.

1.2 Goals of SWAMP in the Los Angeles Region

In the Los Angeles region, both the Site-Specific Monitoring goals and the Regional Monitoring goals have been integrated into one ambient monitoring program that encompasses regional goals while still obtaining site-specific information. The Site-Specific Monitoring portion develops site-specific information on representative sites or water bodies that are (1) known or suspected to have water quality problems and (2) known or suspected to be clean. Uses of this information include, but are not limited to, development of 305(b) reports, 303 (d) listing or delisting, TMDL development, and NPDES permit renewals. Ultimately, the following questions will be answered:

- What is the percentage of streams in a watershed or the region that support their beneficial uses (e.g., water contact recreation, cold freshwater habitat, etc.?)
- Is the percent of streams in a watershed or the region that support their beneficial uses increasing or decreasing over time?

1.3 Overview of the Los Angeles Region SWAMP Program

Sampling and analysis will be used to assess ambient conditions of watersheds in Los Angeles and Ventura counties and will further delineate the nature, extent, and sources of toxic pollutants which have been detected or are suspected to be problematic for this region and its individual watersheds. In general, in lieu of extant temporally and spatially diverse information on a watershed, the approach is to assess the watershed by sampling randomly selected sites while assessing the tributaries by sampling directed sites. Where extensive information is already available or where the watershed is small and therefore does not lend itself to a random sampling design, the watershed is assessed by sampling directed sites.

Where applicable, a triad approach (benthic community analysis, water chemistry, and toxicity testing) will be used. The benthic community analysis, or bioassessment, historically has been overlooked but is useful in assessing water quality because of 1) the sensitivity of benthic macroinvertebrates to low-level disturbances and 2) the integration of water quality conditions over time. Thus, the composition of aquatic communities reflects a cumulative response to multiple stressors over time and is a direct measure of ecological condition. The analysis performed will follow the California Stream Bioassessment Protocol developed by the California Department of Fish and Game (CDFG), which focuses on the benthic macroinvertebrate assemblage and a physical habitat assessment. The information gathered will be used in trend analysis, identifying impaired beneficial uses, as well as potentially in the development of an index of biological integrity.

1.4 Selection and Description of Sampled Waterbodies

Watershed Selection

The Los Angeles Regional Water Quality Control Board (LARWQCB) proposes to visit each hydrologic unit one year ahead of the Watershed Management Initiative (WMI) schedule for targeted watersheds, which rotate on a five-year cycle. This allows for data to be gathered, analyzed, and interpreted for use the following year during NPDES permit renewals, development of 305(b) reports, 303(d) listing of Water Quality-Limited segments, and TMDL development. The Santa Monica Bay (SMB) Watershed Management Area (WMA) (Figure 1) was on the WMI schedule for 2003-2004, thus it was sampled under the second year of SWAMP funding, fiscal year 2001-2002.

Watershed Description

The SMB WMA is 414 miles^2 and encompasses a high diversity in geological and hydrological characteristics, habitat features, and human activities. The WMA includes several large sub-watersheds, such as the Malibu Creek and Ballona Creek watersheds, and numerous small sub-watersheds. SMB is a nationally significant water body; it was included in the National Estuary Program in 1989. Urbanization has had a significant impact on the riparian and wetland resources of the watershed, primarily through filling, alteration of flows, and decrease in water quality. It is estimated that 95% of the historic wetlands of the SMB WMA have been destroyed, with the remaining wetlands significantly degraded. Almost every beneficial uses defined in the Basin Plan for the Region occurs somewhere in this WMA. Yet many of these beneficial uses have been impaired for years. While some of the impaired areas are showing signs of recovery, beneficial uses that are in relatively good condition still face the threat of degradation. A considerable number of monitoring programs have been implemented in the SMB WMA, particularly over the last twenty years. Sampling efforts generally focus on assessment of urban runoff effects along the coastline and determination of reservoirs of PCB- and DDT-contaminated sediment in the Palos Verdes Shelf area.

Existing and potential beneficial use impairment problems in the watershed fall into two major categories: human health risk, and natural habitat (wildlife) degradation. The former is primarily associated with recreational uses of the SMB. The latter is associated with terrestrial, aquatic, and marine environments. Pollutant loadings that originate from human activities are common causes of both human health risks and habitat degradation. Prior to this study, various reaches of this watershed had been 303(d) listed for beach closures, swimming restrictions, shellfish harvesting advisories, enteric viruses, pathogens, coliform, algae, eutrophication, unnatural scum/foam, ammonia, odors, low dissolved oxygen (DO) and/or organic enrichment, trash, mercury, lead, cadmium, copper, nickel, silver, arsenic, zinc, selenium, tributyl tin, toxicity, benthic community effects, fish consumption advisories, sediment toxicity, PAHs, DDT, pesticides, PCBs, dieldrin, chlordane, exotic vegetation, habitat alteration, hydromodification, reduced tidal flushing, debris, chloride, and specific conductance.

Malibu Creek drains mostly undeveloped mountain areas, large acreage residential properties and has many natural stream reaches. Previous sampling indicates that water quality in some streams within the Malibu Creek watershed is impaired by nutrients and nutrient-related effects, coliform and coliform-related effects, trash, and, in some instances, metals (CRWQCB LAR 2001). While natural sources contribute, non-point source pollution from human activities is strongly implicated including ill-placed or malfunctioning septic systems and runoff from horse corrals. Nutrient inputs are also contributed by urban runoff and the Tapia Water Reclamation Facility (Tapia), which discharges tertiary-treated effluent into the Creek about five miles upstream of Malibu Lagoon from November 15 to April 15 of the following year. A nutrient TMDL for the mainstem of the Creek is in progress.

Ballona Creek is completely channelized to the ocean except for the estuarine portion, which has a soft bottom. It drains both residential and commercial highly developed areas. Previous sampling indicates impairment in this watershed due to coliform and coliform-related effects, trash, PCBs and pesticides of historical origin (such as DDT, chlordane, and dieldrin), and their effects (sediment toxicity), and metals (lead, silver, arsenic, copper, cadmium, and zinc), and their effects (water column toxicity), and tributyl tin (CRWQCB LAR 2001). Both dry weather and storm runoff from the main channel and two major tributaries have been found to be toxic to marine organisms.

Toxicity was also found during storms in the ocean near the mouth of Ballona Creek. Preliminary investigations showed that the sources of toxicity varied, and were associated with metals on one occasion and with organic chemicals on another occasion. Further efforts are needed to identify the sources of toxicity. One hundred fifty-seven of the 191 National Pollutant Discharge Elimination System (NPDES) discharges to the SMB WMA go to Ballona Creek. Led by the Los Angeles Basin Contaminated Sediment Task Force, the US Army Corps of Engineers (USACE) is conducting a study to identify sources of heavy metals loadings within the watershed. The results of the study could provide useful information to develop a TMDL for selected heavy metals.

Previous sampling indicates impairment in many of the other small urban watersheds in the SMB WMA due to one or several of the following: coliform, ammonia, lead, copper (and toxicity likely associated with metals), trash, and low dissolved oxygen (CRWQCB LAR 2001).

The main goals of the sampling in the SMB WMA were:

- to obtain an overall view of the health of the watershed;
- to obtain baseline information on smaller streams within the watershed that have not been sampled previously;
- to provide information on potential reference sites in the watershed; and
- to provide information that can be used to determine beneficial use attainment or non-attainment.

1.5 Scope of Report

This is the second SWAMP report prepared for LARWQCB. This report provides a summary of data collected under the 2001-2002 LARWQCB Task Order. Data were collected in March-April 2003 and February-March 2004. Data were analyzed for spatial patterns and compared with established water quality criteria; there is insufficient data to support temporal trend analysis. Additionally, most sites were only sampled once in a given year; the data presented are each a “snapshot in time” and reflect the quality of the water at the time of sampling only. More frequent sampling would be required to determine the temporal extent or persistence of any potential problems brought to light in this report. This report does not provide an analysis of beneficial use support or determination of impairment of water bodies; however, data provided herein can be used in support of such determinations.

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2 METHODS

2.1 Watershed Monitoring Strategy and Sampling Design

SMB itself has been monitored thoroughly; thus, LARWQCB decided to conduct directed sampling at 61 sites distributed among the approximately 30 coastal sub-watersheds of the SMB WMA (Figure 1). Many of these sub-watersheds have not been sampled at all and others have been sampled modestly at best. In most cases, two sites were sampled in each sub-watershed. In such cases, the original study design called for one site to be located in the upper watershed and the other in the lower watershed near its intersection with Pacific Coast Highway. However, due to the ability to find sites with running water and access, sites designated "Upper" were not always in the true upper portion of the watershed, and in some cases were located in close proximity to the "Lower" sites.

A total of 59 sites were sampled between 2003 and 2004; samples were never collected from Upper Encinal Canyon Creek (9) Lower Agua Amarga into Lunada Bay (56), because neither had water when sample collection was attempted. The Malibu Creek watershed has been monitored extensively by Heal the Bay. Five of the existing Heal the Bay sites were sampled for dissolved metals in order to complete the data being collected for the watershed as a whole.

Sampling was conducted during spring 2003 (March-April) and spring 2004 (February-March) (Appendix A; a sample of the information in Appendix A is presented in Table 1). Sampling at all stations included field measurements (conductivity, DO, pH, salinity, temperature, turbidity, and current speed), conventional water column chemistry (alkalinity, ammonia-N, boron, chloride, chlorophyll a, conductivity, dissolved oxygen, fluoride, hardness, nitrate-N, nitrite-N, orthophosphate, sulfate, total dissolved solids (TDS), temperature, total Kjeldahl nitrogen (TKN), total phosphorous (P), and turbidity) and bacteriology. Total nitrogen (N) was calculated as the sum of nitrate-N, nitrite-N, and TKN, and if any value was less than the method detection limit (MDL), 0 was used. Bioassessment was conducted at 39 sites and enzyme-linked immunosorbent assay (ELISA) analyses for chlorpyrifos and diazinon were conducted at 37 sites. During spring 2003, a subset of 20 stations was sampled for water column toxicity, dissolved metals, and organophosphate chemistry, and another subset of 5 stations was sampled for dissolved metals only. Additionally, 2 lower sub-watershed stations located near gas stations were tested for MTBE.

2.2 Sample Collection

All field measurements, sample collection, transportation and chain of custody procedures were performed according to protocols specified in the SWAMP Quality Assurance Management Plan (QAMP) and its appendices (Puckett 2002, http://www.swrcb.ca.gov/swamp/qapp.html).

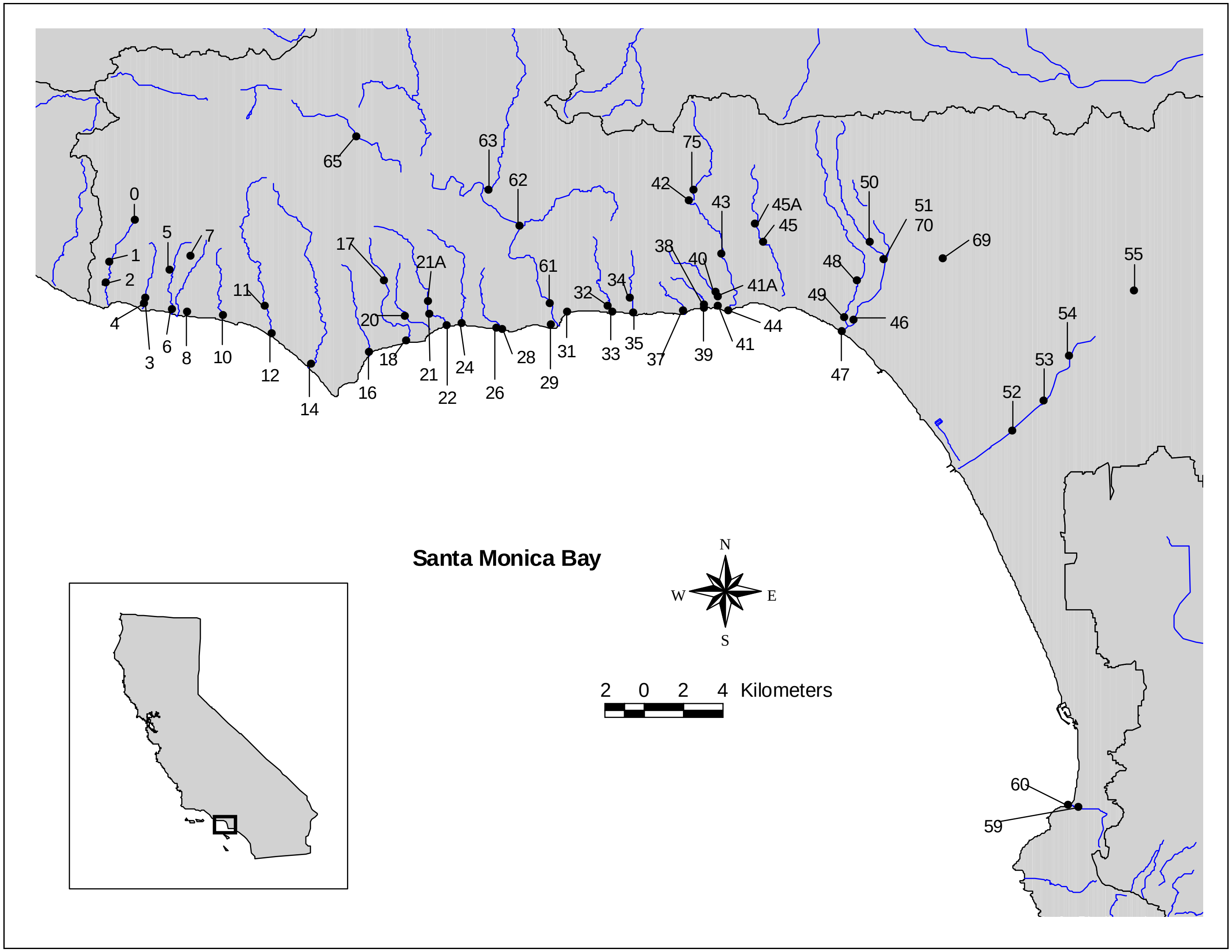

Figure 1. Sites in the SMB WMA sampled during 2003 and 2004.

Table 1. A sample of the sampling information presented in Appendix A .

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB000	Arroyo Sequit at Fork	04/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
		16/Mar/2004									✓	
404SMB001	Arroyo Sequit Upper	04/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
		16/Mar/2004									✓	
404SMB002	Arroyo Sequit Lower	04/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
404SMB003	San Nicholas Canyon Creek Upper	26/Mar/2003	✓	✓				✓		✓		
		01/Mar/2004	✓	✓						✓		
404SMB004	San Nicholas Canyon Creek Lower	04/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		26/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		

2.3 Sample Analysis

Analytical Chemistry

Appendix B lists each chemical constituent in water with its respective analytical laboratory, method, MDL, reporting limit (RL), and units. In several instances, analytical laboratory, method, MDL or RL changed between 2003 and 2004, and this is noted in the table. Trace organics analyzed were organophosphate pesticides (OPs), triazines, and volatile organic compounds (VOCs).

Toxicity

Toxicity in the SMB WMA was assessed in the spring of 2003 using the freshwater species *Ceriodaphnia dubia* (water flea) and *Pimephales promelas* (fathead minnow) for all 20 sites. Toxicity was assessed once at each site with the exception of Trancas Canyon Creek Lower(12), at which toxicity was assessed twice (March 5 and 12 2003). Protocols for each test and associated supporting materials are available in Appendix F of the QAMP.

Results of the toxicity tests are reported as acute (mortality), chronic (reduced growth or reproduction), or no toxicity. Field samples were compared to controls and toxicity was considered to occur if both of the following criteria were met: sample mean significantly different from control (significance level: $p<0.05$) and sample mean <80% of control. If the sample mean was <80% of control but the p-value was >0.05 due to high variability, or if the p-value was <0.05 but the sample mean was not <80% of the control mean, toxicity was not considered to occur.

Bioassessment

The analysis of the biotic condition of the macroinvertebrate benthic communities, or bioassessment, was used to evaluate ecological condition at 39 sites in the SMB watershed in 2003 by the CDFG Aquatic Bioassessment Laboratory (ABL). Six sites were re-sampled in 2004 for a total of 45 samples. Sampling procedures and analytical methods are available in the QAMP and its Appendix G. A benthic index of biotic integrity (B-IBI) was recently developed for the southern California coastal region (Ode et al. 2005) and was used to characterize the biotic condition of the sites.

2.4 Comparison to established criteria

Chemical concentrations in water were compared to objectives established in the 1994 Basin Plan (CRWQCB LAR 1994) and to US Environmental Protection Agency (USEPA) and CDFG recommended 4-day and 1-hour average and instantaneous maxima criteria for protection of fresh and saltwater aquatic life as summarized in Marshack (2003). If none of these types of thresholds have been established, data were compared to other criteria included in Marshack (2003) such as California primary and secondary maximum contaminant levels (MCLs), Department of Health Services (DHS) action levels, and California Toxics Rule (CTR)/National Toxics Rule (NTR) criteria. Data were also compared to USEPA recommended limits (USEPA 1986) and suggested threshold values for reference conditions in streams in level III ecoregion 6 (USEPA 2000a). Three sites (Malibu Lagoon (29), Topanga Lagoon (44) and Ballona Creek at Centinela (52)) experience tidal influence and are not subject to criteria for inland surface waters. Data from these sites were compared to available criteria for marine waters, such as the daily and instantaneous maxima in the California Ocean Plan (SWRCB 2001) and the criterion maximum concentrations (CMC) and criterion continuous concentrations (CCC) in the CTR (USEPA 2000b).

Criteria for some metals in freshwater increase with hardness (Marshack 2003). The lowest hardness in this dataset was 320 mg l^{-1} $CaCO_3$. We compared our data to the criteria listed for waters with a hardness of 320 mg l^{-1} $CaCO_3$; if our highest value was less than the listed value, then all of our other values were below the criteria as well, regardless of hardness.

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3 QUALITY ASSURANCE

In any project of great magnitude, such as SWAMP, assuring the quality of the data is a critical step in accepting and using the data provided from the study. As the results of SWAMP will be used to support rulemaking, enforcement, regulatory, and policy decisions, thorough objectives for achieving quality data are outlined in the QAMP. In short, data quality is assured through analysis of:

- Field blind duplicates
- Laboratory replicates
- Laboratory method blanks
- Matrix spikes and matrix spike duplicates
- Certified reference materials/laboratory control spikes.

Data in this report have been verified according to SWAMP Standard Operating Procedures (SOPs) for chemistry, field and toxicity data verification. Data have not been validated.

3.1 Field Blind Duplicates

Field blind duplicates (FDQ) were analyzed to assess field and laboratory procedures. Field blind duplicates for water were taken at 3 stations each year (2003: 404SMB029, -035, and -044; 2004: 404SMB011, -065, and 405SMB050) by taking a separate grab sample immediately following collection of the field sample. Duplicate values were compared to field sample values from each site and relative percent difference (RPD) was calculated:

=|((Value1-Value2)|/(AVERAGE(Value1+Value2)))*100

where:
Value1=field sample value
Value2=duplicate sample value.

If either Value 1 or Value 2 was < 3 times the MDL, the RPD was not calculated as the values are too low to calculate a meaningful difference between them. RPDs <25% were considered acceptable as specified in the QAMP. RPDs >25% are shown in Table 2; all other RPDs were acceptable.

Table 2. Water field blind duplicates that exceeded the allowable 25% relative percent difference (RPD) from field samples. Values were not compared if either one or both were less than three times the method detection limit (MDL).

Analyte	Site	Date	Field Sample	Field Duplicate	Units	RPD	Laboratory
Conventionals							
Chlorophyll a	404SMB029	26/Mar/2003	11.5	46.9	µg/L	121.2	MPSL-DFG
	404SMB035	27/Mar/2003	1.96	0.396	µg/L	132.8	MPSL-DFG
	405SMB050	25/Feb/2004	1.1	0.217	µg/L	134.1	MPSL-DFG
Nitrate-N	404SMB065	25/Feb/2004	0.0181	0.0241	mg/L	28.4	DFG-WPCL
TKN	404SMB029	12/Mar/2003	3.63	5.01	mg/L	31.9	DFG-WPCL
Orthophosphate-P	404SMB029	12/Mar/2003	0.039	0.0291	mg/L	29.1	DFG-WPCL
Total P	404SMB029	26/Mar/2003	0.974	1.39	mg/L	35.2	DFG-WPCL
Metals							
Cadmium, Dissolved	404SMB044	04/Mar/2003	0.16	0.11	µg/L	37.0	MPSL-DFG
Lead, Dissolved	404SMB044	04/Mar/2003	0.12	0.21	µg/L	54.5	MPSL-DFG
Selenium, Dissolved	404SMB044	04/Mar/2003	0.31	0.03	µg/L	164.7	MPSL-DFG
Zinc, Dissolved	404SMB044	04/Mar/2003	1	1.33	µg/L	28.3	MPSL-DFG

3.2 Laboratory Duplicates

Laboratory duplicates were analyzed to assess laboratory precision. Per the QAMP, at least one laboratory duplicate should be analyzed per 20 samples or one per batch, whichever is more frequent; however there were several batches where laboratory duplicates were not performed at the required frequency (Table 3). The duplicates were compared to the parent samples and RPD was calculated as described above where Value1=parent sample value and Value2=duplicate sample value. If either Value 1 or Value 2 was < 3 times the MDL, the RPD was not calculated as the values are too low to calculate a meaningful difference between them. RDPs <25% were considered acceptable as specified in the QAMP. Only one RPD was > 25% (Table 4); all other RPDs were acceptable.

Table 3. Batches for which no laboratory duplicates were run.

Analyte	Batch ID	Laboratory
Chlorpyrifos and Diazinon	72ELGC	UCD-GC
Chlorpyrifos and Diazinon	74ELGC	UCD-GC
Chlorophyll a	CHL03-0011	MPSL-DFG

Table 4. Laboratory duplicate that exceeded the allowable 25% relative percent difference (RPD).

Analyte	Site	Date	Parent Sample Value	Duplicate Sample Value	Units	RPD	Laboratory	Batch ID
Lead, Dissolved	405SMB045	26/Mar/2003	0.014	0.022	µg/L	44.44	MPSL-DFG	ICP050603

3.3 Laboratory Method Blanks

Laboratory method blanks were used to assess laboratory contamination during all stages of sample preparation and analysis. The method blanks were blank water that was processed through the entire analytical procedure in a manner identical to the samples. Per the QAMP for both organic and inorganic analyses, at least one laboratory method blank should be analyzed per 20 samples or one per batch, whichever is more frequent; however there were several batches where blanks were not performed at the required frequency (Table 5). For both organic and inorganic analyses, at least one laboratory method blank was run in every sample batch. A result is acceptable if it is less than the specified MDL for a given analyte. Unacceptable results, in which analytes were detected not quantified (≥MDL but <RL) or detected (≥RL) are presented in Table 6. A total of 15 method blanks had detected or detected not quantified (DNQ) values (values between the MDL and the RL); these blanks were distributed across 12 analytes and 7 batches.

Table 5. Batches for which no laboratory blanks were run.

Analyte	Batch ID	Notes	Laboratory
Dissolved Metals	ICP050603		MPSL-DFG
OPs	L-030803-OP	No blanks for extraction dates 03/08, 03/10, and 03/15/2005	DFG-WPCL
OPs	L-032703-OP	No blanks for extraction date 03/27/05	DFG-WPCL

Table 6. Laboratory method blanks in which analytes were detected. Blankwater was the matrix in all cases.

Analyte	Units	Result	MDL	RL	Detected	AnalysisDate	Method Name	Laboratory	Batch ID
Ammonia as N	mg/L	0.042	0.04	0.1	DNQ	05/Mar/2004	EPA 350.3	DFG-WPCL	030504-NH3
Cadmium,Total	µg/L	0.009	0.003	0.009	Yes	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
Cadmium,Total	µg/L	0.016	0.003	0.009	Yes	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
Chloride	mg/L	0.25	0.2	0.25	Yes	06/Mar/2003	EPA 300.0	DFG-WPCL	030603-CL
Chromium,Total	µg/L	0.004	0.004	0.01	DNQ	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
Copper,Total	µg/L	0.135	0.03	0.09	Yes	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
Fluoride	mg/L	0.015	0.01	0.02	DNQ	16/Apr/2003	EPA 340.2	DFG-WPCL	041603-F
Fluoride	mg/L	0.02	0.02	0.05	DNQ	08/Mar/2004	SM 4500-F-C	DFG-WPCL	030804-F
Fluoride	mg/L	0.02	0.02	0.05	DNQ	08/Mar/2004	SM 4500-F-C	DFG-WPCL	030804-F-1
Nickel,Total	µg/L	0.055	0.03	0.09	DNQ	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
OrthoPhosphate as P	mg/L	0.0496	0.005	0.01	Yes	26/Mar/2003	QC 10115011M	DFG-WPCL	032603-OPO4
Selenium,Total	µg/L	0.022	0.01	0.03	DNQ	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
Silver,Total	µg/L	0.04	0.03	0.09	DNQ	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103
Sulfate	mg/L	28.8	0.4	1	Yes	26/Mar/2003	EPA 300.0	DFG-WPCL	032603-SO4
Zinc,Total	µg/L	0.072	0.02	0.06	Yes	11/Sep/2003	EPA 1638M	MLML-TM	HiResICP091103

3.4 Matrix Spikes and Matrix Spike Duplicates

A laboratory fortified sample matrix (matrix spike, or MS) and a laboratory fortified sample matrix duplicate (MSD) were used both to evaluate the effect of the sample matrix on the recovery of the compound(s) of interest and to assess analytical precision and accuracy. Aliquots of randomly selected parent samples were spiked with known amounts of target analytes. The percent recovery (%R) of the spike was calculated as follows:

%R=(MS Result – Parent Result)/(Expected Value – Parent Result) * 100

The percent recovery acceptance criteria for the analyte groups are presented in Table 7. This process was repeated for a subset of parent samples to create MSDs. As required by the QAMP, for both organic and inorganic analyses at least one MS/MSD pair should be performed per 20 samples or one per batch, whichever is more frequent, however there were several batches where MS/MSDs were not performed at the required frequency (Table 8).

The MS and their duplicates were compared and the RPD was calculated as described above where Value1=matrix spike value and Value2=matrix spike duplicate value. RDPs <25% were considered acceptable as specified in the QAMP. Unacceptable MS/MSDs and RPDs are presented in Table 9. All other MS/MSDs and RPDs were acceptable.

Table 7. Percent recovery acceptance criteria for different categories of analytes in water.

Analyte Category	% Recovery Acceptance Criteria
Conventional Constituents	80-120
Trace Metals (Including Mercury)	75-125
Synthetic Organics (PCBs, PAHs, OCHs, OPs)	50-150
Chlorpyrifos and Diazinon (ELISA method)	80-120

Table 8. Batches for which no matrix spikes were run.

Analyte	Batch ID	Notes	Laboratory
Total Phosphorus	040203-TPHOS-1		DFG-WPCL
Total Phosphorus	040903-TPHOS-1		DFG-WPCL
Total Kjeldahl Nitrogen	041003-TKN-1		DFG-WPCL
OPs	L-030803-OP	No MS/MSD for extraction dates 03/08, 03/10, and 03/15/2005	DFG-WPCL
VOAs	L-031903-MtBE		DFG-WPCL
OPs	L-032703-OP	No MS/MSD for extraction date 03/27/05	DFG-WPCL

Table 9. Matrix spikes (MS), matrix spike duplicates (MSD), and relative percent differences (RPD) that did not meet specified criteria. Boldface type indicates values that did not meet quality control criteria.

Analyte	Site	Sample Date	Batch ID	% Recovery Acceptance Criteria	MS % Recovery	MSD % Recovery	RPD	Laboratory
Alkalinity as $CaCO_3$	404SMB039	25/Mar/2003	040203-ALK	80-120	82.61	**78.26**	5.41	DFG-WPCL
Boron	404SMB039	25/Mar/2003	R4-040803-B	80-120	110	**225**	**68.66**	SFL
Boron	000NONSW	02/Apr/2003	R4-040203-B	80-120	**123**	117	5.00	SFL
Boron	404SMB002	01/Mar/2004	B403091130	80-120	**73**	66	10.07	SFL
Nitrate as N	405SMB052	03/Apr/2003	040403-NO3	80-120	111.90	**126.19**	12.00	DFG-WPCL
Silver,Dissolved	728SSDNE1	30/Sep/2002	HiResICP091103	75-125	124.00	**144.80**	15.48	MPSL-DFG
Nitrogen, Total Kjeldahl	405SMB046	05/Mar/2003	031803-TKN-2	80-120	96.0	**123.6**	**25.14**	DFG-WPCL
Nitrogen, Total Kjeldahl	404SMB062	26/Mar/2003	041003-TKN	80-120	**121.6**	117.2	3.69	DFG-WPCL

3.5 Certified Reference Materials and Laboratory Control Spikes

Certified reference materials (CRM), laboratory control spikes (LCS), and laboratory control materials (LCM) were analyzed to assess the accuracy of a given analysis method (i.e., the closeness of a measurement to the "true" value). As required by the QAMP, one CRM, LCS, or LCM should be analyzed per 20 samples or one per batch, whichever is more frequent, however there were several batches where CRMs, LCSs, or LCMs were not performed at the required frequency (Table 10). The percent recovery acceptance criteria are presented in Table 7. Unacceptable CRM, LCS, and LCM recoveries are presented in Table 11; all other recoveries were acceptable.

Table 10. Batches for which no CRM, LCS, or LCM were run.

Analyte	Batch ID	Notes	Laboratory
OPs	L-030803-OP	No LCS for extraction dates 03/08, 03/10, and 03/15/2005	DFG-WPCL

Table 11. Laboratory control material (LCM) that did not meet quality control acceptance criteria.

Analyte	Sample Type	Batch ID	% Recovery Acceptance Criteria	% Recovery	Laboratory
Diazinon	LCM	70ELGC	80-120	121.2	UCD-GC
Diazinon	LCM	72ELGC	80-120	136	UCD-GC
Diazinon	LCM	74ELGC	80-120	127.2	UCD-GC

3.6 Toxicity tests

There were some minor deviations in water quality parameters during the tests, however, the data should be considered acceptable for the intended purpose.

3.7 Contamination

On February 12, 2004, the CDFG Water Pollution Control Laboratory (DFG-WPCL) notified SWAMP participants of a low level of contamination that occurred in samples analyzed for NO_3 by flow injection analysis method (FIA). The contamination (0.036 ± 0.027 mg l^{-1} [36 ppb]) was significant only for NO_3 results reported <0.150 mg l^{-1} (150 ppb). A list of samples that were analyzed via FIA and therefore positively biased by 0.036 mg l^{-1} is presented in Table 12. These samples were not given different symbols in Figure 26 as the concentrations are very low and are well below Basin Plan criteria for NO_3.

3.8 QA/QC Summary

The data must meet two of the following three types of quality assurance/quality control (QA/QC) criteria to be considered acceptable:

- Laboratory duplicates RPD
- MS/MSD recovery and RPD
- CRM, LCS, LCM recovery.

For example, if the laboratory duplicate RPD is >25% but the MS/MSD and CRM criteria are met for an analyte, then the data are acceptable and can be used.

All data are acceptable with the following exceptions:

- The quality of values from L-030803-OP for samples extracted on 08/Mar, 10/Mar, and 15/Mar/2005 cannot be evaluated because no MS/MSD or LCS were performed with these samples. Thus, the values can only be assessed against the laboratory duplicate RPD criterion and cannot be either accepted or rejected.
- The quality of values from 72ELGC and 74ELGC cannot be evaluated because the LCM percent recoveries for each batch were unacceptable and no laboratory duplicates were performed. The values can be assessed against two of the three QA/QC criteria but did not meet the LCM criterion. The values cannot be assessed against the third criterion, laboratory duplicate RPD, and thus cannot be either accepted or rejected.

Results for these analytes are presented in this report but measured values should be considered estimated and should be interpreted cautiously.

Table 12. Samples with low level (0.36 ± 0.27 mg l^{-1}) nitrate-N contamination.

Site	Sample Date	Batch ID	Nitrate-N (mg l^{-1})	Method Name
404SMB000	04/Mar/2003	030503-NO3-2	0.119	QC 10107041B
404SMB001	04/Mar/2003	030503-NO3-2	0.0579	QC 10107041B
404SMB002	04/Mar/2003	030503-NO3-2	0.0452	QC 10107041B
404SMB003	26/Mar/2003	032703-NO3	0.0466	QC 10107041B
404SMB004	04/Mar/2003	030503-NO3-2	0.0375	QC 10107041B
404SMB004	26/Mar/2003	032703-NO3	0.0498	QC 10107041B
404SMB005	05/Mar/2003	030603-NO3-2	0.0612	QC 10107041B
404SMB006	04/Mar/2003	030503-NO3-2	0.0313	QC 10107041B
404SMB007	25/Mar/2003	032603-NO3	0.11	QC 10107041B
404SMB008	05/Mar/2003	030603-NO3-2	0.0365	QC 10107041B
404SMB010	04/Mar/2003	030603-NO3-2	0.0318	QC 10107041B
404SMB010	24/Mar/2003	032603-NO3	0.063	QC 10107041B
404SMB011	05/Mar/2003	030603-NO3-2	0.0321	QC 10107041B
404SMB011	24/Mar/2003	032603-NO3	0.136	QC 10107041B
404SMB017	11/Mar/2003	031203-NO3	0.0442	QC 10107041B
404SMB017	25/Mar/2003	032703-NO3	0.123	QC 10107041B
404SMB020	11/Mar/2003	031203-NO3	0.11	QC 10107041B
404SMB020	24/Mar/2003	032603-NO3	0.0978	QC 10107041B
404SMB021	11/Mar/2003	031203-NO3	0.0418	QC 10107041B
404SMB022	11/Mar/2003	031303-NO3	0.0326	QC 10107041B
404SMB022	25/Mar/2003	032703-NO3	0.102	QC 10107041B
404SMB024	12/Mar/2003	031303-NO3	0.0359	QC 10107041B
404SMB024	25/Mar/2003	032703-NO3	0.0434	QC 10107041B
404SMB026	03/Mar/2003	030503-NO3-2	0.0871	QC 10107041B
404SMB026	25/Mar/2003	032703-NO3	0.14	QC 10107041B
404SMB029	12/Mar/2003	031303-NO3	0.0426	QC 10107041B
404SMB029	26/Mar/2003	032703-NO3	0.0445	QC 10107041B
404SMB032	11/Mar/2003	031303-NO3	0.0341	QC 10107041B
404SMB032	26/Mar/2003	032803-NO3	0.0329	QC 10107041B
404SMB033	11/Mar/2003	031203-NO3	0.0401	QC 10107041B
404SMB034	11/Mar/2003	031303-NO3	0.0361	QC 10107041B
404SMB034	27/Mar/2003	032803-NO3	0.0354	QC 10107041B
404SMB035	11/Mar/2003	031203-NO3	0.0498	QC 10107041B
404SMB035	27/Mar/2003	032803-NO3	0.049	QC 10107041B
404SMB038	10/Mar/2003	031203-NO3	0.0349	QC 10107041B
404SMB038	27/Mar/2003	032803-NO3	0.0373	QC 10107041B
404SMB040	10/Mar/2003	031203-NO3	0.039	QC 10107041B
404SMB040	27/Mar/2003	032803-NO3	0.0347	QC 10107041B
404SMB041	10/Mar/2003	031203-NO3	0.0355	QC 10107041B
404SMB041	27/Mar/2003	032803-NO3	0.0315	QC 10107041B
404SMB042	04/Mar/2003	030603-NO3-2	0.0767	QC 10107041B

Table 12 continued.

404SMB043	03/Mar/2003	030503-NO3-2	0.0467	QC 10107041B
404SMB044	04/Mar/2003	030603-NO3-2	0.0328	QC 10107041B
404SMB044	26/Mar/2003	032803-NO3	0.0774	QC 10107041B
404SMB21A	11/Mar/2003	031303-NO3	0.109	QC 10107041B
405SMB050	10/Mar/2003	031203-NO3	0.0349	QC 10107041B
405SMB060	12/Mar/2003	031303-NO3	0.0903	QC 10107041B
405SMB060	27/Mar/2003	032803-NO3	0.137	QC 10107041B

4 RESULTS

4.1 Field Measurements in Water

Dissolved oxygen, pH, specific conductivity, temperature, turbidity, velocity

DO ranged from 12.4 to 189 % saturation in the SMB watershed (Figure 2). Basin Plan objectives for DO are presented in mg l^{-1} (CRWQCB LAR 1994) preventing direct comparison of the data collected to the established objectives. A suggested threshold for DO in freshwater is 90% saturation (http://www.lakeaccess.org/russ/oxygen.htm). DO at 34 sites was below this level during at least one sampling event (Figure 3). Comparison to 90% saturation may not be appropriate for the three brackish sites, but two of these three, Malibu Lagoon (29) and Ballona Creek at Centinela (52), had DO concentrations <30% saturation and would be considered hypoxic in an estuarine/marine context (Kamer and Stein 2003).

pH ranged from 6.54 to 9.77 (Figure 4). The acceptable range for pH is 6.5 to 8.5 (CRWQCB LAR 1994); no sites had pH < 6.5 but pH was > 8.5 at 9 sites (Figure 5). However, one of these sites was Malibu Lagoon (29), for which there is no numeric pH criterion.

Specific conductivity ranged from 0.195 to 17.03 mS cm^{-1} (Figure 6). 94.7% of the values were < 5 mS cm^{-1}. Salinity ranged from 0.09 to 10.04 ppt (Figure 7). The highest salinities were found at sites in the lower portions of the sub-watersheds and indicate that these sites may experience tidal influence causing brackish conditions at least some of the time.

Temperature ranged from 9.22 to 22 78 °C (Figure 8). All measurements were made in the months of February and March. Average temperatures between 2003 and 2004 were very similar: 14.68 ± 0.32 (mean ± SE) in 2003 and 14.16 ± 0.32 in 2004.

Turbidity ranged from 0 to 85 NTU (Figure 9). There are no numeric Basin Plan objectives for turbidity. Values from 28 sites were below the USEPA suggested threshold value for reference conditions for turbidity in streams in level III (Xeric West) ecoregion 6 (southern and central California chaparral and oak woodlands of the) of 1.9 NTU (USEPA 2000a) (Figure 10).

Current speed ranged from 0.174 to 3.58 ft s^{-1} at 38 sites (Figure 11). At 45 sites, current speed was not measured because it was too shallow or because the instrument failed. At another 32 sites, the instrument was successfully deployed but the current speed was too low to be measured.

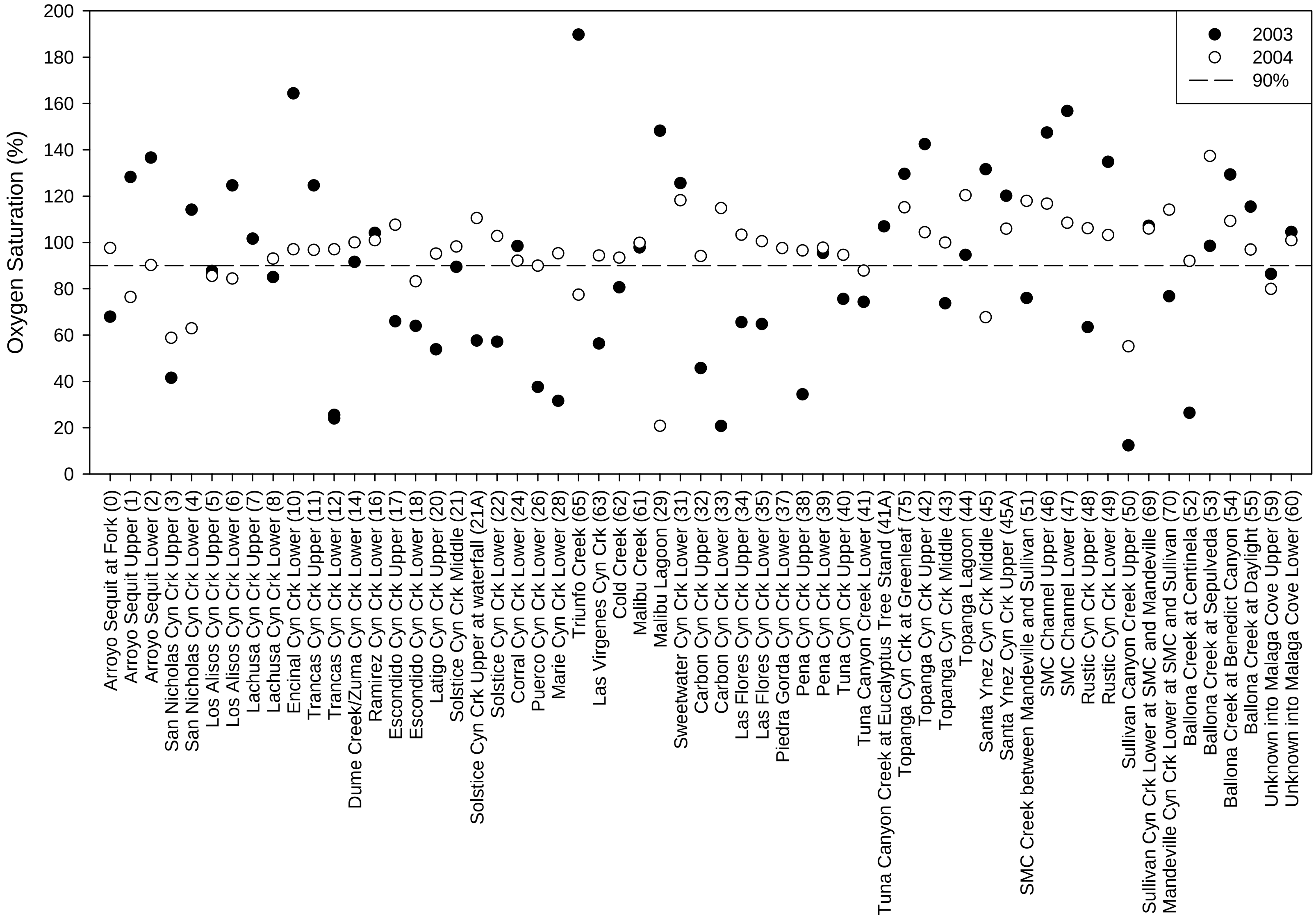

Figure 2. Dissolved oxygen % saturation at sites in the SMB WMA. 90% saturation is a suggested threshold for freshwater.

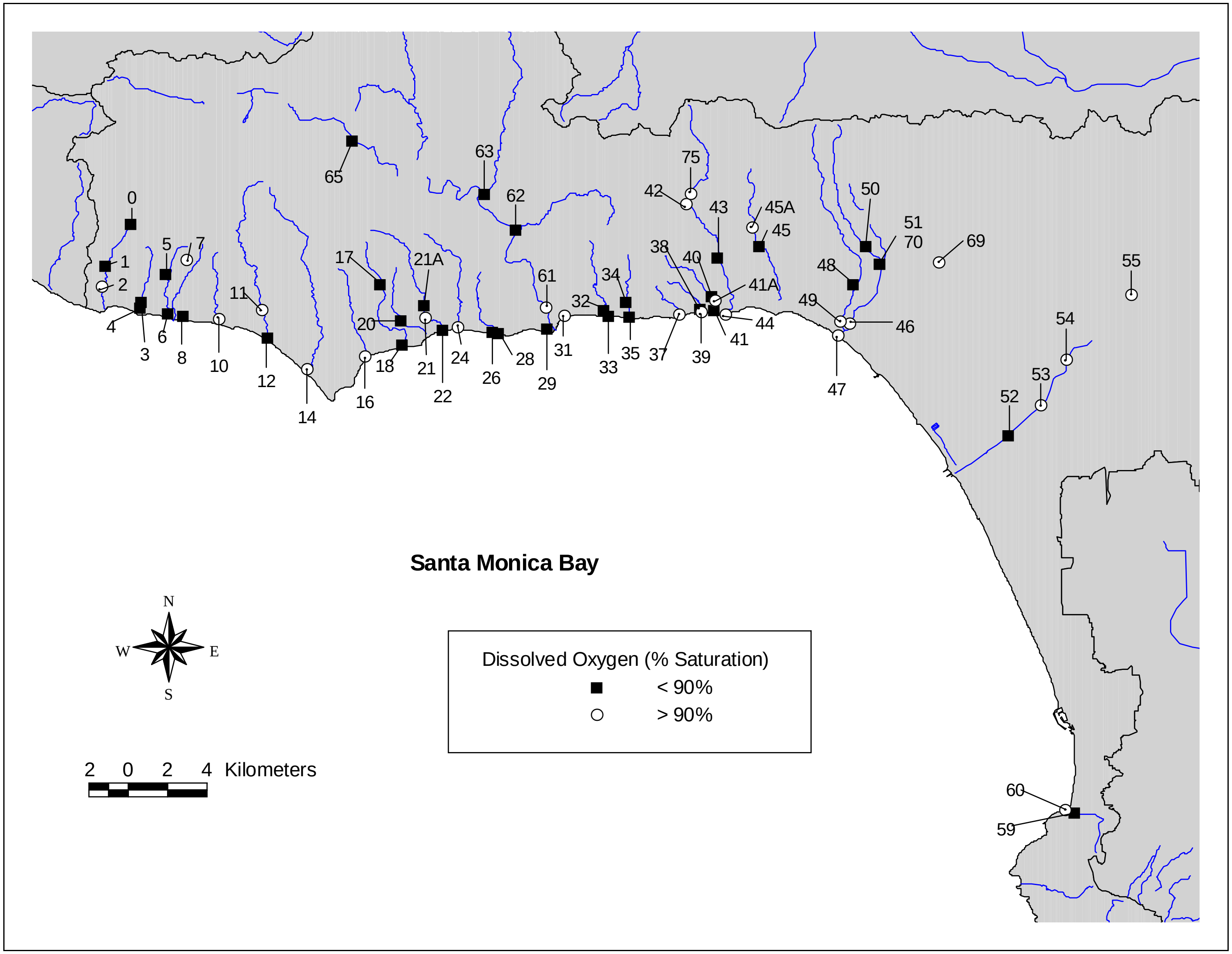

Figure 3. Dissolved oxygen % saturation spatially in the SMB WMA.

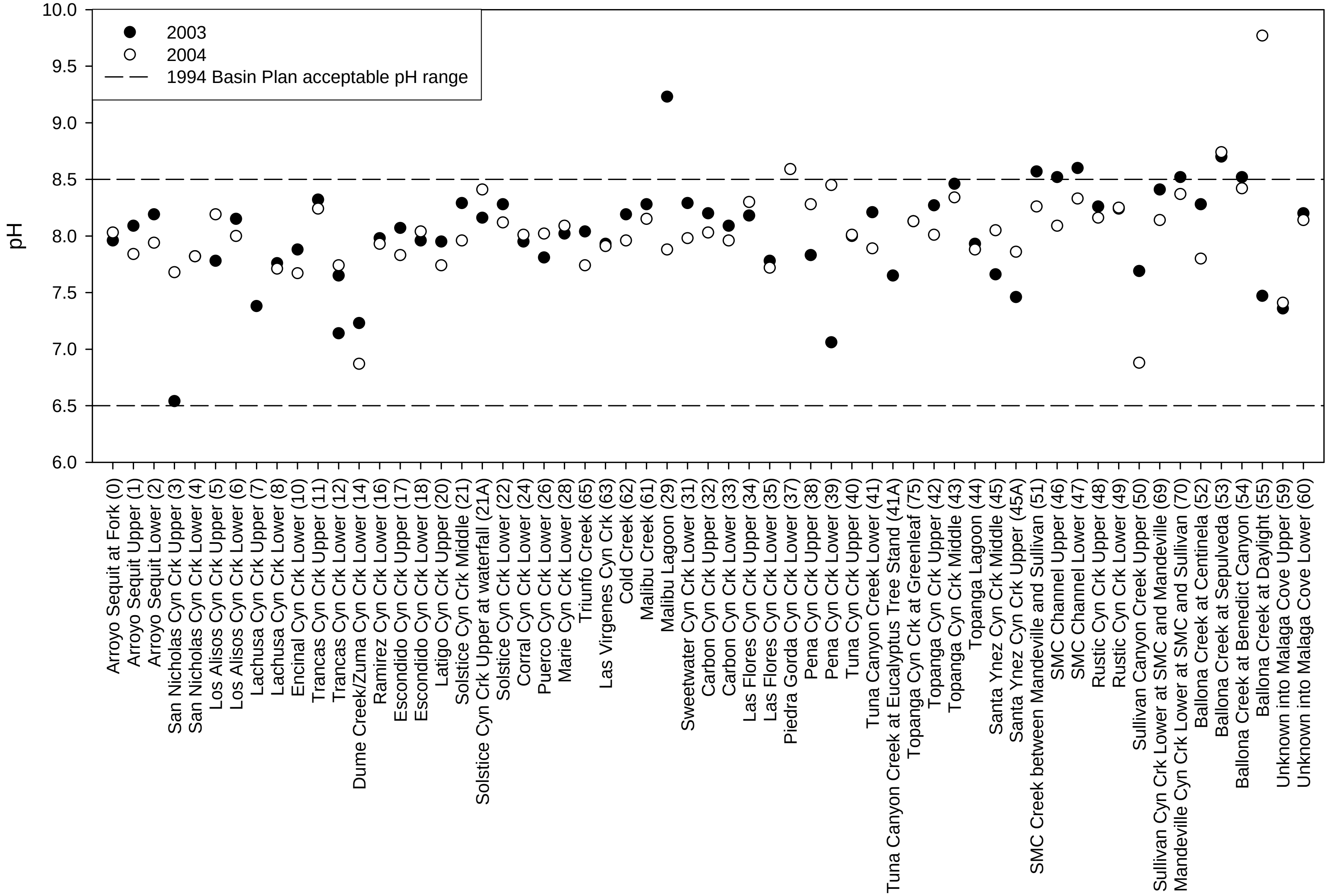

Figure 4. pH at sites in the SMB WMA. 6.5 and 8.5 are the lower and upper acceptable limits, respectively, for pH in inland surface waters in the 1994 Basin Plan.

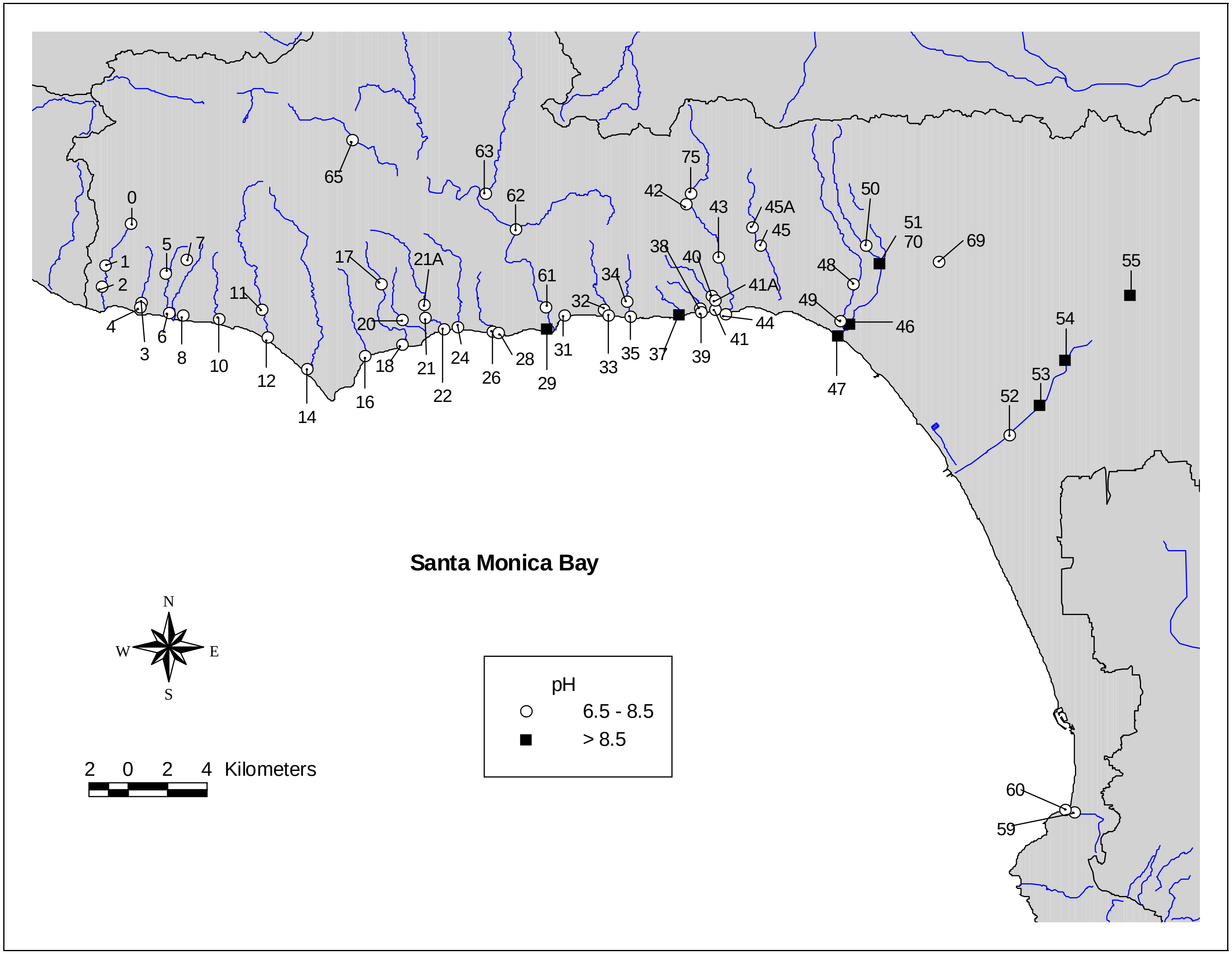

Figure 5. pH spatially in the SMB WMA.

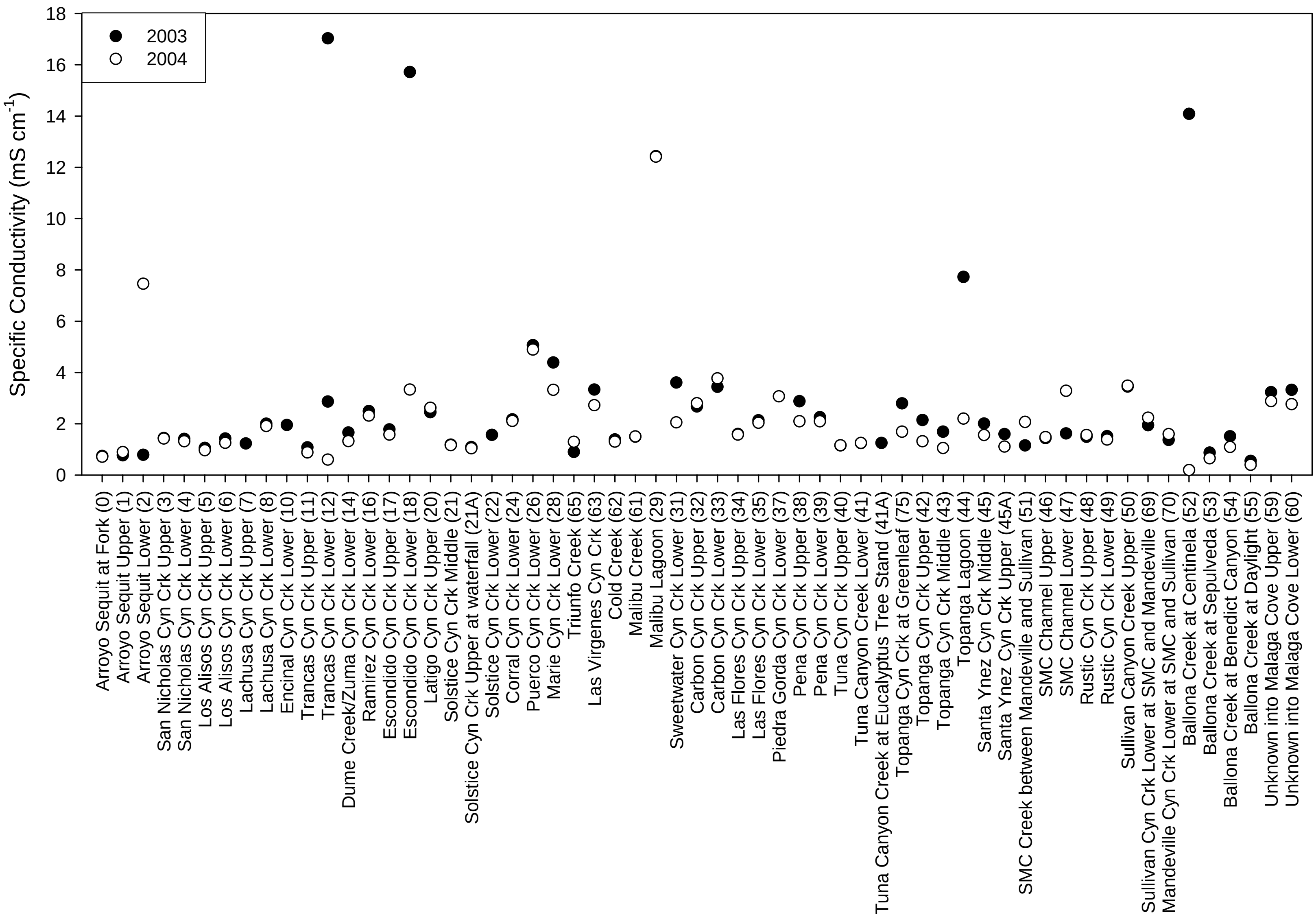

Figure 6. Specific conductivity at sites in the SMB WMA.

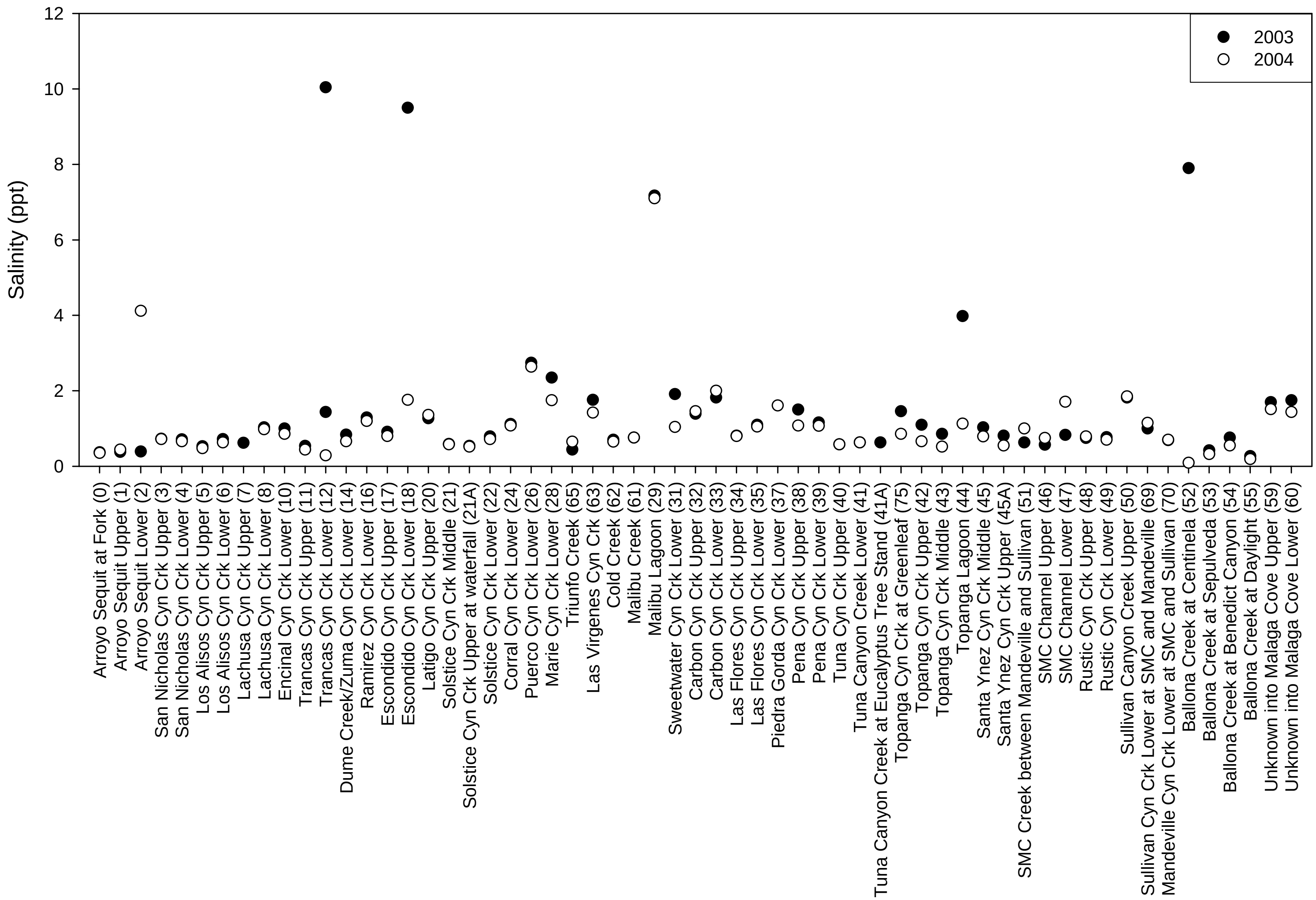

Figure 7. Salinity at sites in the SMB WMA.

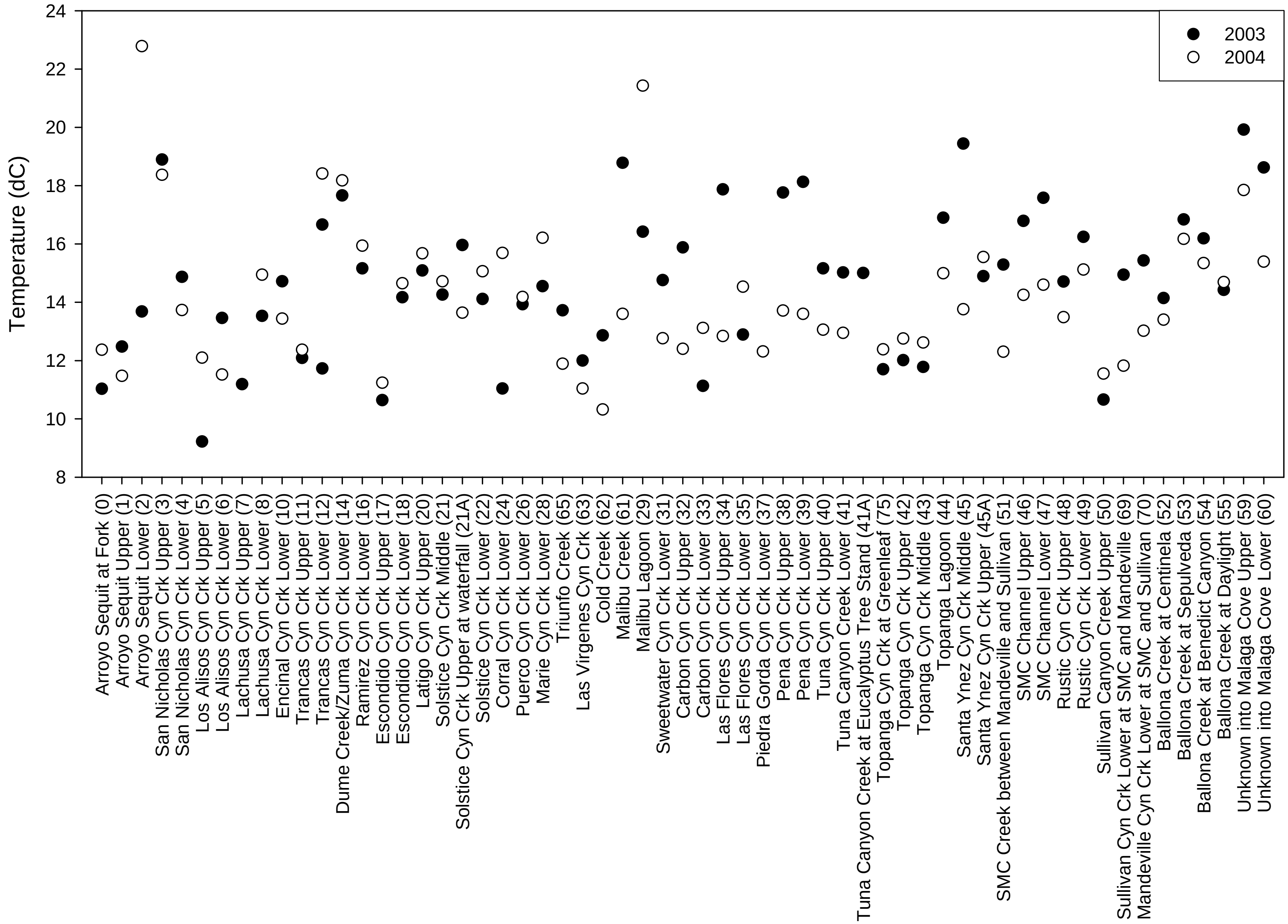

Figure 8. Temperature at sites in the SMB WMA.

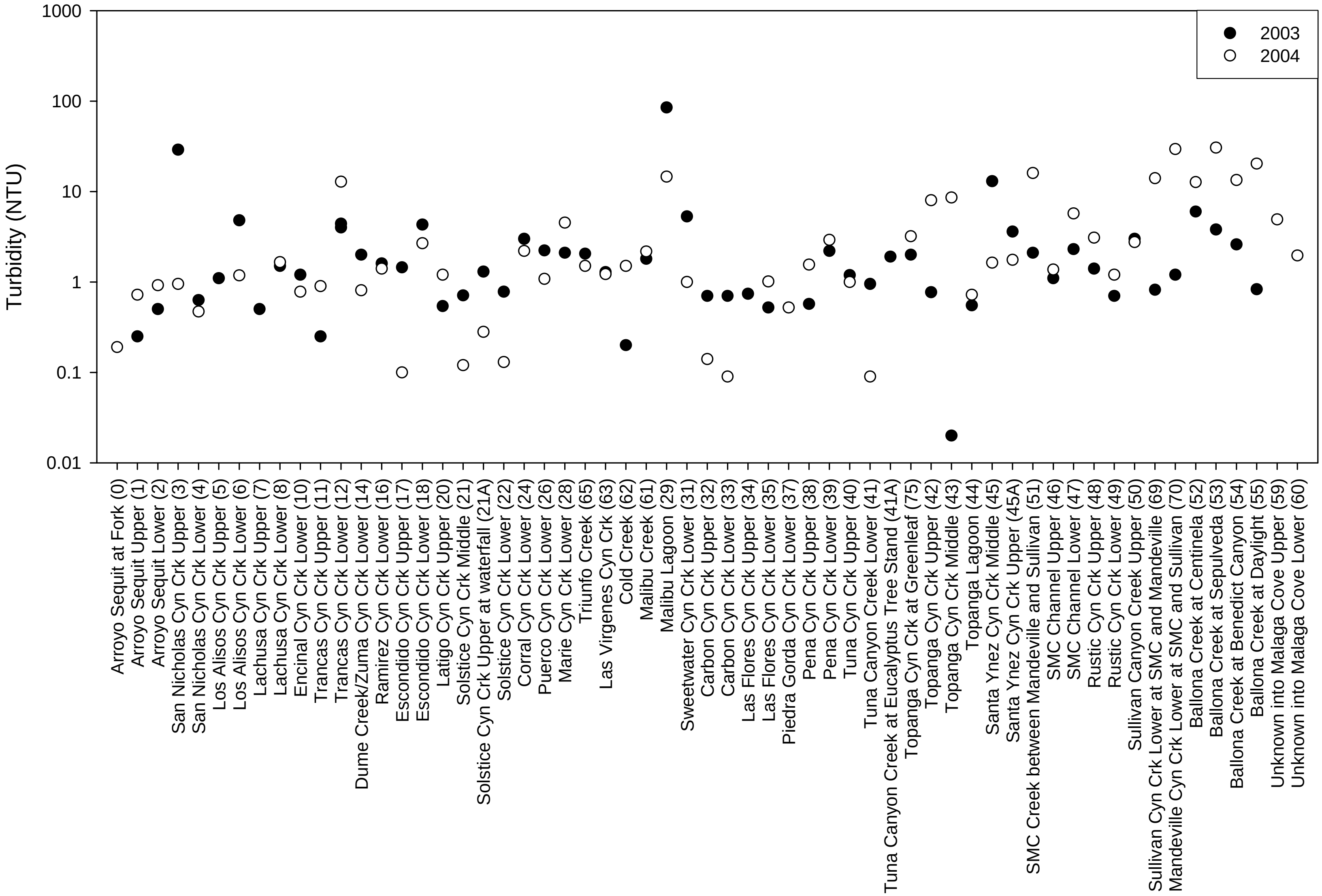

Figure 9. Turbidity at sites in the SMB WMA.

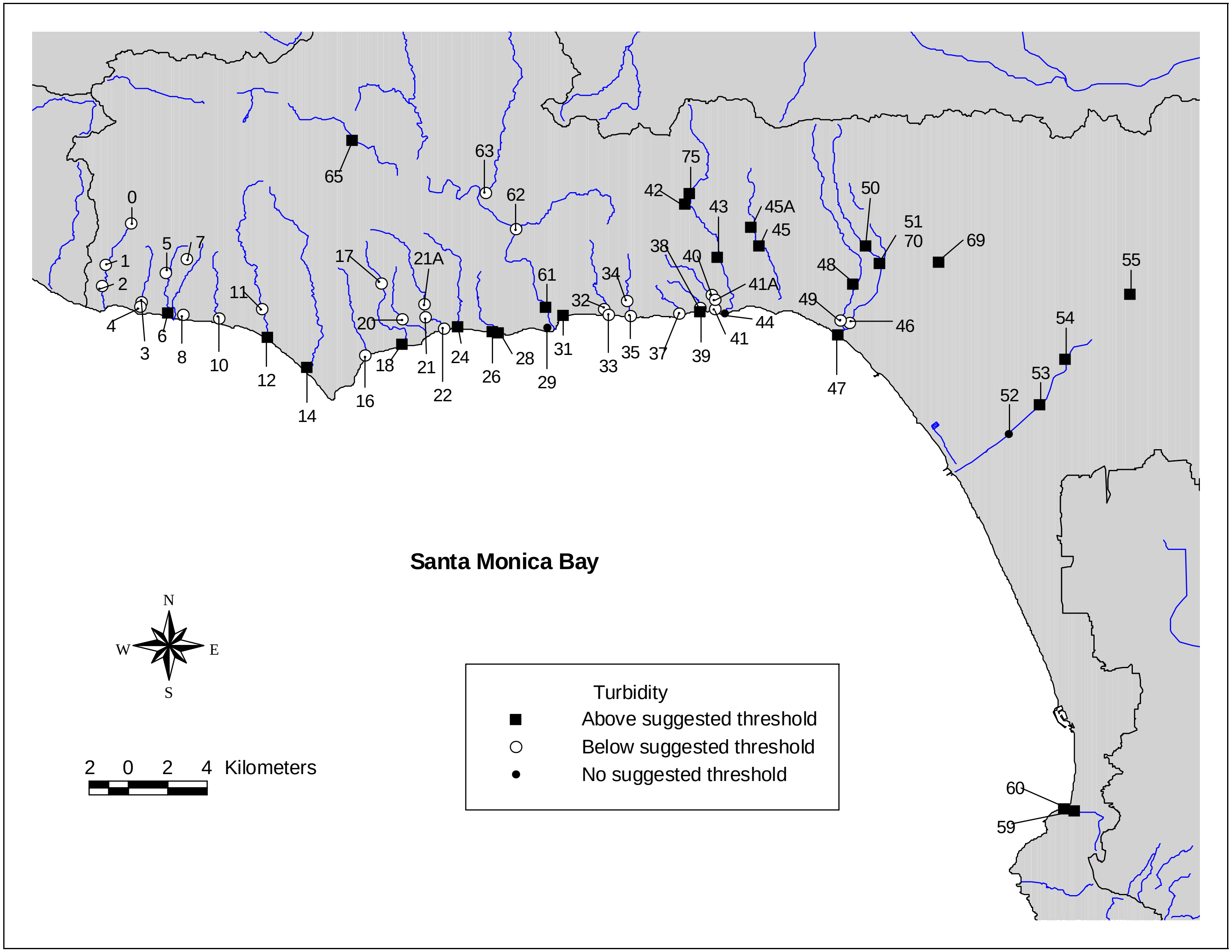

Figure 10. Turbidity spatially in the SMB WMA.

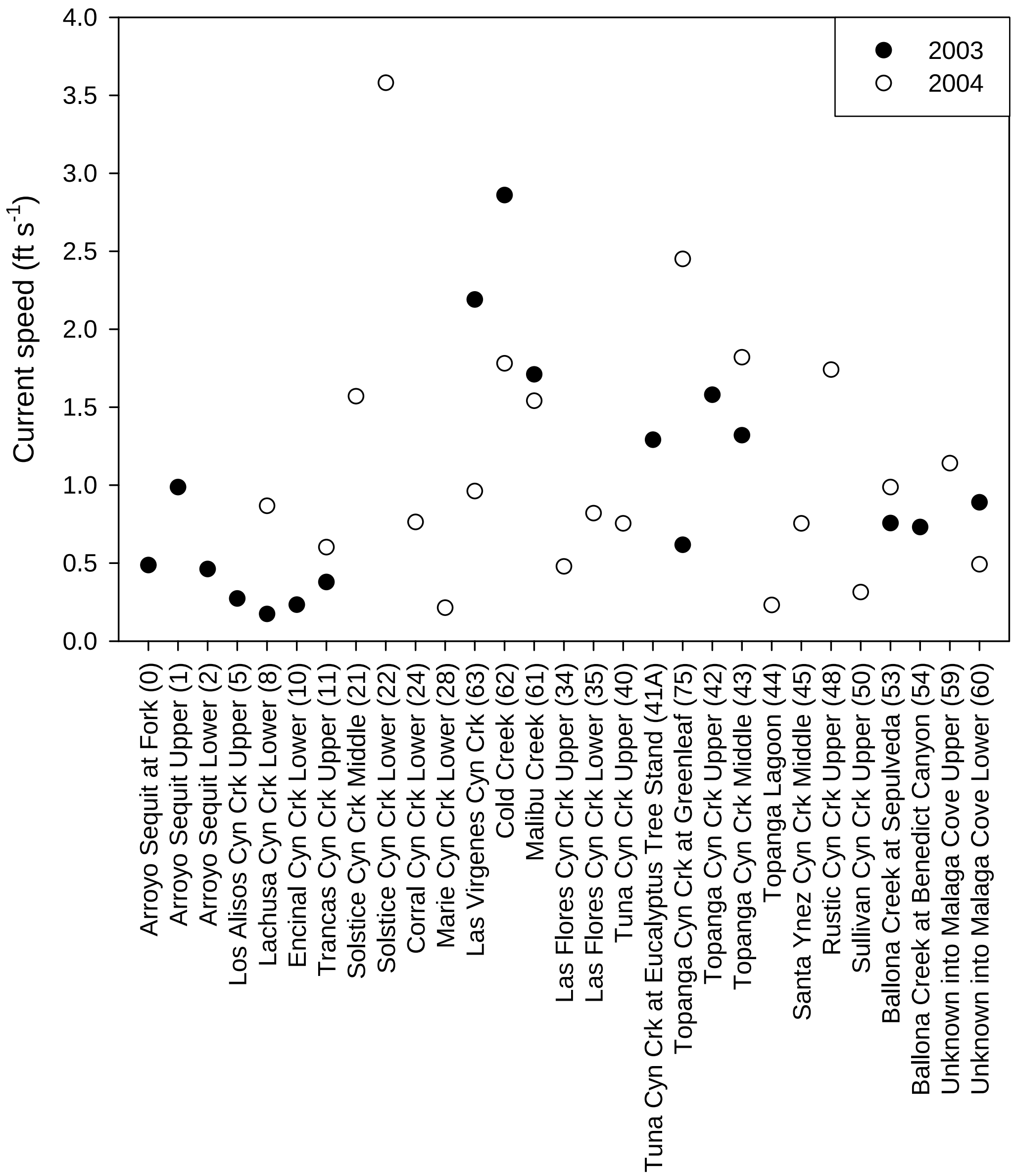

Figure 11. Current speed at sites in the SMB WMA.

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4.2 Conventional Constituents in Water

Alkalinity, ammonia, boron, chloride, chlorophyll a, fluoride, hardness, nitrogen, phosphorus, sulfate, TDS

Alkalinity ranged from 35 to 582 mg l^{-1} in the SMB WMA (Figure 12). All values exceeded the USEPA criterion of 20 mg l^{-1} (USEPA 1986). Waters over 20 mg l^{-1} should be well buffered against large fluctuations in pH.

Total ammonia-N ranged from 0.041 to 0.357 mg l^{-1} (Figure 13). 72.2% of the values were below the MDL, which was 0.05 mg l^{-1} in 2003 and 0.04 mg l^{-1} in 2004. All values were below the 1-hour average objective for cold waters, which varies with pH, and the 4-day average objective, which varies with pH and temperature (CRWQCB LAR 1994). Un-ionized ammonia-N values were calculated for the 32 sites where total ammonia-N was detected. Values ranged from 0.0001 to 0.1079 mg l^{-1} (Figure 14). With the exception of the value from Ballona Creek at Daylight (55), all values were below the 1-hour and 4-day average objectives for cold waters, which vary with pH and temperature (CRWQCB LAR 1994).

Boron ranged from 0.12 to 2.3 mg l^{-1} (Figure 15). Values from 5 sites in the northern portion of the WMA exceeded the California DHS action level for drinking water of 1.0 mg l^{-1} (Marshack 2003): Upper and Lower San Nicholas Canyon Creek (3 and 4), Lower Sweetwater Canyon Creek (31), and Upper and Lower Pena Canyon Creek (38 and 39) (Figure 16). Boron at Malibu Lagoon (29) was > 1.0 mg l^{-1}, but this is a brackish site that is not subject to drinking water criteria. None of the sites in the Malibu Creek watershed exceeded their waterbody specific objective of 2.0 mg l^{-1} (CRWQCB LAR 1994), and Basin Plan objectives for boron do not exist for the rest of the sites.

Chloride ranged from 15.7 to 6280 mg l^{-1} (Figure 17). Compared to the USEPA National Ambient Water Quality Criteria for protection of freshwater aquatic life, values from 2 sites exceeded 860 mg l^{-1} (1-hour average) and values from 11 sites 230 mg l^{-1} (4-day average) (Marshack 2003) (Figure 18). One value from Las Virgenes Canyon Creek (63) also exceeded the waterbody specific objective of 500 mg l^{-1} (CRWQCB LAR 1994). Basin Plan objectives for chloride do not exist for the rest of the sites. Chloride exceeded 860 mg l^{-1} at Malibu Lagoon (29), Topanga Lagoon (44) and Ballona Creek at Centinela (52), but these sites are not subject to freshwater aquatic life protection criteria.

Chlorophyll a ranged from 0.05 to 43.9 µg l^{-1} (Figure 19). There are no established objectives for suspended chlorophyll a in the 1994 Basin Plan or elsewhere. The USEPA suggested threshold value for reference conditions for chlorophyll a in streams in level III ecoregion 6 is 2.39 µg l^{-1} (USEPA 2000a); values from 14 sites exceeded this suggested threshold (Figure 20). Chlorophyll a at Malibu Lagoon (29) and Ballona Creek at Centinela (52) exceeded 2.39 µg l^{-1} but these sites are subject to tidal influence and should not be compared to streams. Concentrations in Malibu Lagoon may be high for estuarine systems however (Bricker et al. 1999).

Fluoride ranged from 0.101 to 2.16 mg l^{-1} (Figure 21). At one site fluoride exceeded the California Primary MCL of 2.0 mg l^{-1}, and values from 5 sites exceeded the California Public

Health Goal for drinking water for toxicity to humans of 1.0 mg l^{-1} (Marshack 2003). These 6 sites in the northern portion of the WMA: Upper and Lower San Nicholas Canyon Creek (3 and 4), Lower Lachusa Canyon Creek (8), Lower Puerco Canyon Creek (26), and Upper and Lower Pena Canyon Creek (38 and 39) (Figure 22). Fluoride is not included in the 1994 Basin Plan.

Hardness (as $CaCO_3$) ranged from 55 to 2420 mg l^{-1} (Figure 23). Hardness values are necessary for interpreting metals data with regard to objectives.

Nitrate-N ranged from 0.0054 to 6.23 mg l^{-1} (Figure 24); 4.8% of the values were below the MDL of 0.005 mg l^{-1}. Many of the highest values were from the Malibu Creek, Santa Monica Canyon Creek, and Ballona Creek watersheds. Nitrite-N ranged from 0.005 to 0.163 mg l^{-1} (Figure 25); 61.7% of the values were below the MDL of 0.005 mg l^{-1}. All nitrite-N values were below the Basin Plan Primary MCL of 1.0 mg l^{-1} and all nitrate-N + nitrite-N values were below the Basin Plan MCL of 10.0 mg l^{-1}, which is also the Malibu Creek watershed objective (CRWQCB LAR 1994). TKN, which is all forms of nitrogen except nitrate-N and nitrite-N, ranged from 0.12 to 8.24 (Figure 26); 21.5% of values were below the MDL of 0.12 mg l^{-1}. Total nitrogen (the sum of nitrate-N, nitrite-N and TKN; a value of 0 was used for any value below its MDL) ranged from 0.12 to 9.61 mg l^{-1} (Figure 27). Values from 37 sites exceeded the USEPA level III ecoregion 6 suggested threshold value for reference conditions of 0.518 mg l^{-1} total nitrogen (USEPA 2000a) (Figure 28).

Orthophosphate-P ranged from 0.007 to 1.27 mg l^{-1} (Figure 29). The highest values were from Lower Trancas Canyon Creek (12) and Malibu Creek (61). Values from 12 sites exceeded the USEPA recommended limit for orthophosphate-P in streams of 0.10 mg l^{-1} (USEPA 1986) (Figure 30). Total phosphorus ranged from 0.0153 to 1.76 mg l^{-1} (Figure 31); 17.4% of the values were below the MDL, which was 0.03 mg l^{-1} in 2003 and 0.015 mg l^{-1} in 2004. The highest values were from Upper San Nicholas Canyon Creek (3), Lower Trancas Canyon Creek (12), Cold Creek (62), Malibu Creek (61) and Malibu Lagoon (29) (Figure 32). Values from 24 sites exceeded the USEPA recommended limit for total phosphorus in streams of 0.10 mg l^{-1} (USEPA 1986) and values from 47 sites exceeded the USEPA level III ecoregion 6 suggested threshold value for reference conditions of 0.03 mg l^{-1} total P (USEPA 2000a).

Sulfate ranged from 17.4 to 1940 mg l^{-1} (Figure 33). Values from 19 sites exceeded the ambient level California Secondary MCL of 250 mg l^{-1} and values from 30 sites exceeded the upper level California Secondary MCL of 500 mg l^{-1} (Figure 34). Values from Las Virgenes Canyon Creek (63), in the Malibu Creek watershed, exceeded the waterbody specific objective of 500 mg l^{-1} (CRWQCB LAR 1994). Basin Plan objectives for sulfate do not exist for the rest of the sites.

TDS ranged from 124 to 11900 mg l^{-1} (Figure 35). Values from only 2 sites were below the California Secondary MCL of 500 mg l^{-1} (Figure 36). The highest values were from sites in the lower portions of sub-watersheds. Values from Las Virgenes Canyon Creek (63) exceeded the waterbody specific objective of 2000 mg l^{-1} (CRWQCB LAR 1994). Basin Plan objectives for TDS do not exist for the rest of the sites.

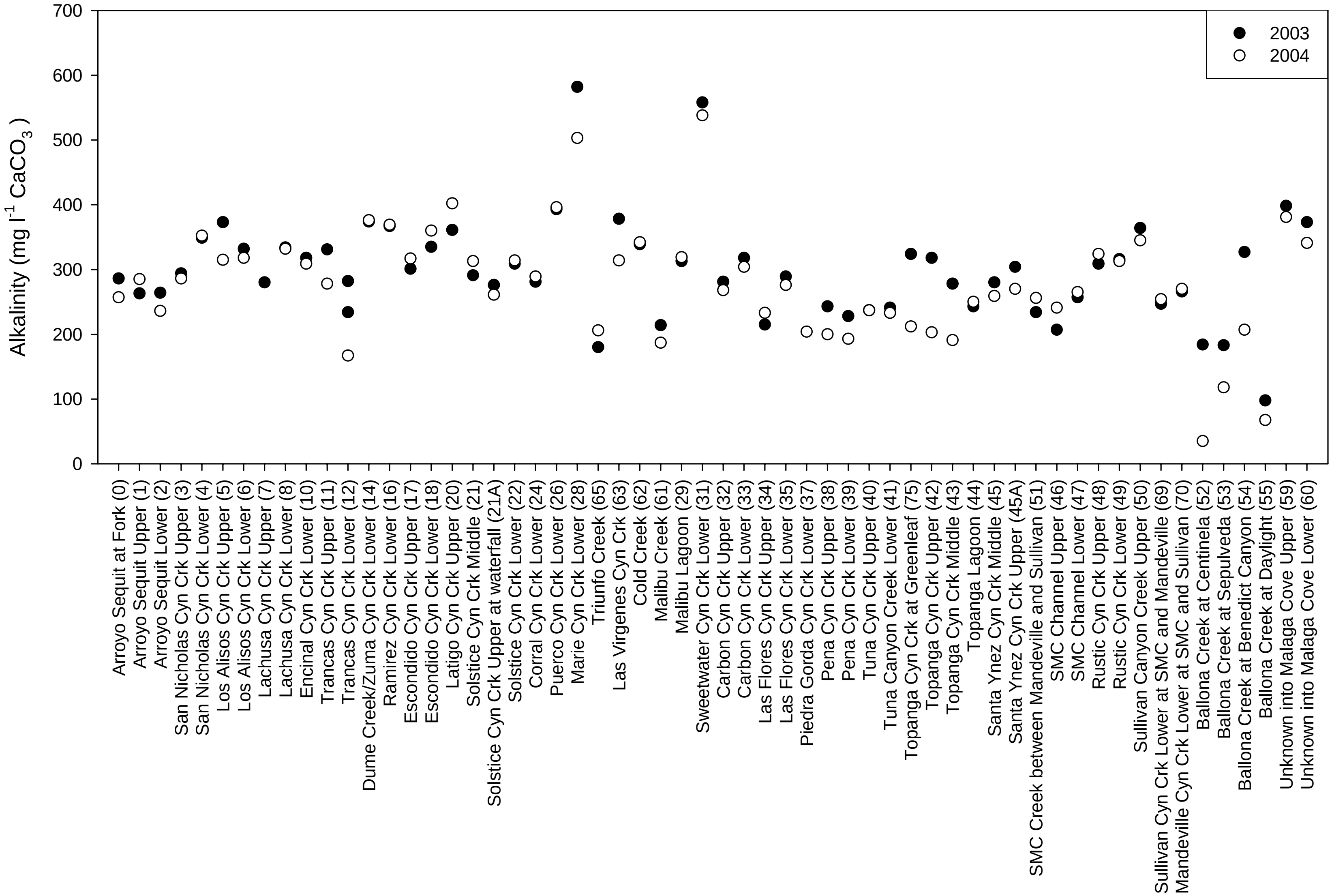

Figure 12. Alkalinity as $CaCO_3$ at sites in the SMB WMA.

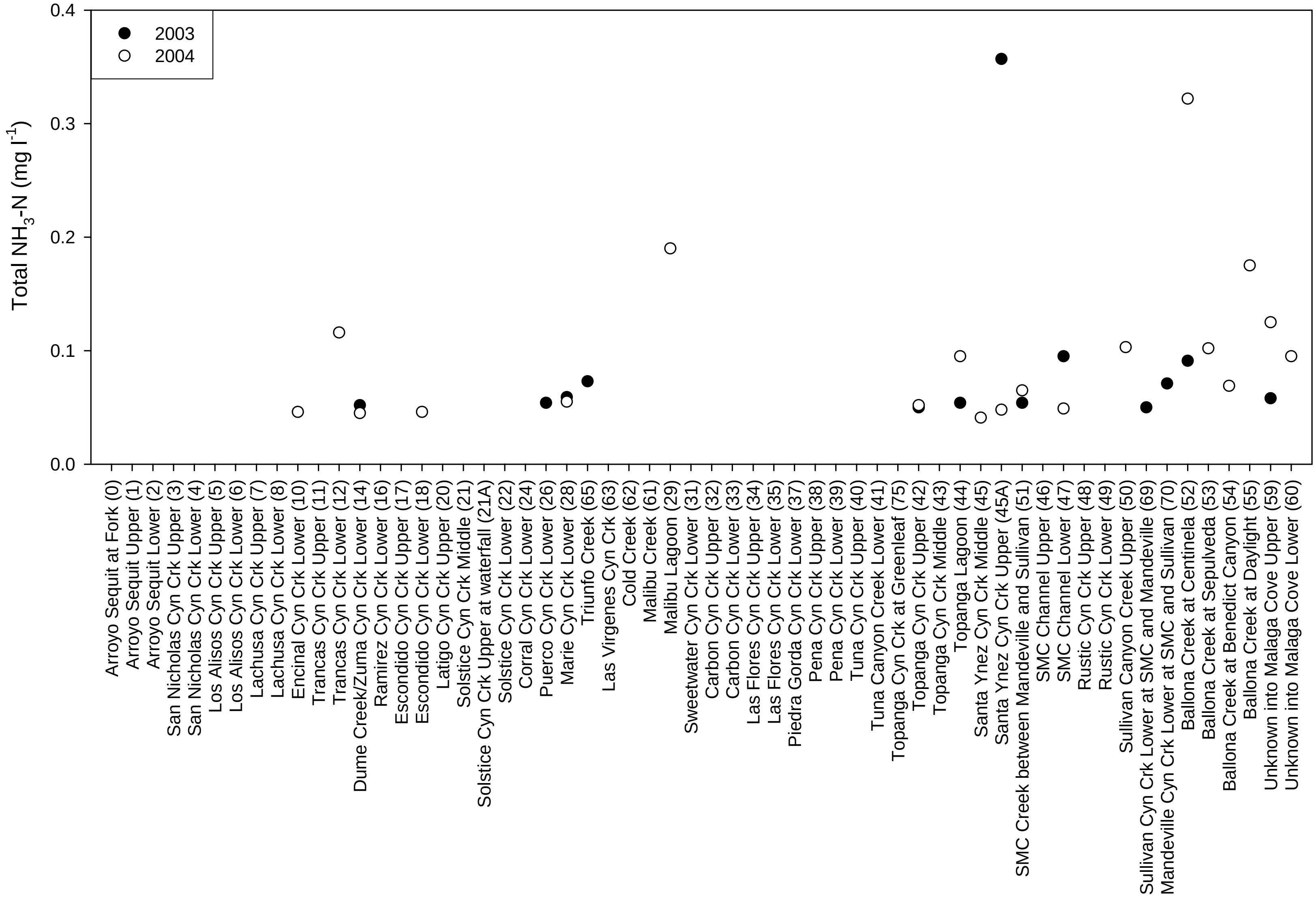

Figure 13. Total ammonia-N at sites in the SMB WMA.

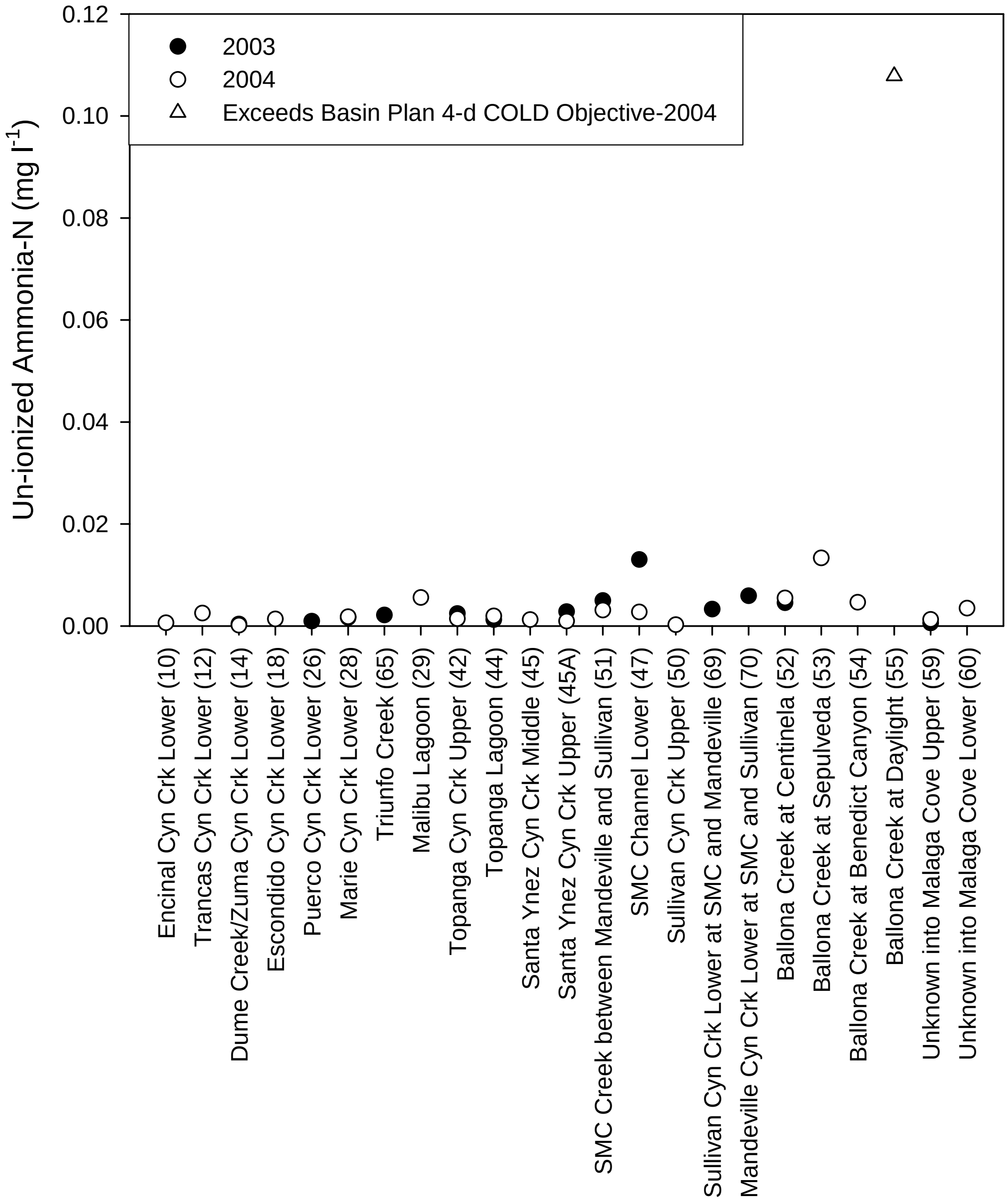

Figure 14. Un-ionized ammonia-N at sites in the SMB WMA.

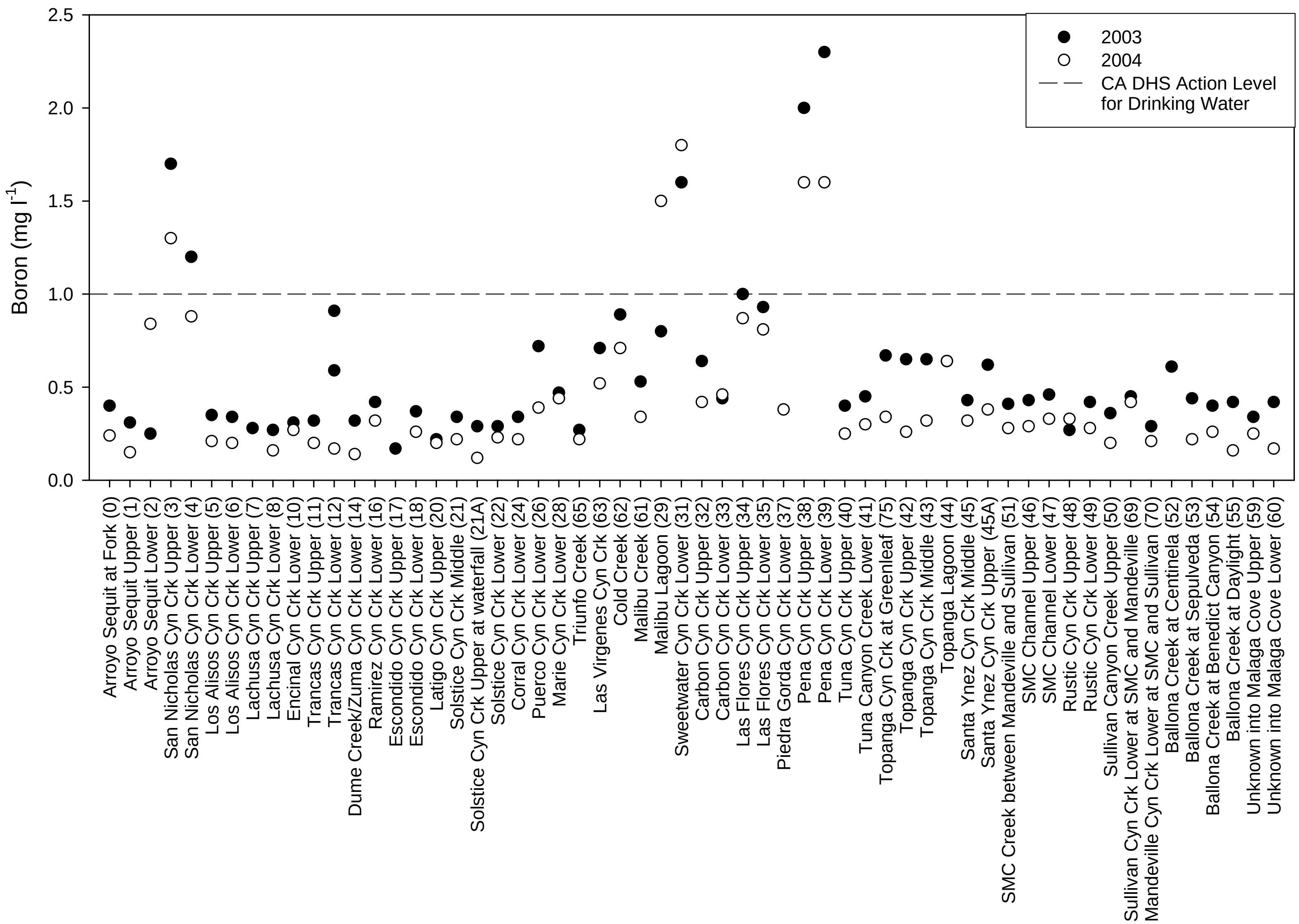

Figure 15. Boron at sites in the SMB WMA.

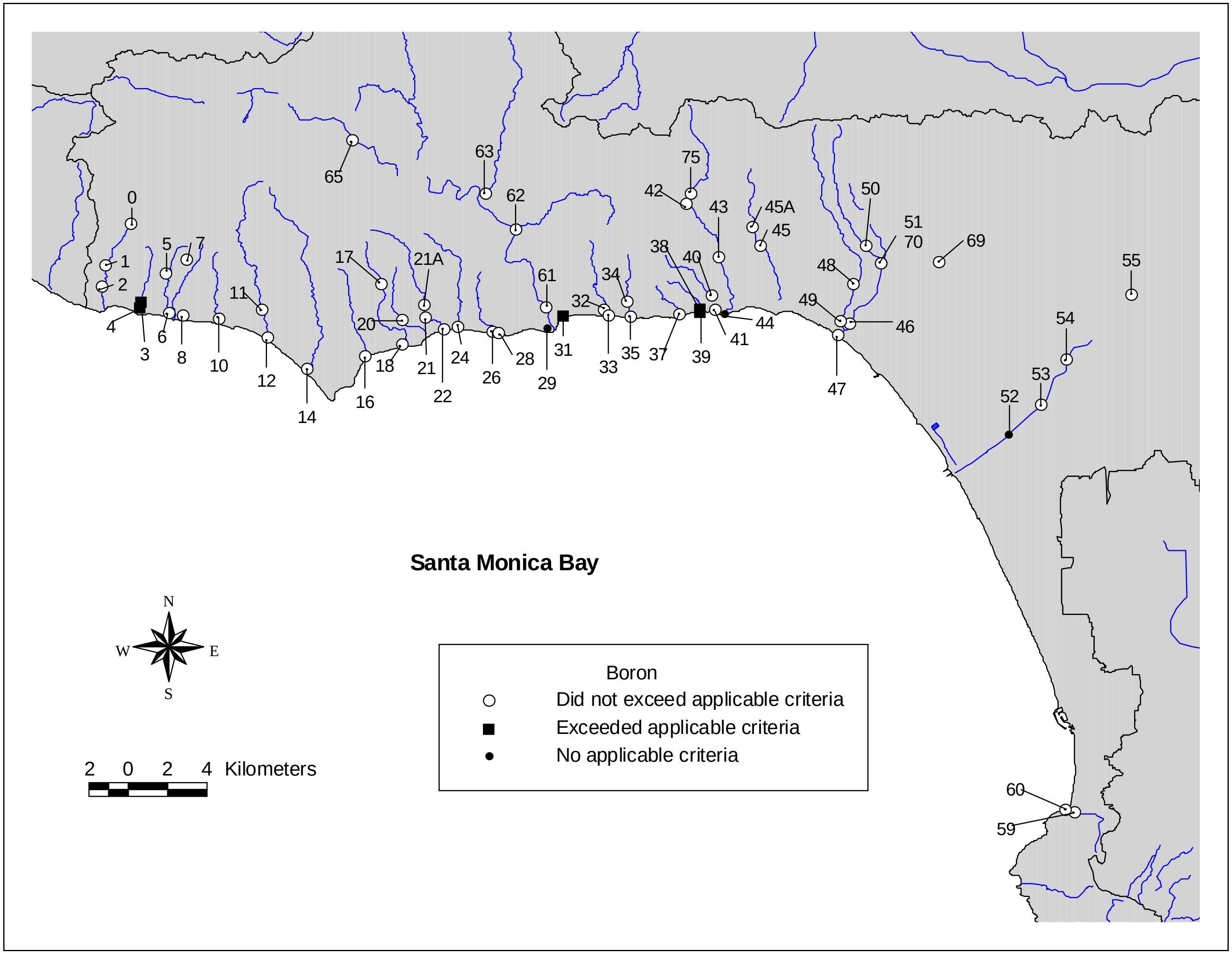

Figure 16. Boron spatially in the SMB WMA.

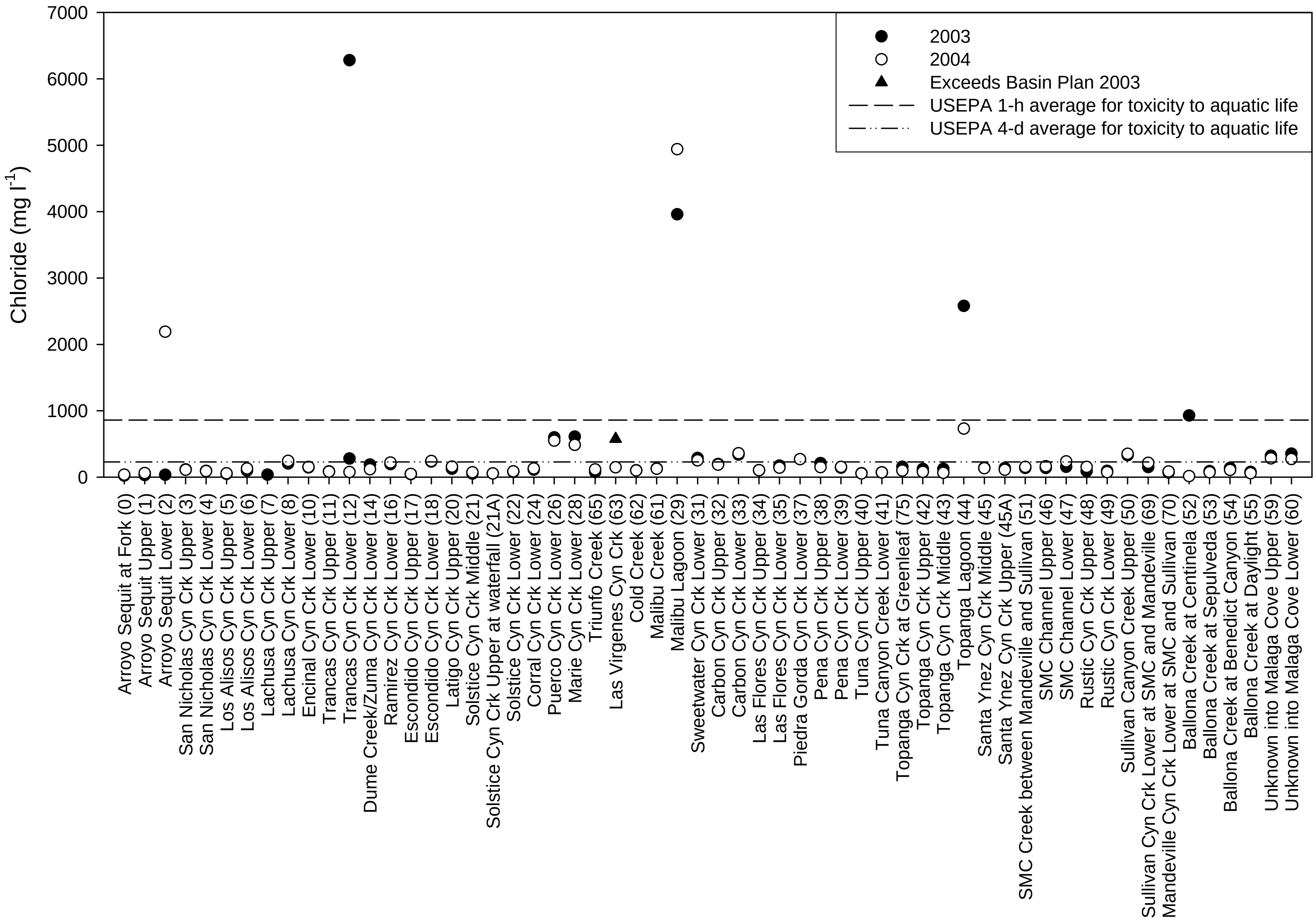

Figure 17. Chloride at sites in the SMB WMA.

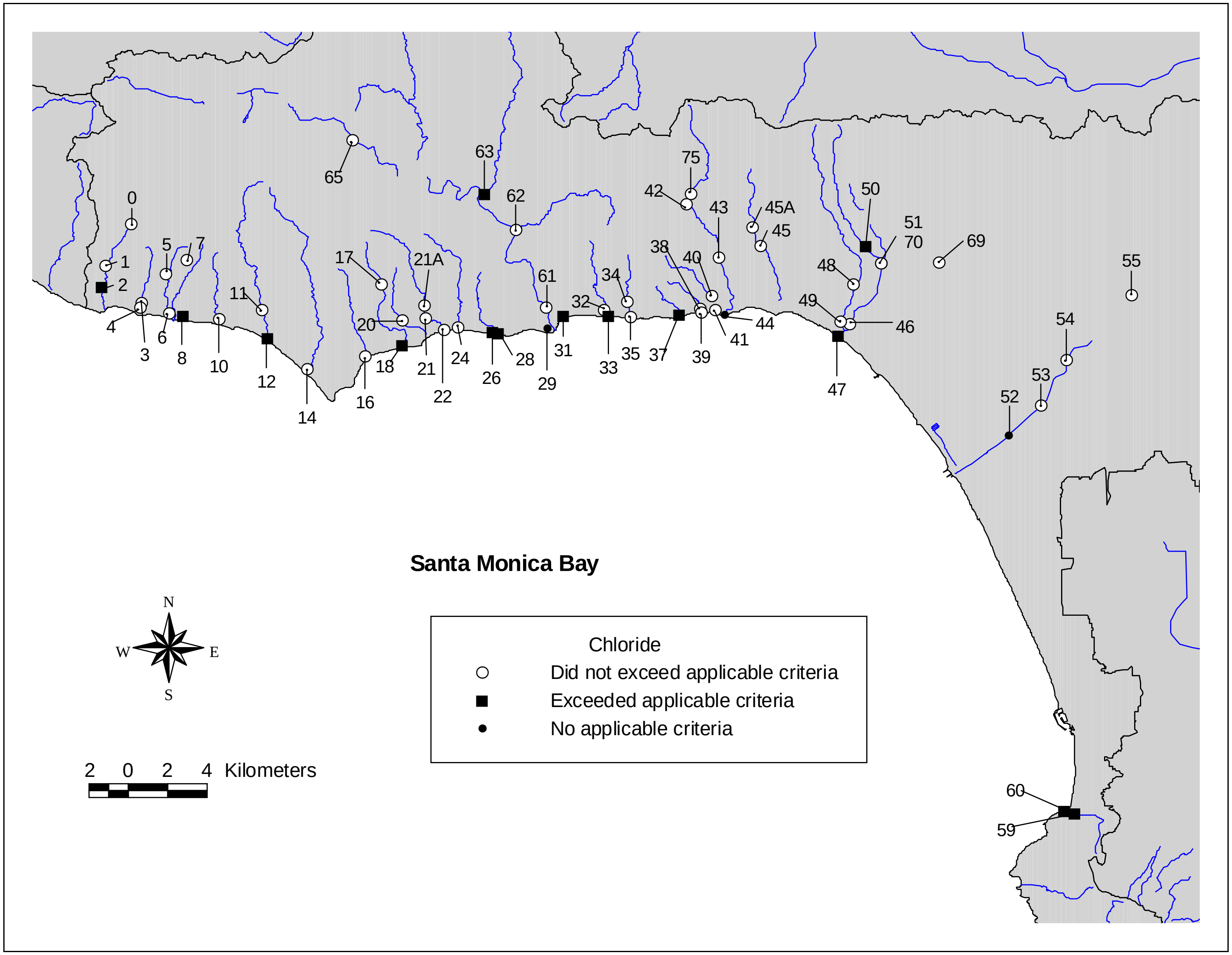

Figure 18. Chloride spatially in the SMB WMA.

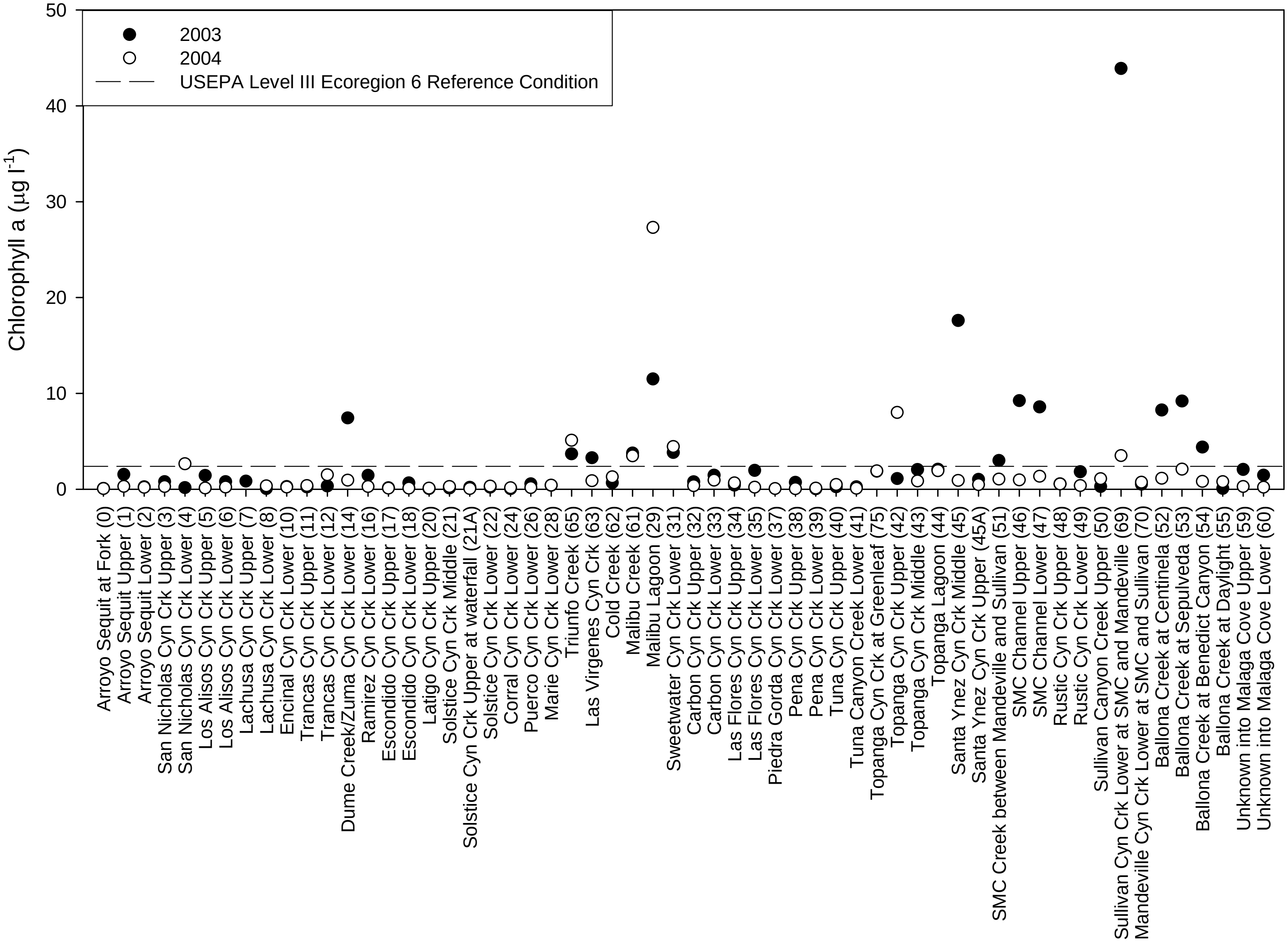

Figure 19. Chlorophyll a at sites in the SMB WMA.

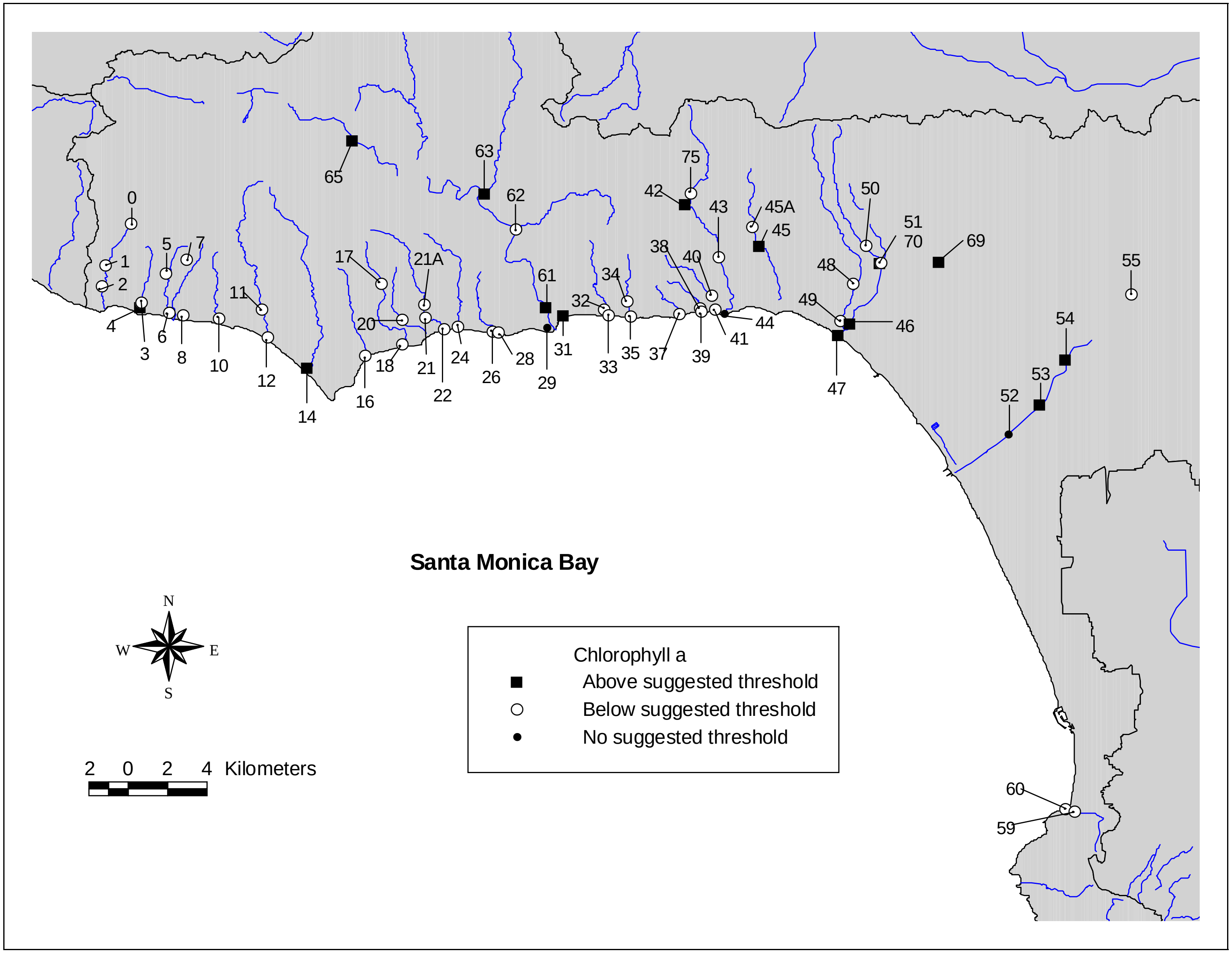

Figure 20. Chlorophyll a spatially in the SMB WMA.

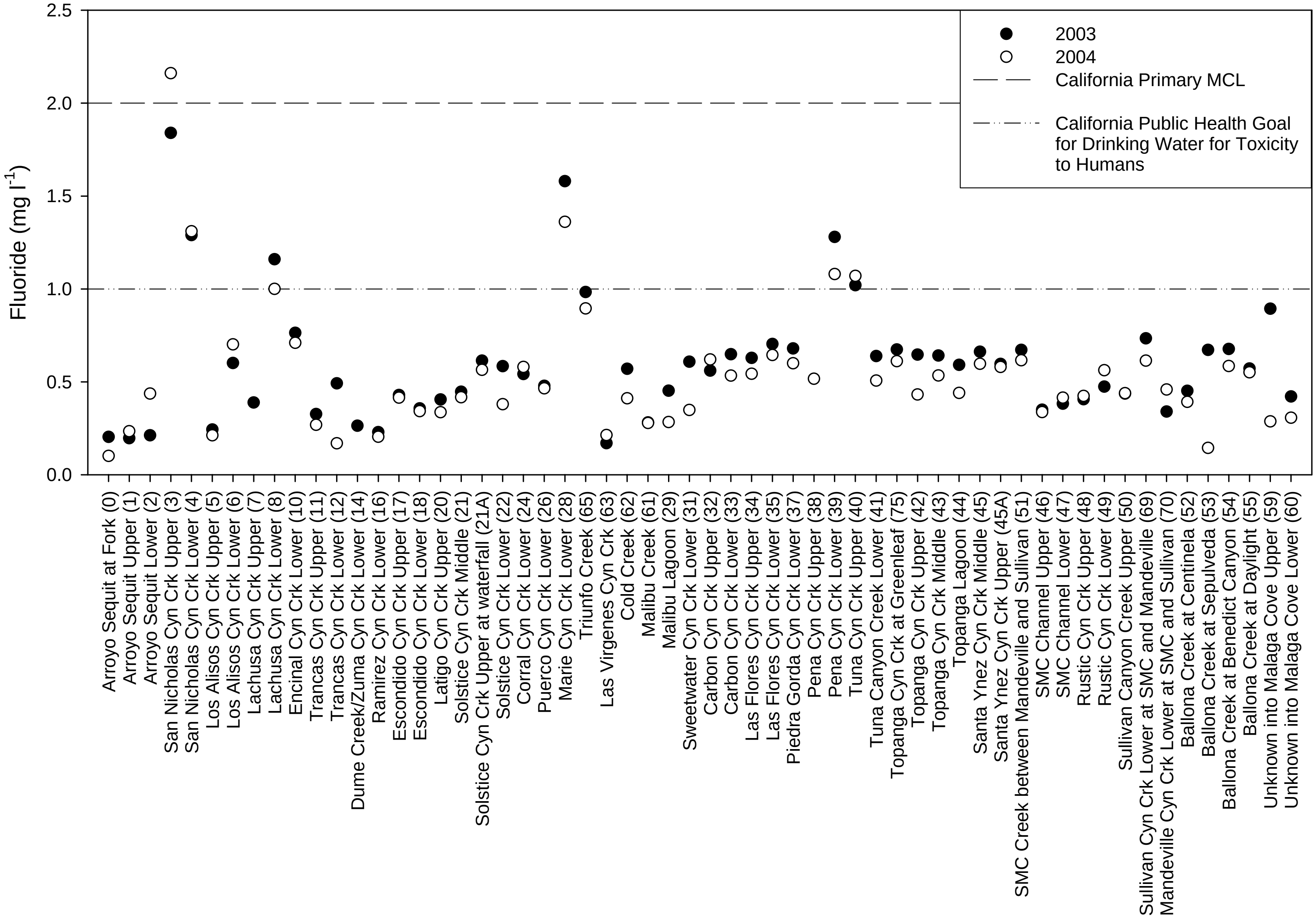

Figure 21. Fluoride at sites in the SMB WMA.

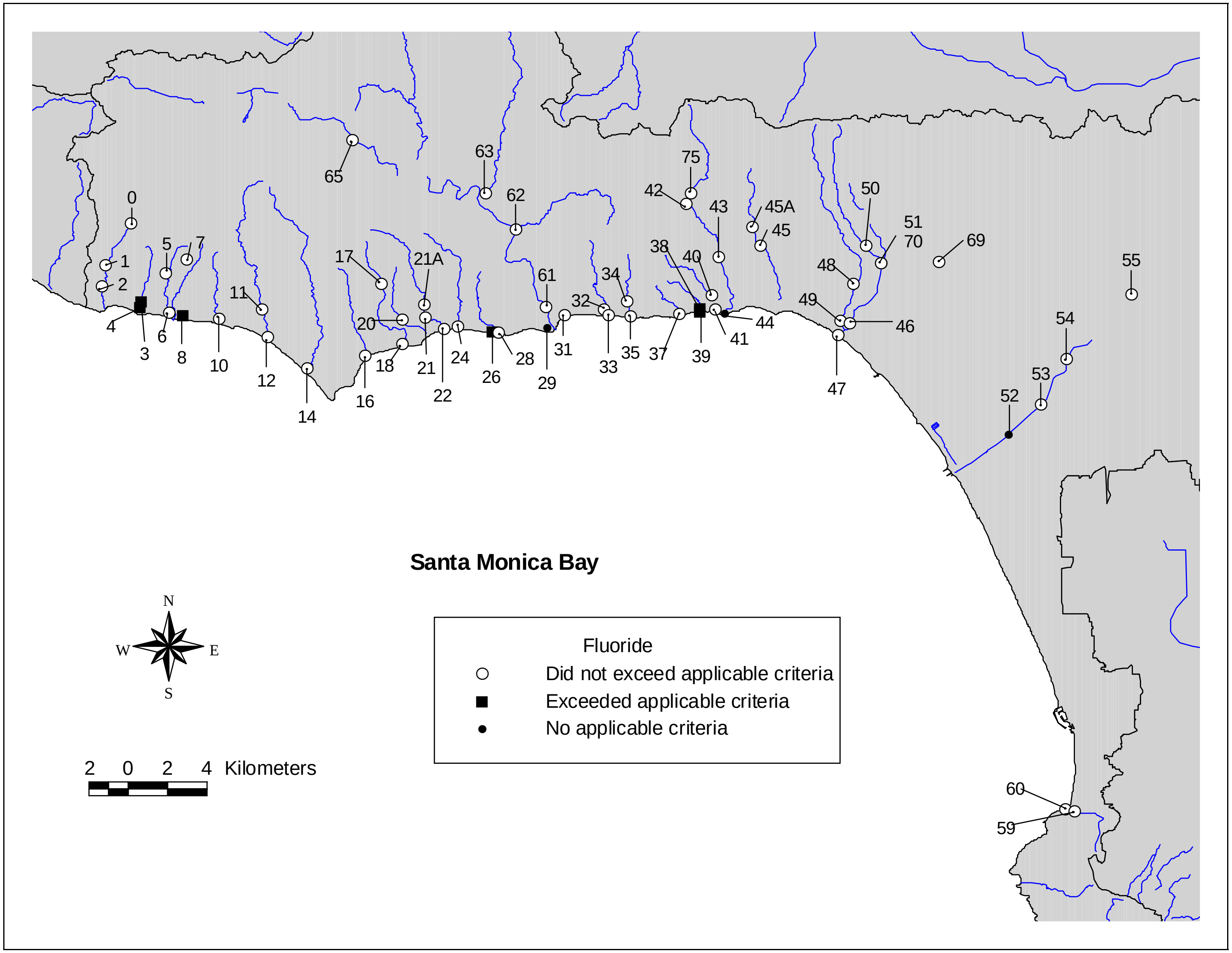

Figure 22. Fluoride spatially in the SMB WMA.

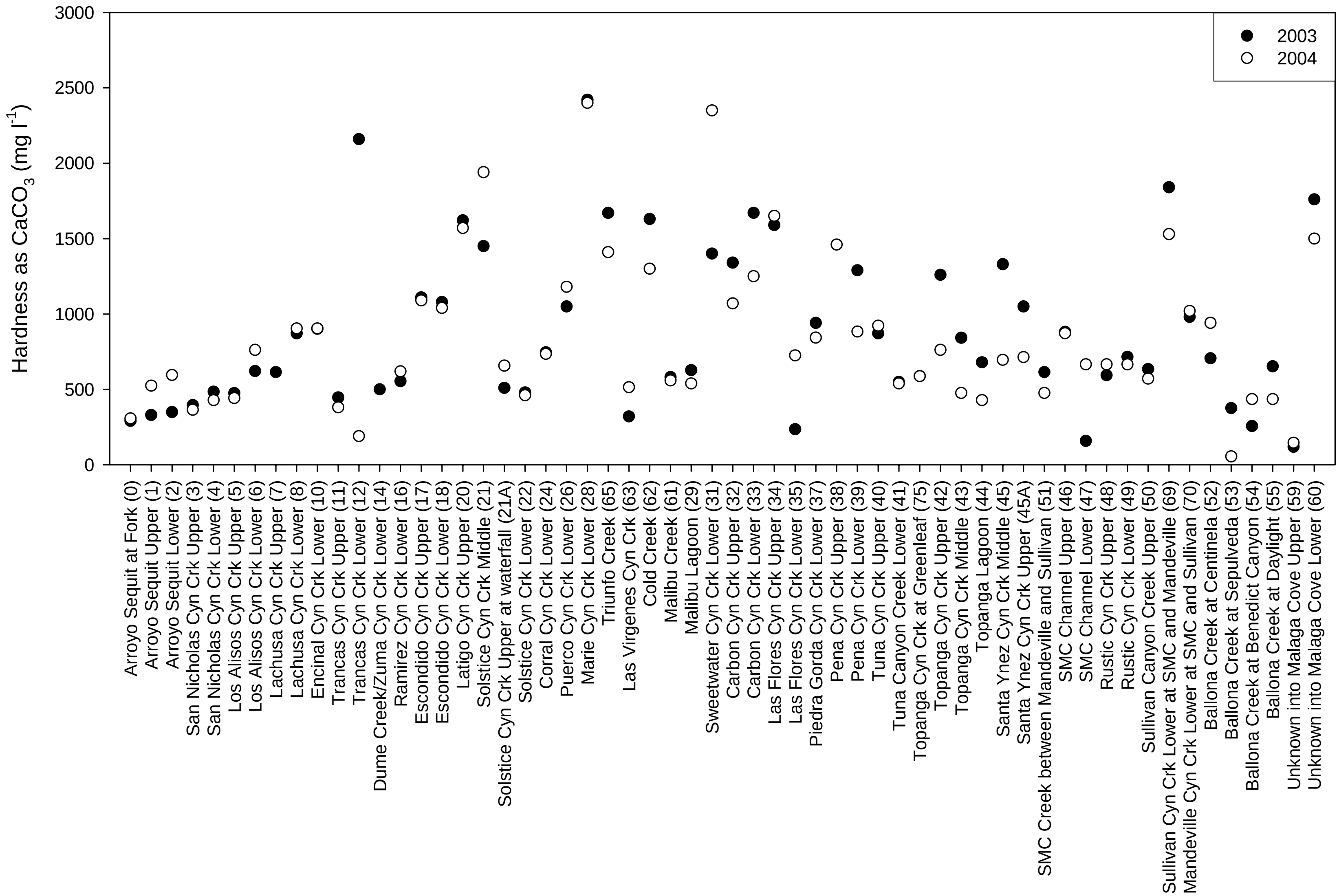

Figure 23. Hardness (as $CaCO_3$) at sites in the SMB WMA.

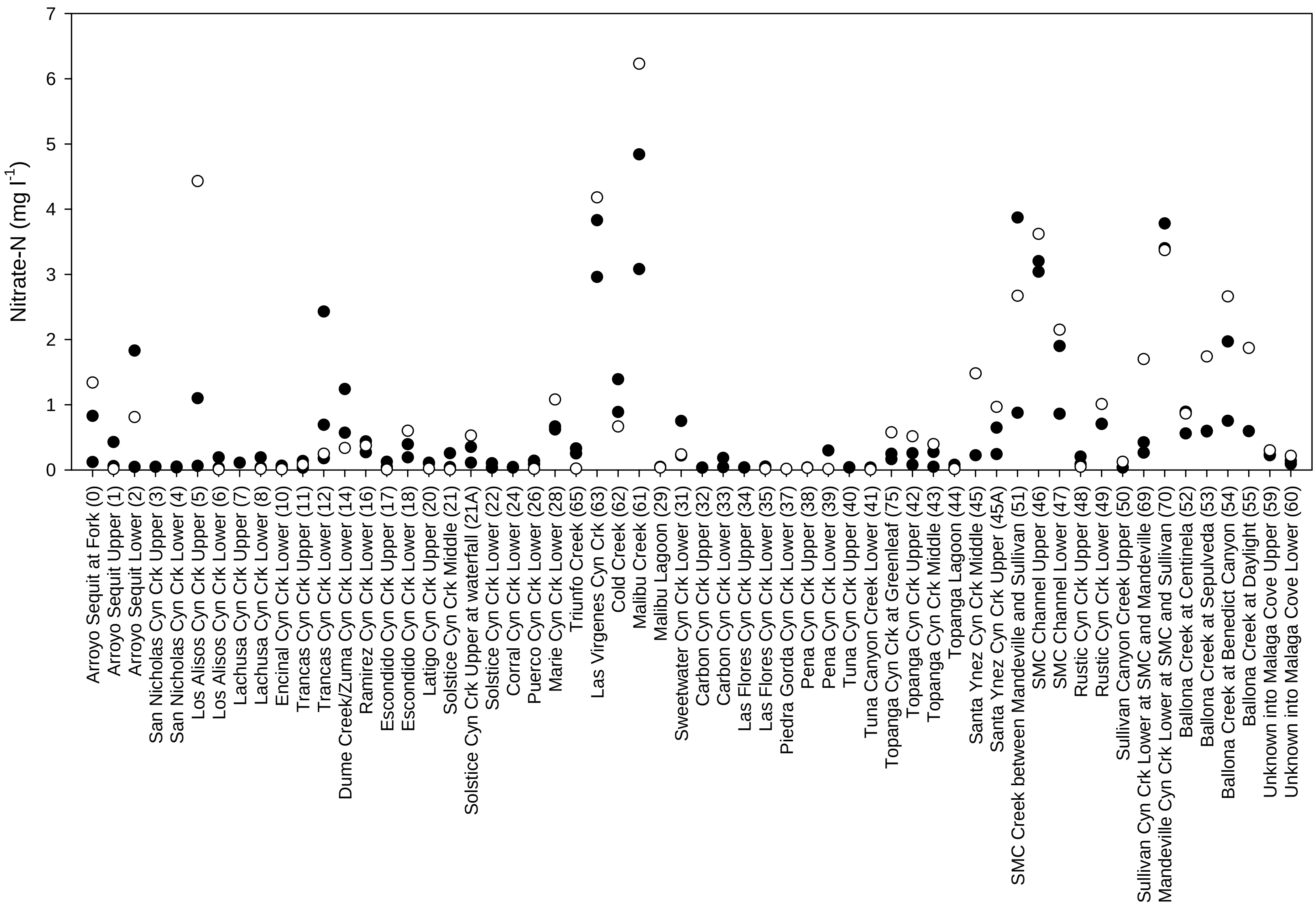

Figure 24. Nitrate-N at sites in the SMB WMA.

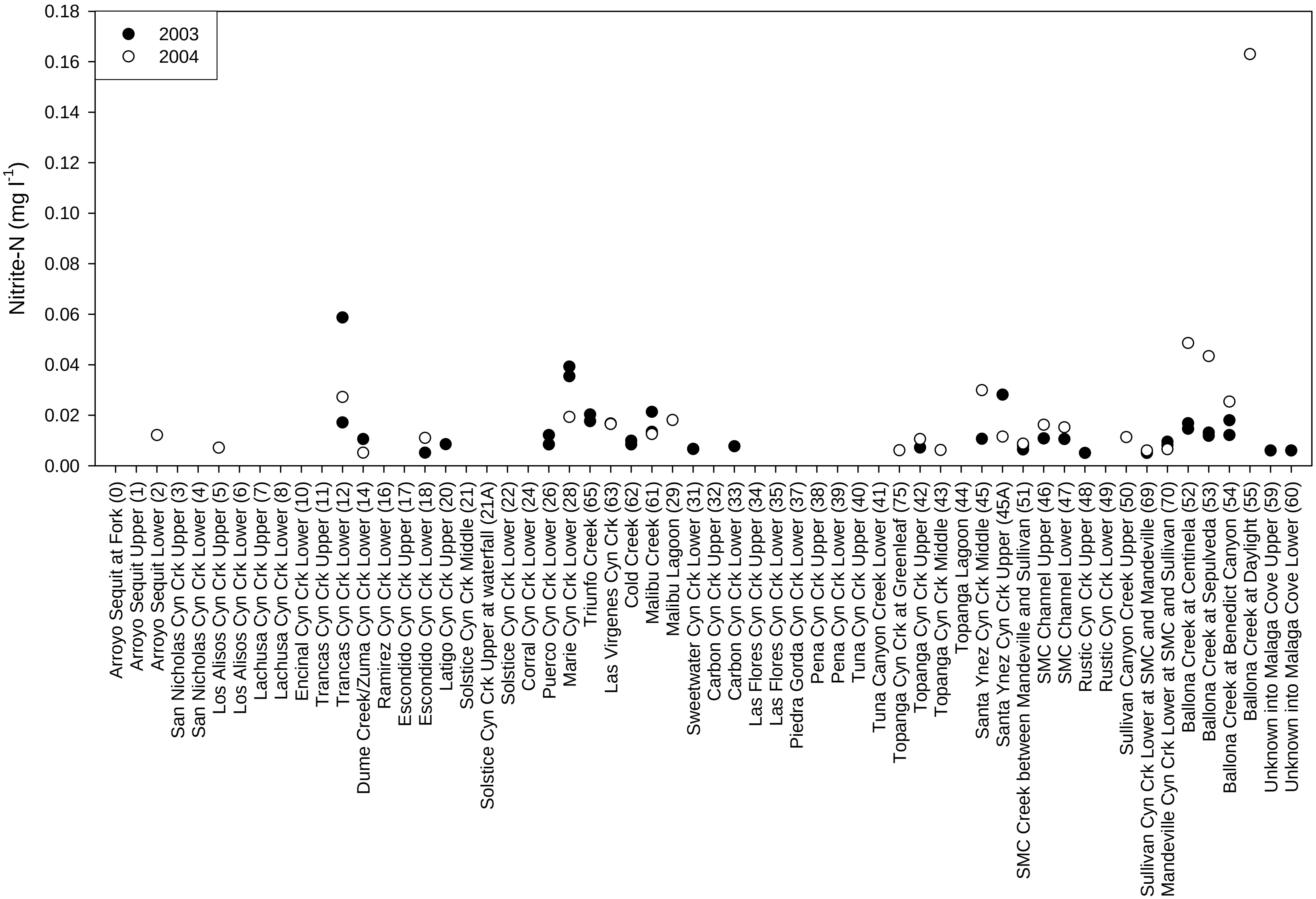

Figure 25. Nitrite-N at sites in the SMB WMA.

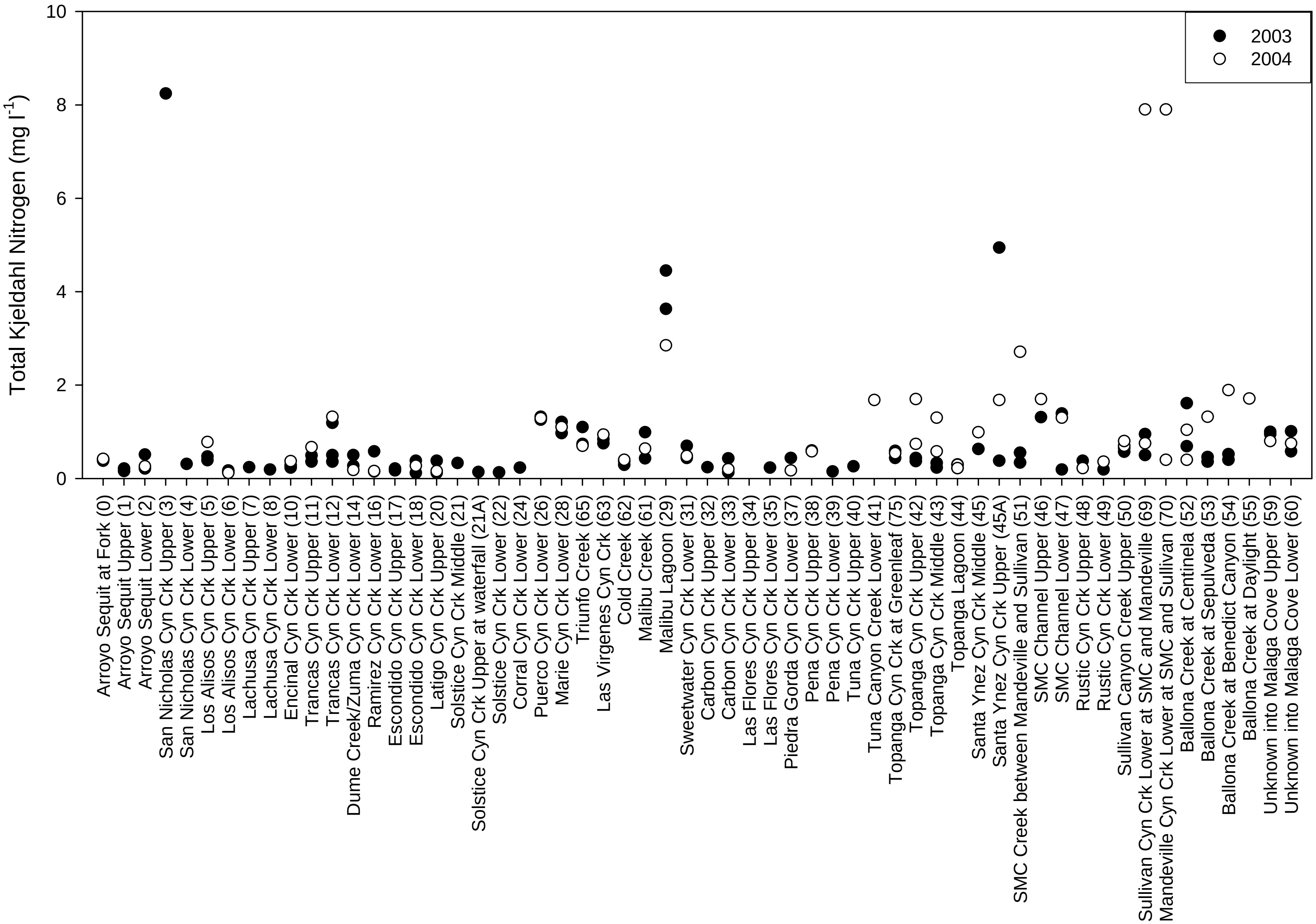

Figure 26. Total Kjeldahl nitrogen at sites in the SMB WMA.

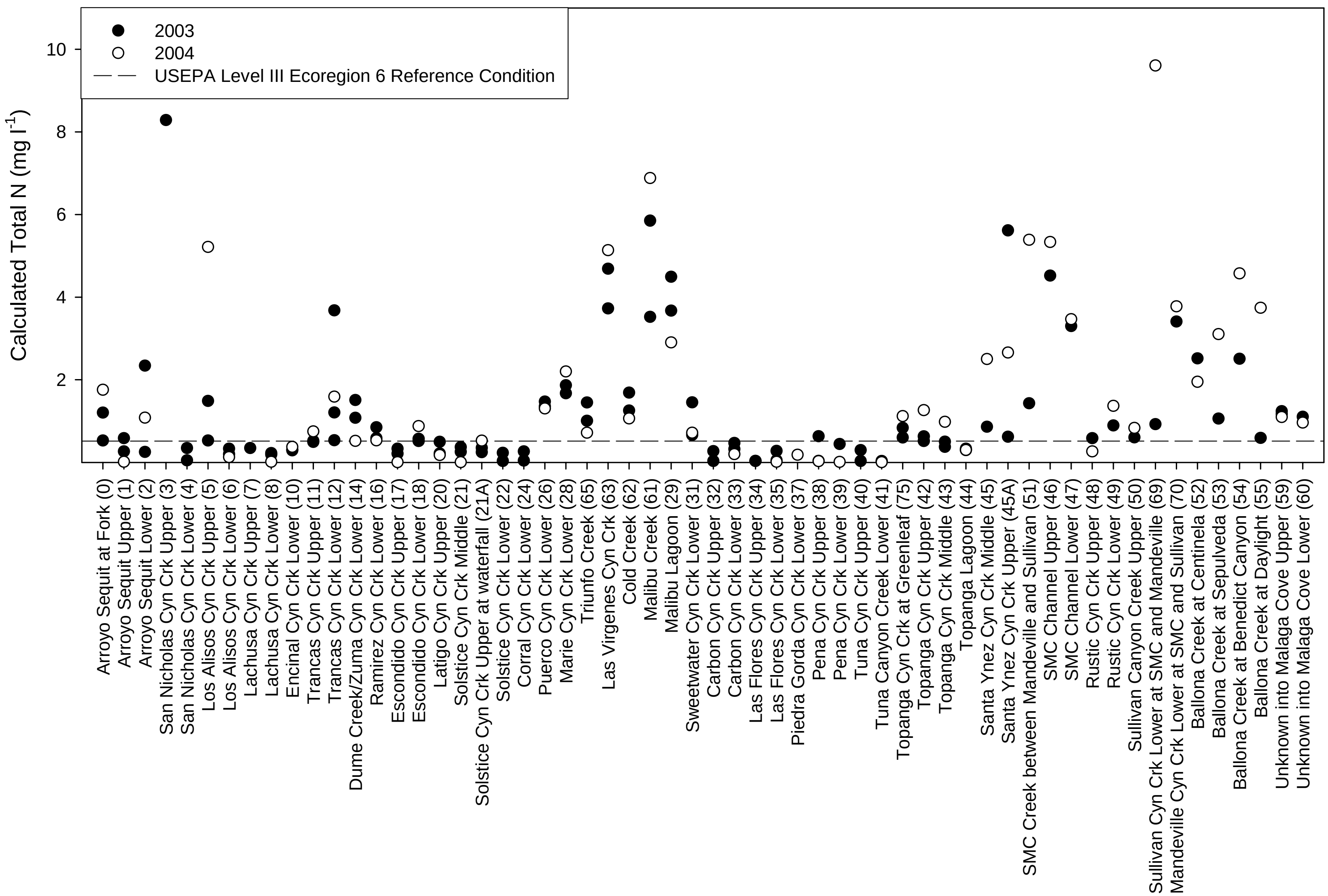

Figure 27. Total nitrogen (calculated) at sites in the SMB WMA.

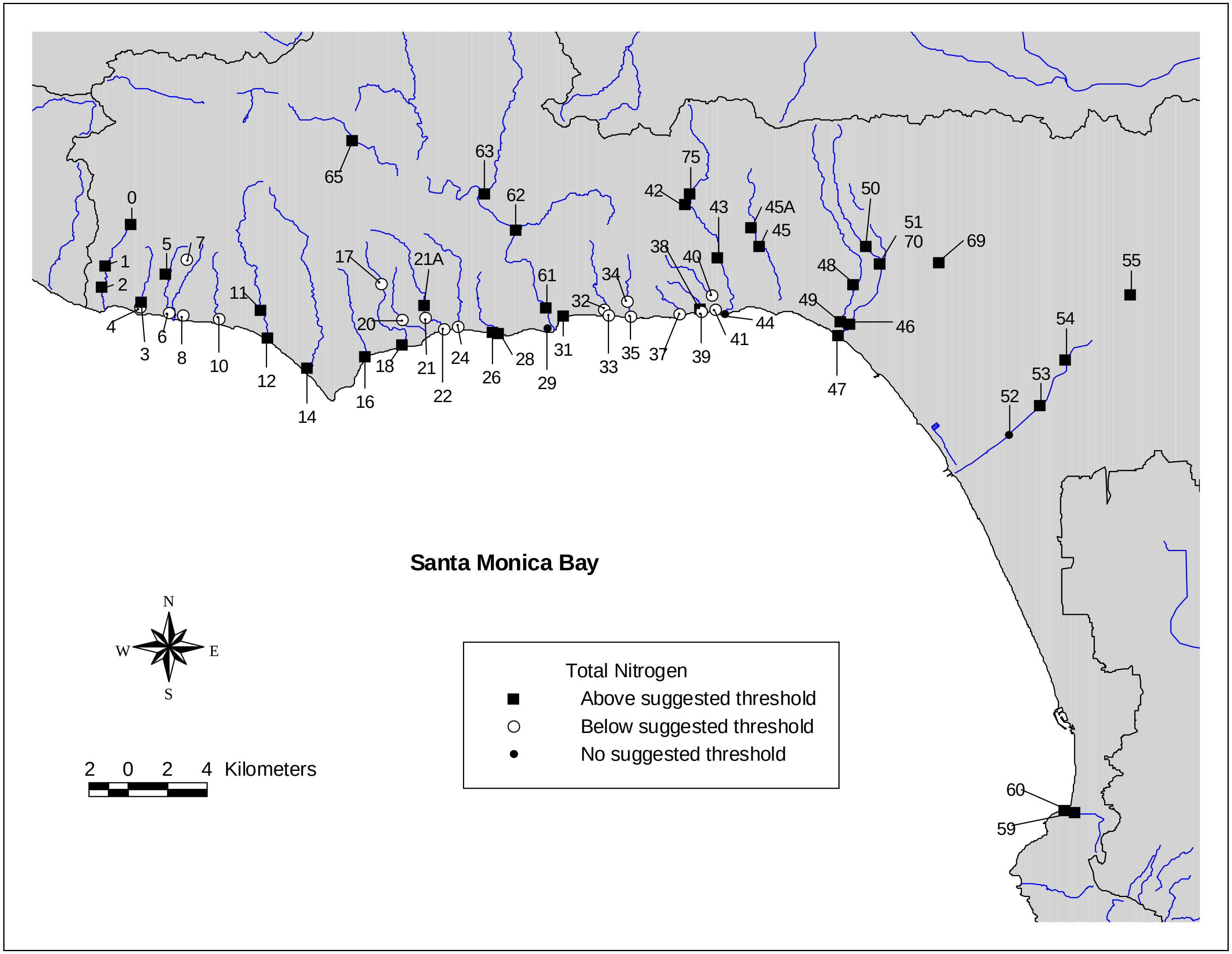

Figure 28. Total nitrogen (calculated) spatially in the SMB WMA.

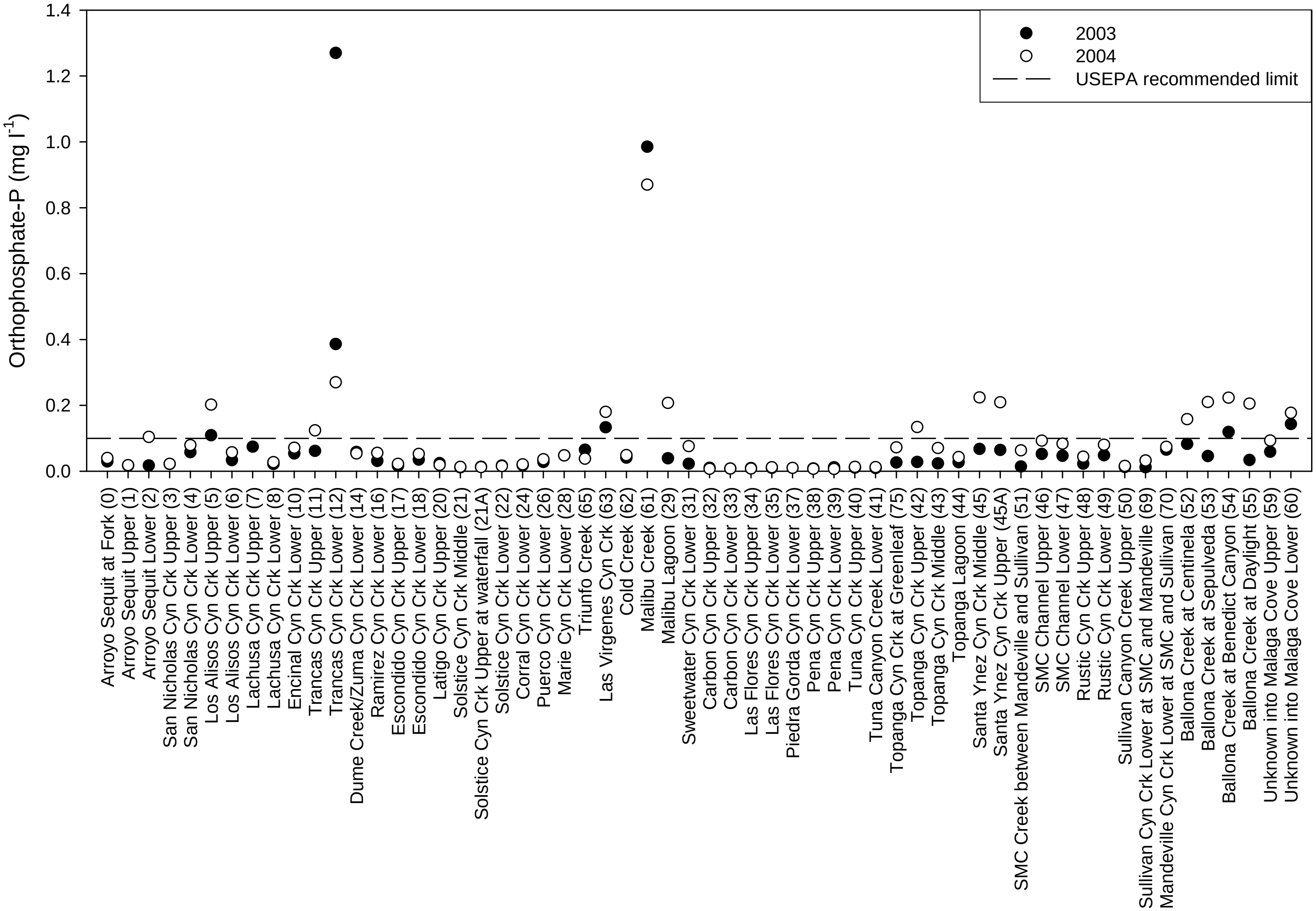

Figure 29. Orthophosphate-P at sites in the SMB WMA.

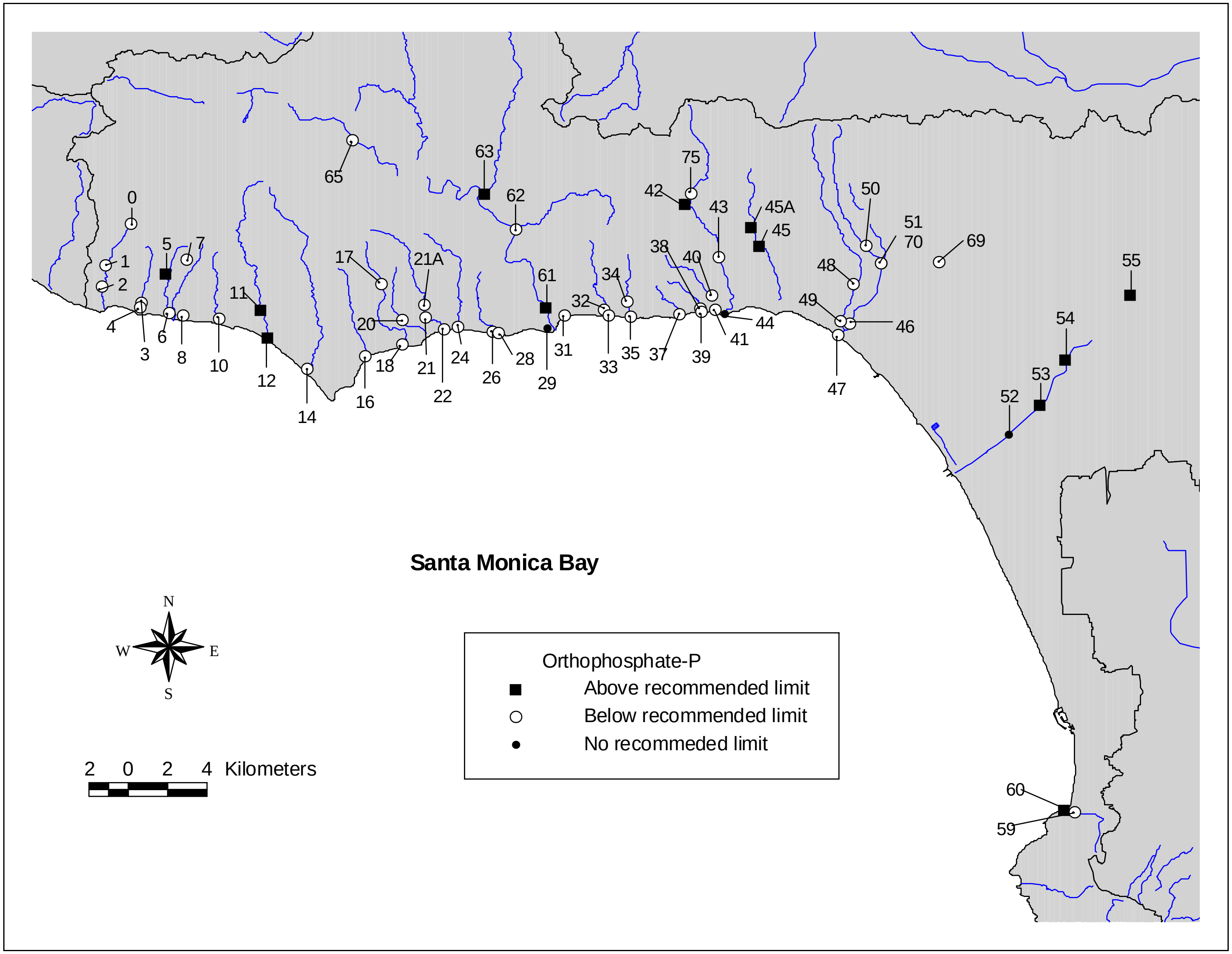

Figure 30. Orthophosphate-P spatially in the SMB WMA.

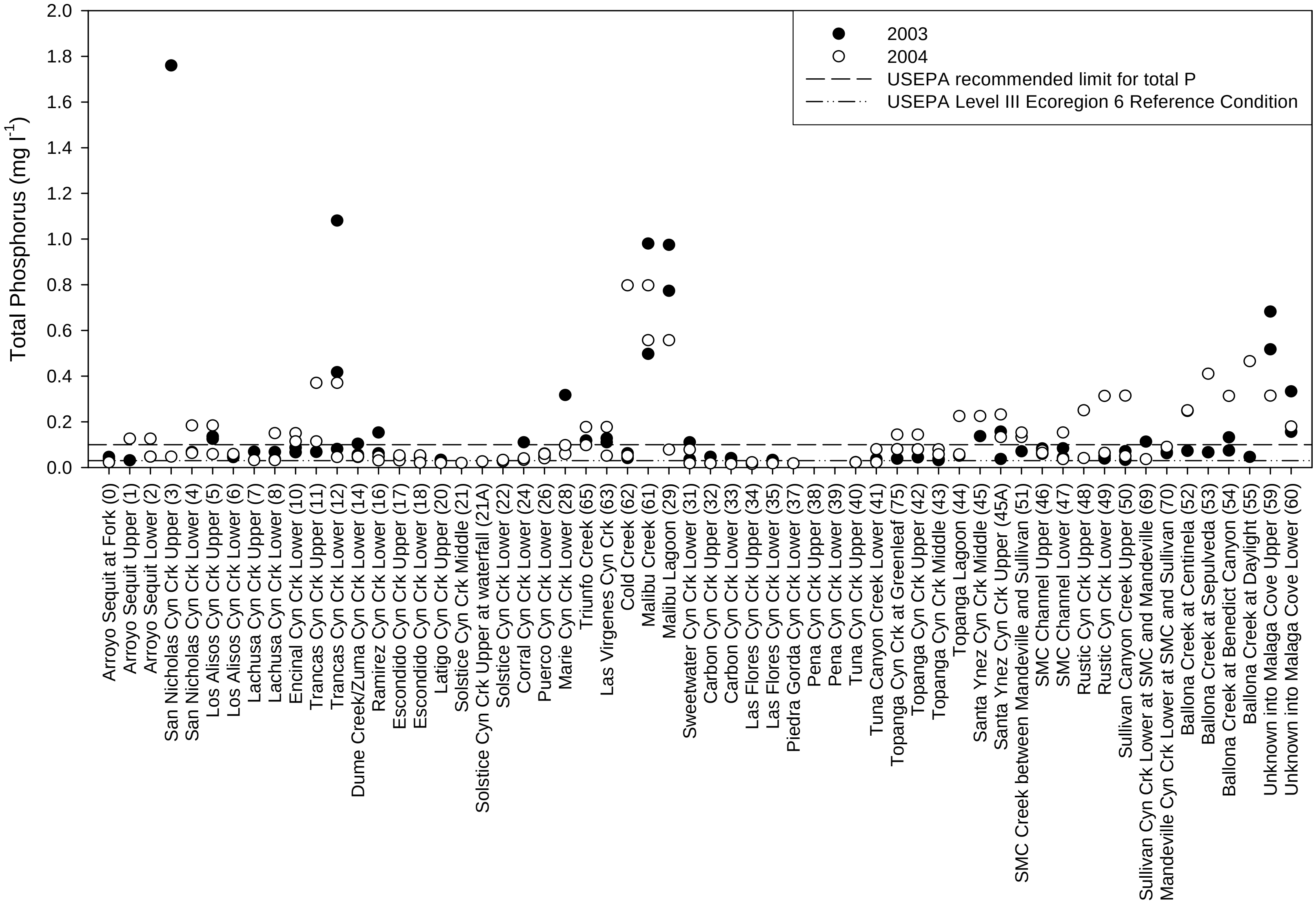

Figure 31. Total phosphorus at sites in the SMB WMA.

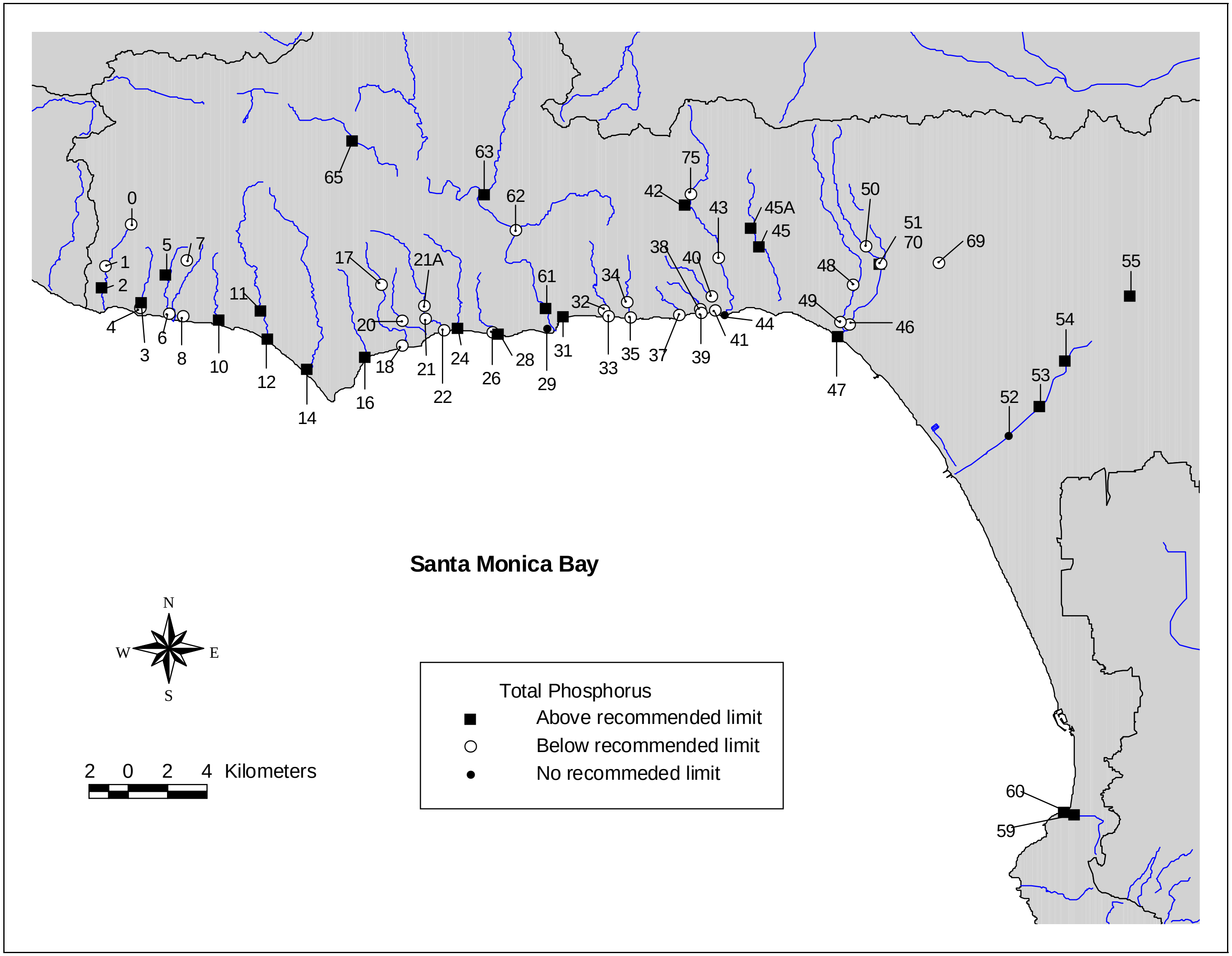

Figure 32. Total phosphorus spatially in the SMB WMA.

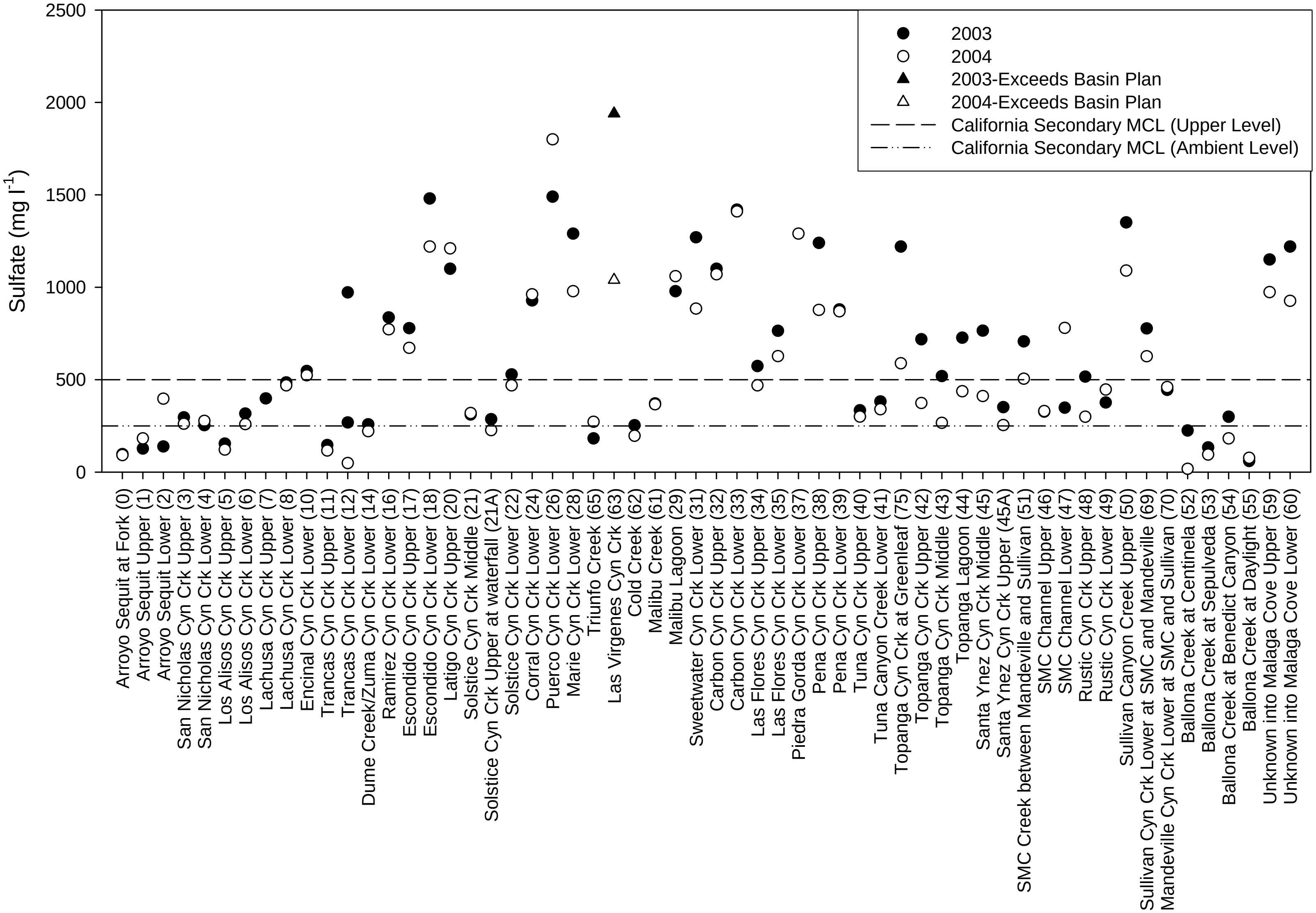

Figure 33. Sulfate at sites in the SMB WMA.

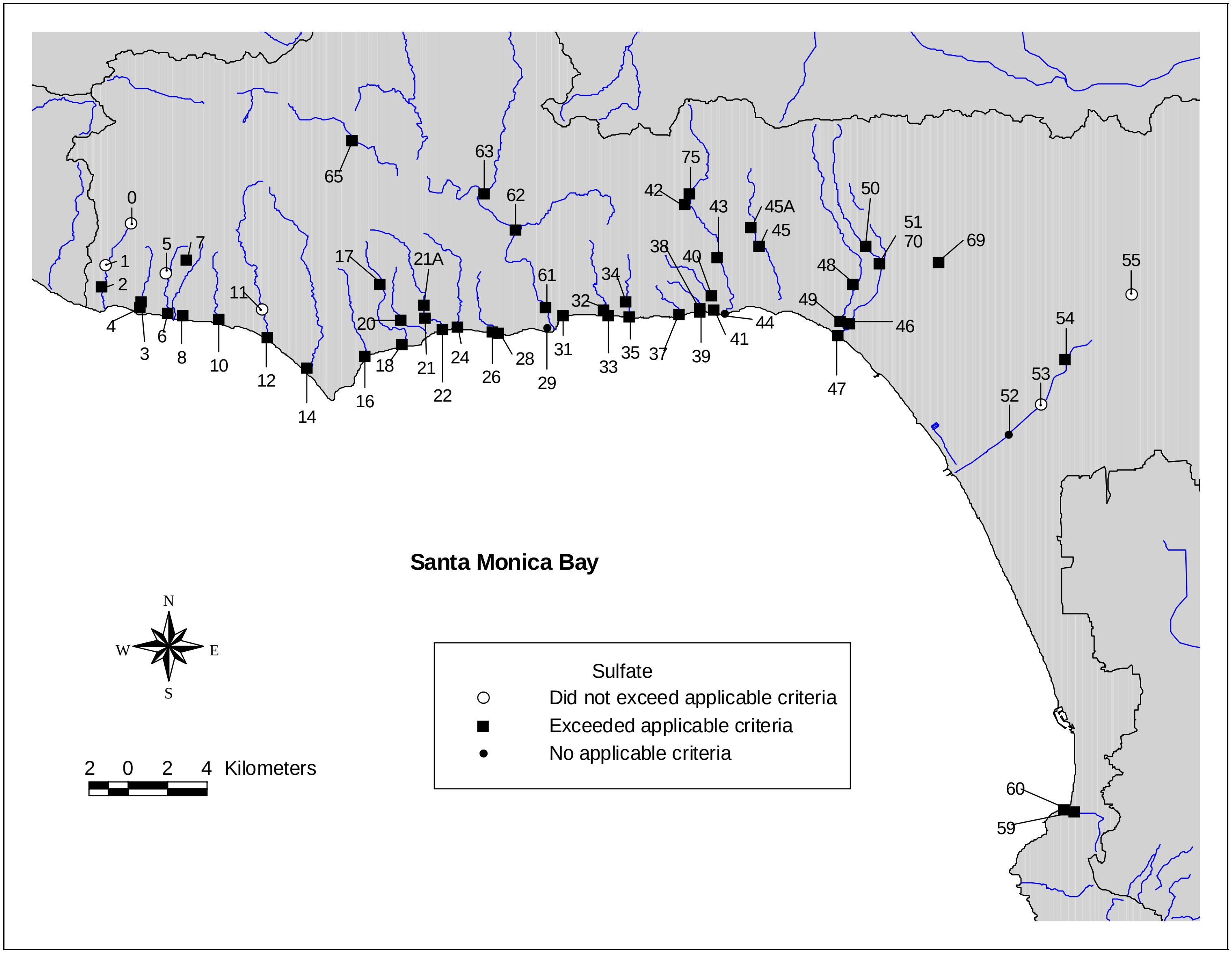

Figure 34. Sulfate spatially in the SMB WMA.

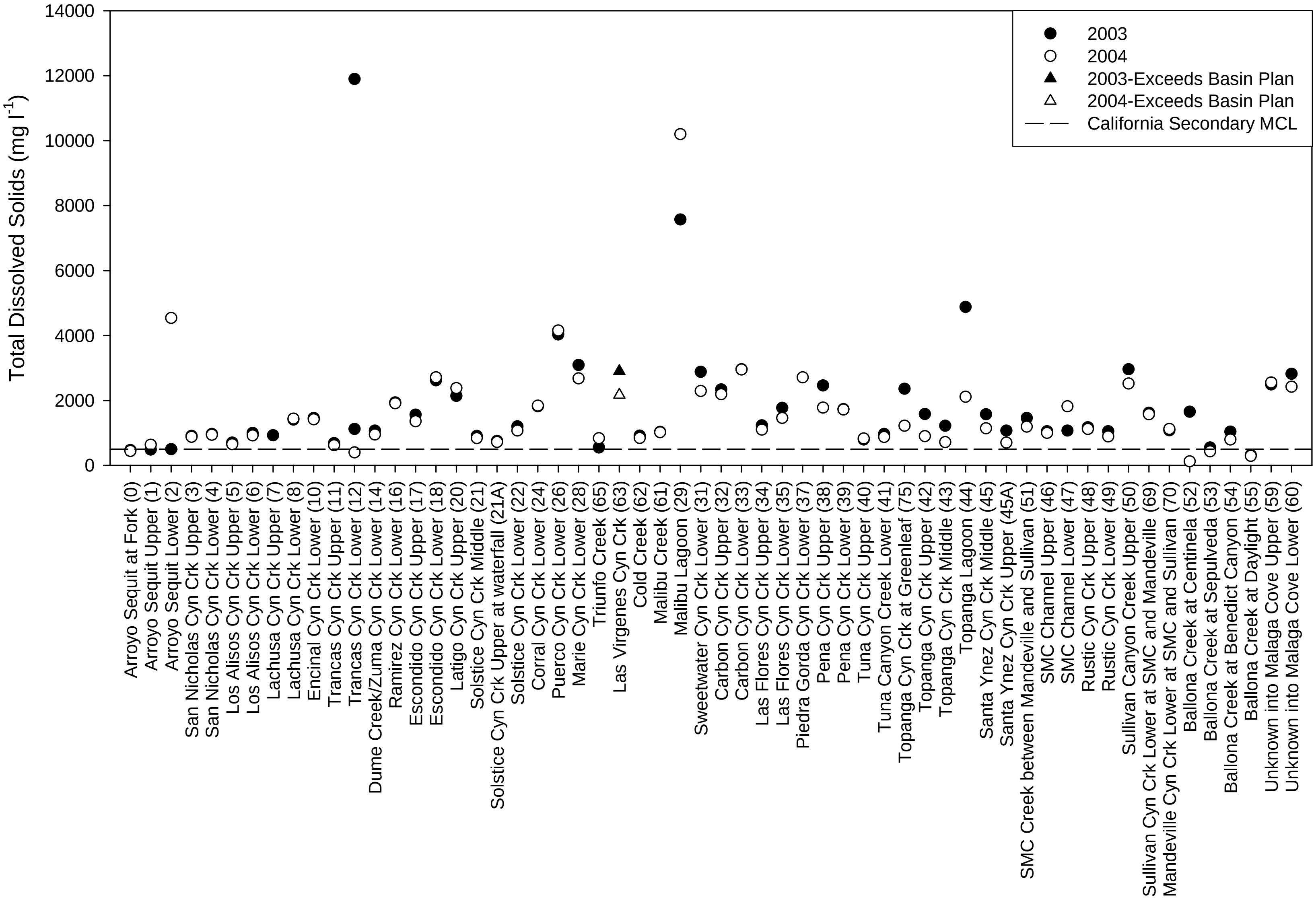

Figure 35. Total dissolved solids at sites in the SMB WMA.

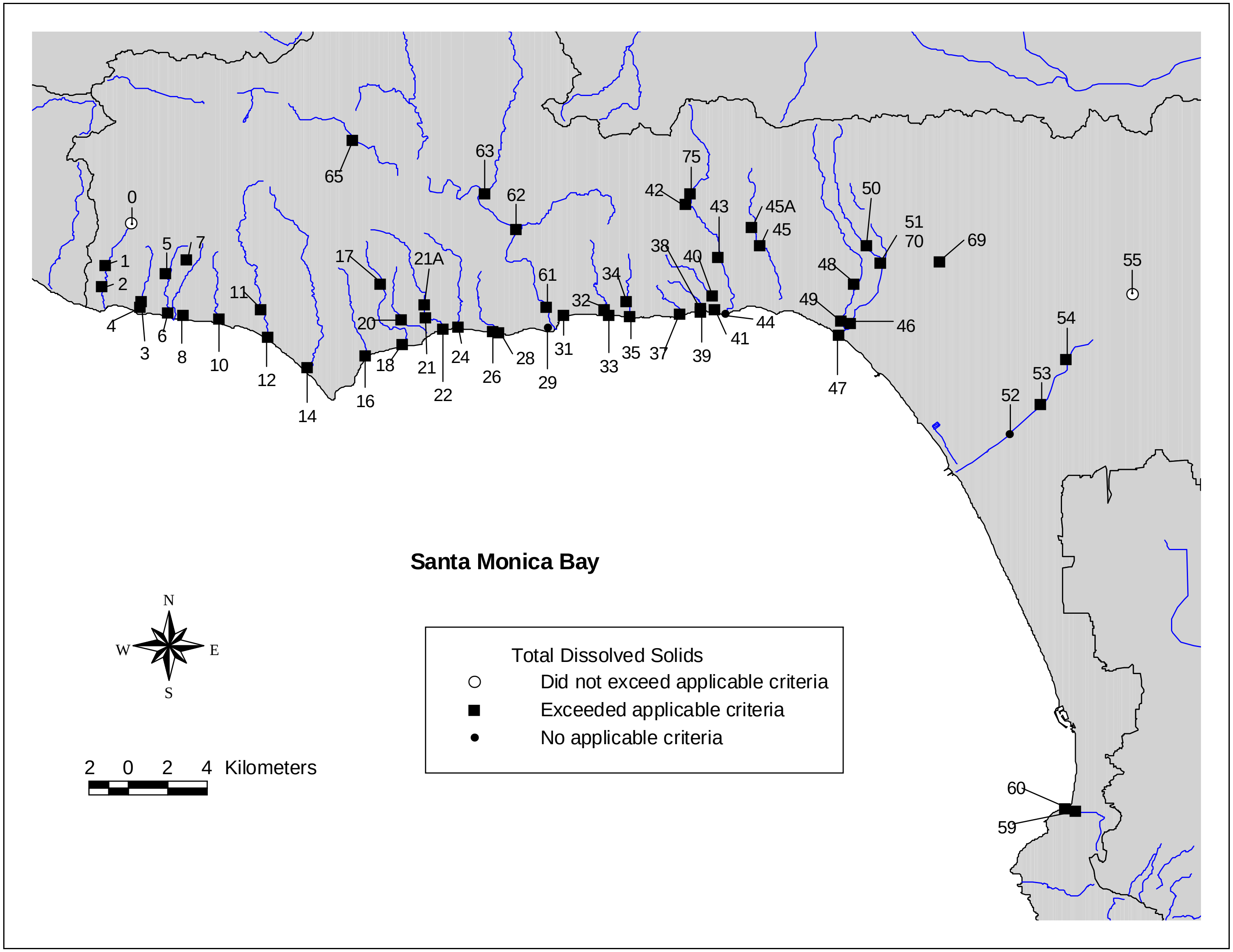

Figure 36. Total dissolved solids spatially in the SMB WMA.

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4.3 Bacteriology

Enterococcus ranged from 10 to 10,462 MPN 100 ml^{-1} (Figure 37); 15.8% of values were below the MDL of 10 MPN 100 ml^{-1}. A value from Ballona Creek at Centinela (52) exceeded the single sample limit for marine waters designated for contact recreation of 104 MPN 100 ml^{-1} (CRWQCB LAR 1994). We were only able to compare bacteria data to the single sample limits specified in the Basin Plan because only single samples were collected, and there are no freshwater single sample limits for Enterococcus.

E. coli ranged from 10 to 24,192 MPN 100 ml^{-1} (Figure 38); 18.4% of values were below the MDL of 10 MPN 100 ml^{-1}. The single sample limit for *E. coli* in freshwaters designated for contact recreation is 235 MPN 100 ml^{-1} (CRWQCB LAR 1994); values from 21 sites exceeded this limit (Figure 39). There are no marine single sample limits for *E. coli*.

Fecal coliform ranged from 20 to more than 160,000 MPN 100 ml^{-1} (Figure 40); 19.3% of values were below the MDL of 20 MPN 100 ml^{-1}. The highest value was from Ballona Creek at Daylight and it exceeded the upper range of the analysis of 160,000 MPN 100 ml^{-1}. The single sample limit for fecal coliform in marine and freshwaters designated for contact recreation is 400 MPN 100 ml^{-1} (CRWQCB LAR 1994); values from 22 sites exceeded this limit (Figure 41).

Total coliform ranged from 20 to more than 160,000 MPN 100 ml^{-1} (Figure 42); 4.4% of values were below the MDL of 20 MPN 100 ml^{-1}. The highest value was again from Ballona Creek at Daylight and it exceeded the upper range of the analysis of 160,000 MPN 100 ml^{-1}. A value from Ballona Creek at Centinela (52) exceeded the single sample limit for marine waters designated for contact recreation of 10,000 MPN 100 ml^{-1} (CRWQCB LAR 1994). There are no freshwater single sample limits for total coliform.

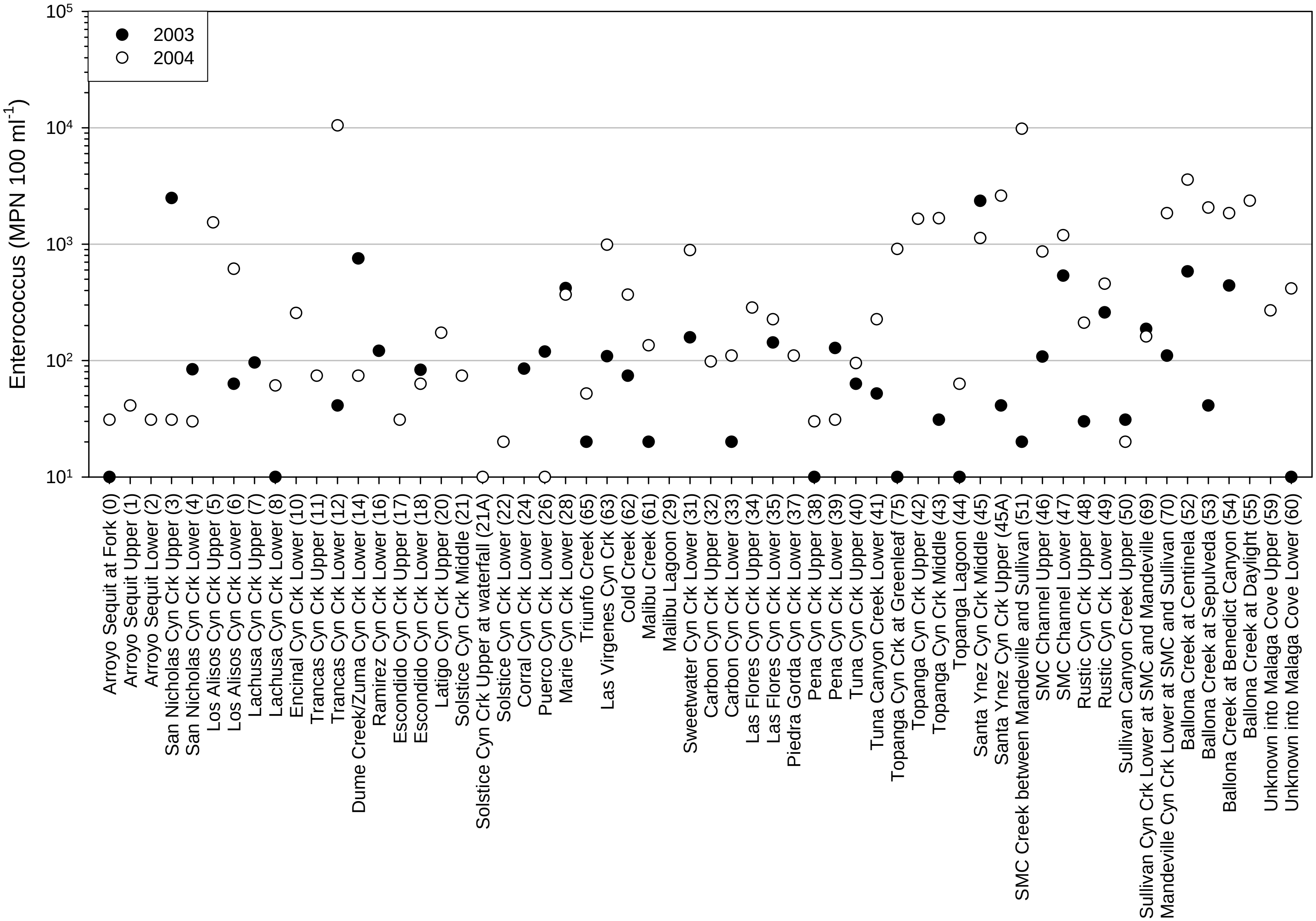

Figure 37. Enterococcus at sites in the SMB WMA.

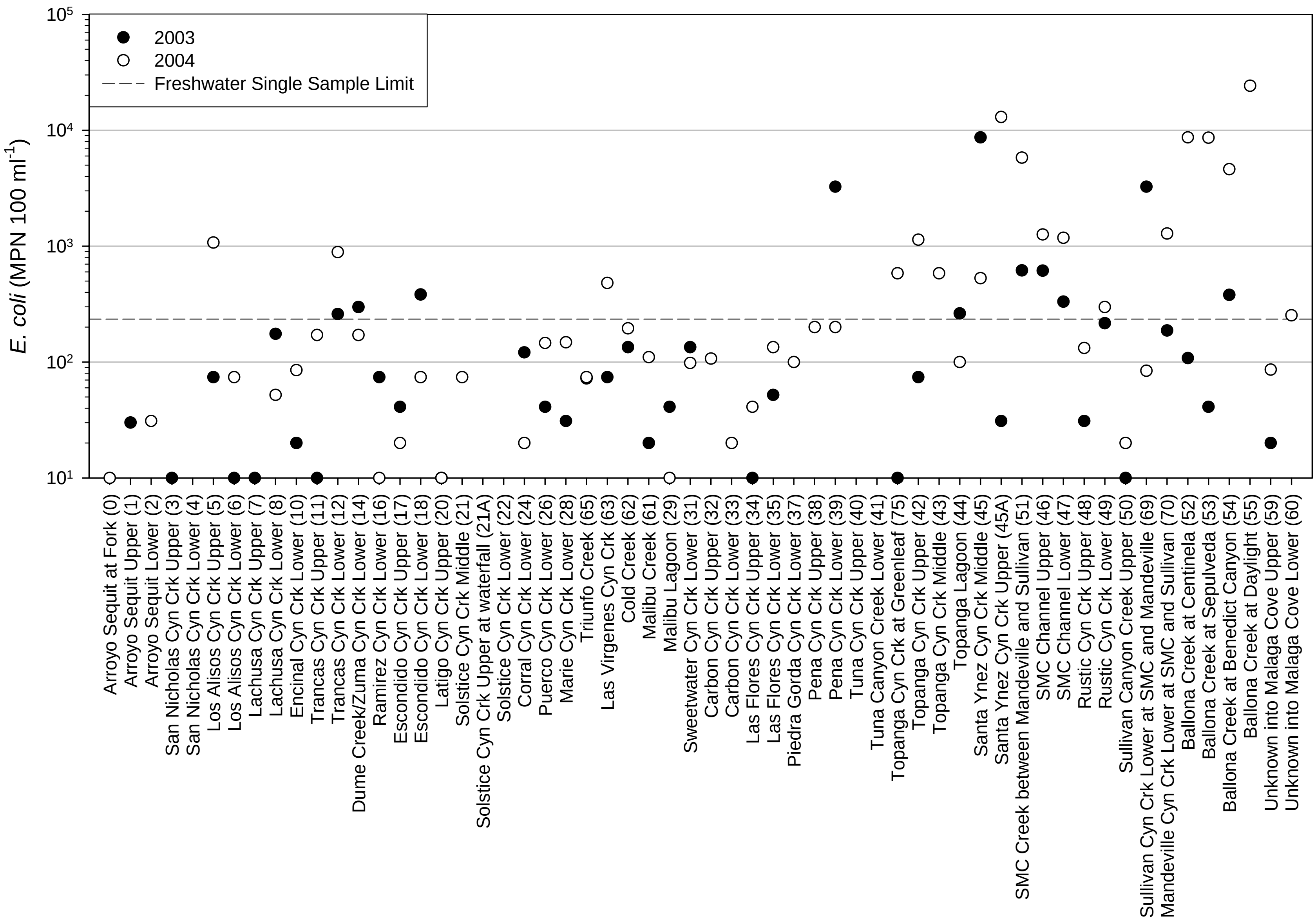

Figure 38. *E. coli* at sites in the SMB WMA.

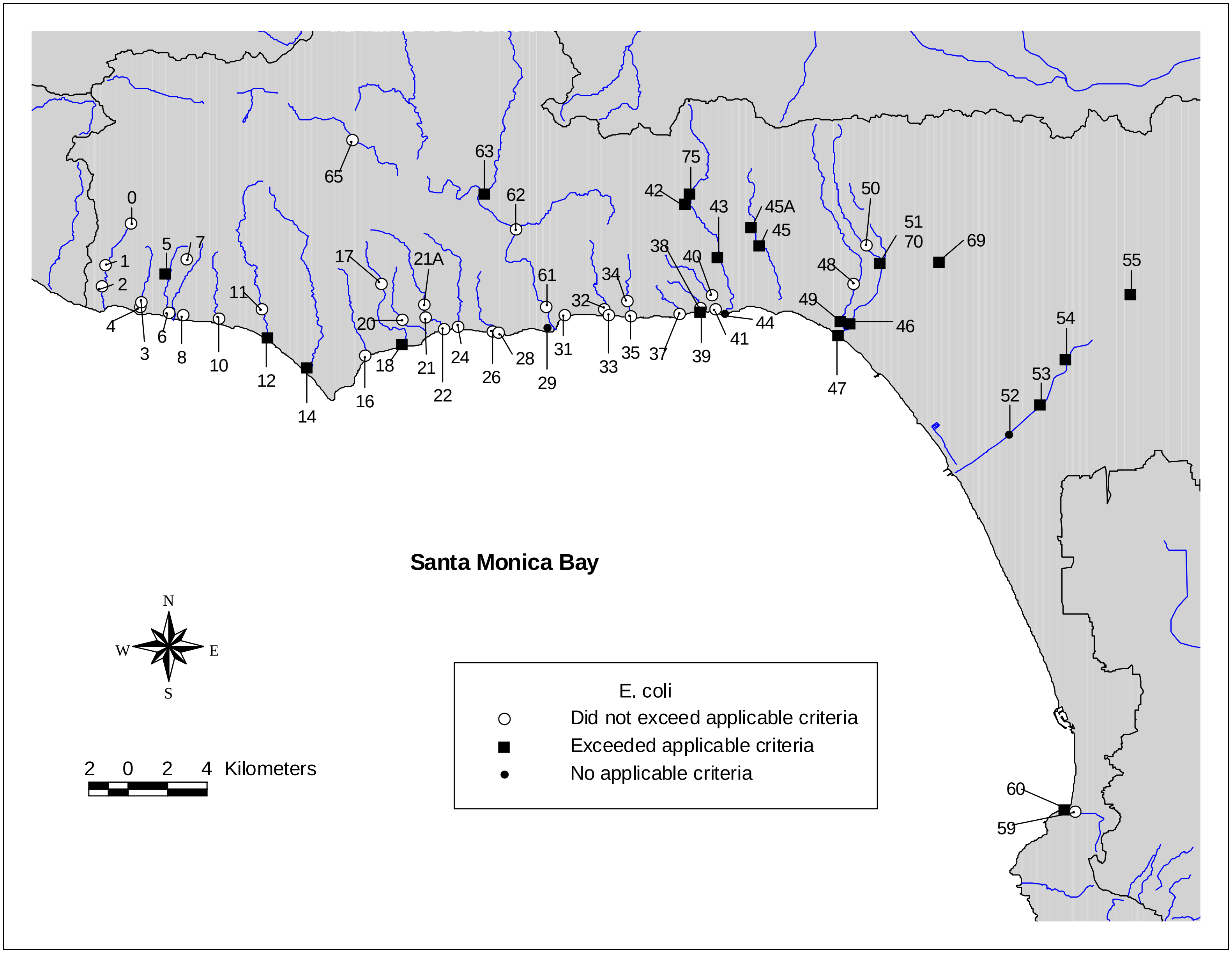

Figure 39. E. coli spatially in the SMB WMA.

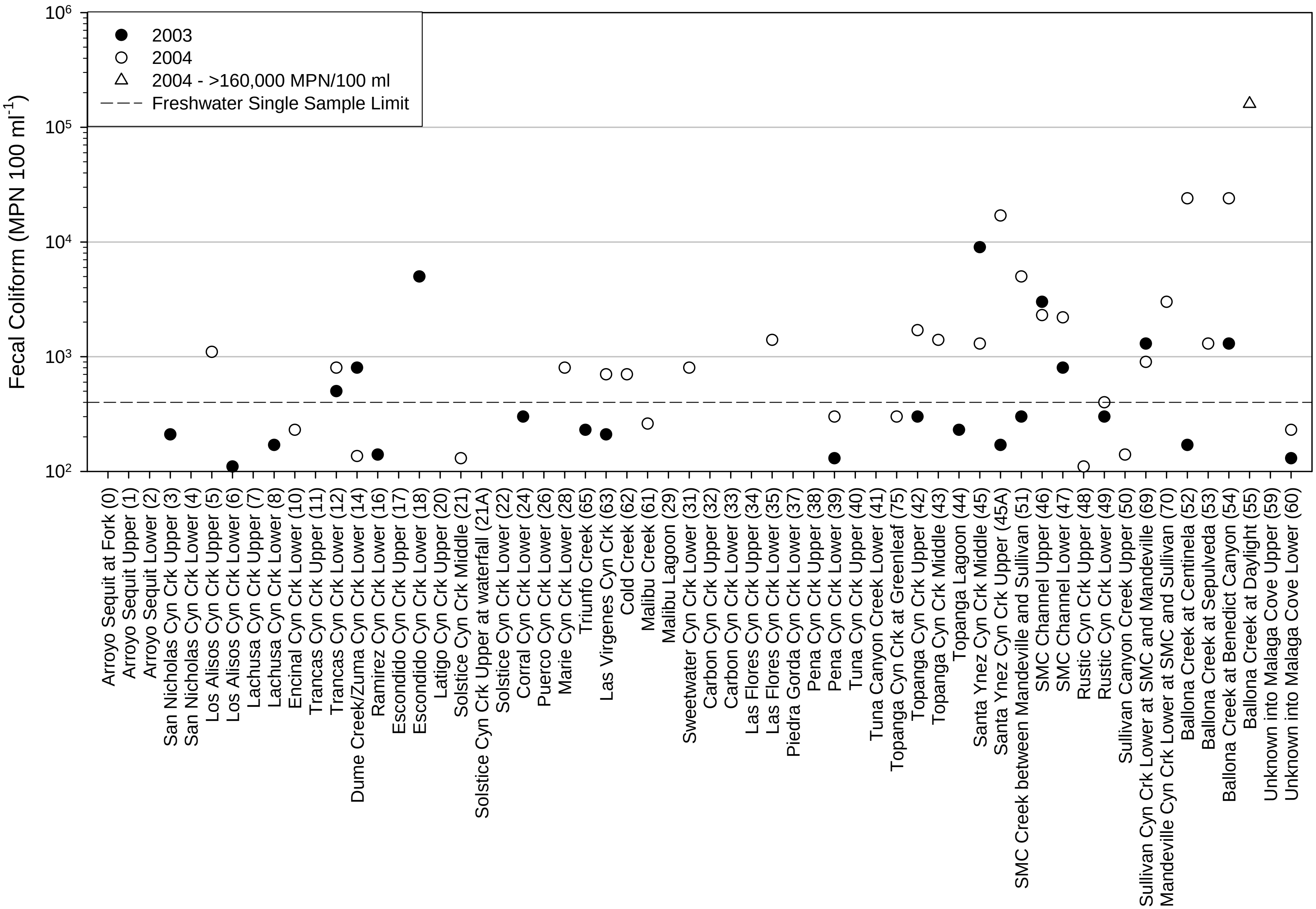

Figure 40. Fecal coliform at sites in the SMB WMA.

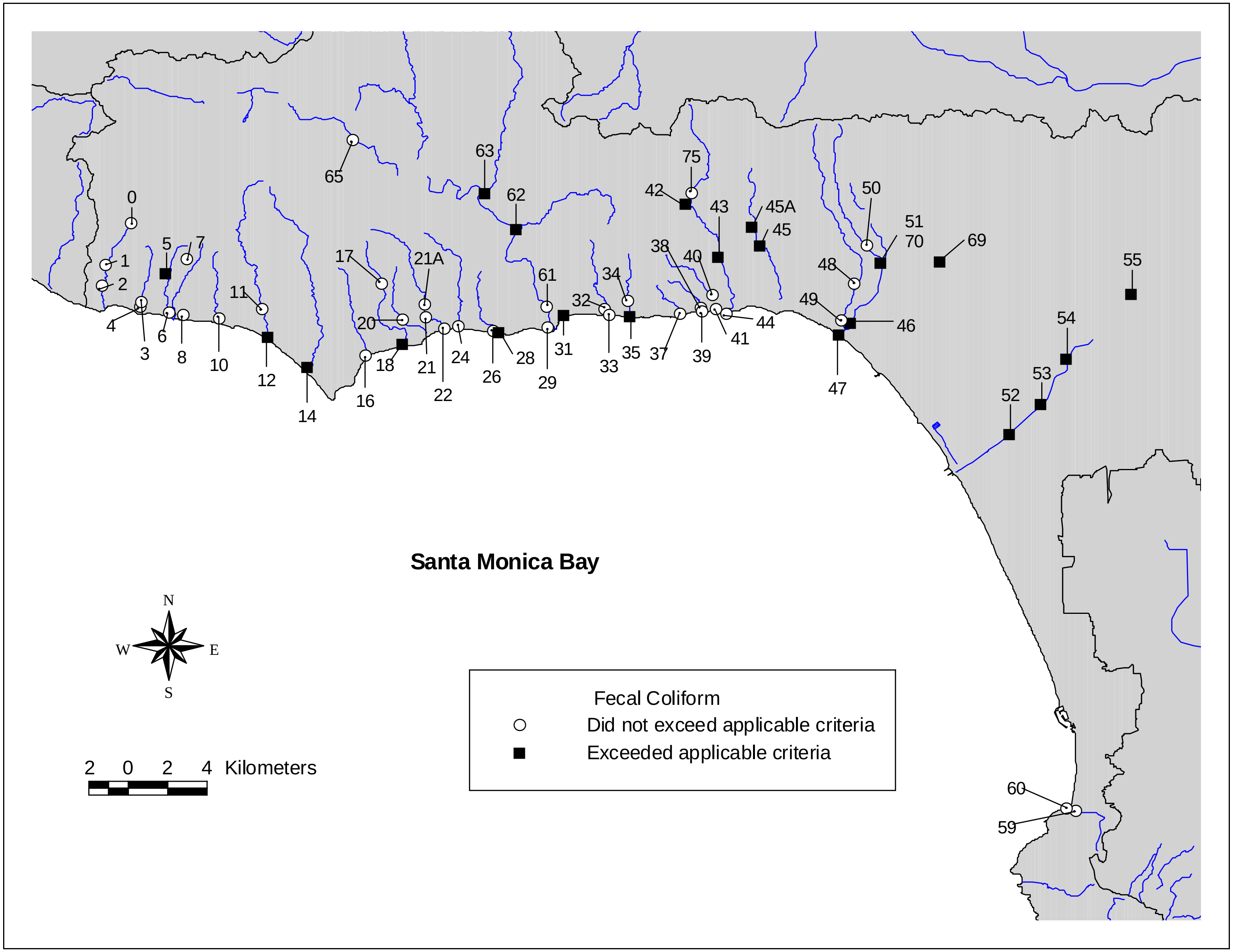

Figure 41. Fecal coliform spatially in the SMB WMA.

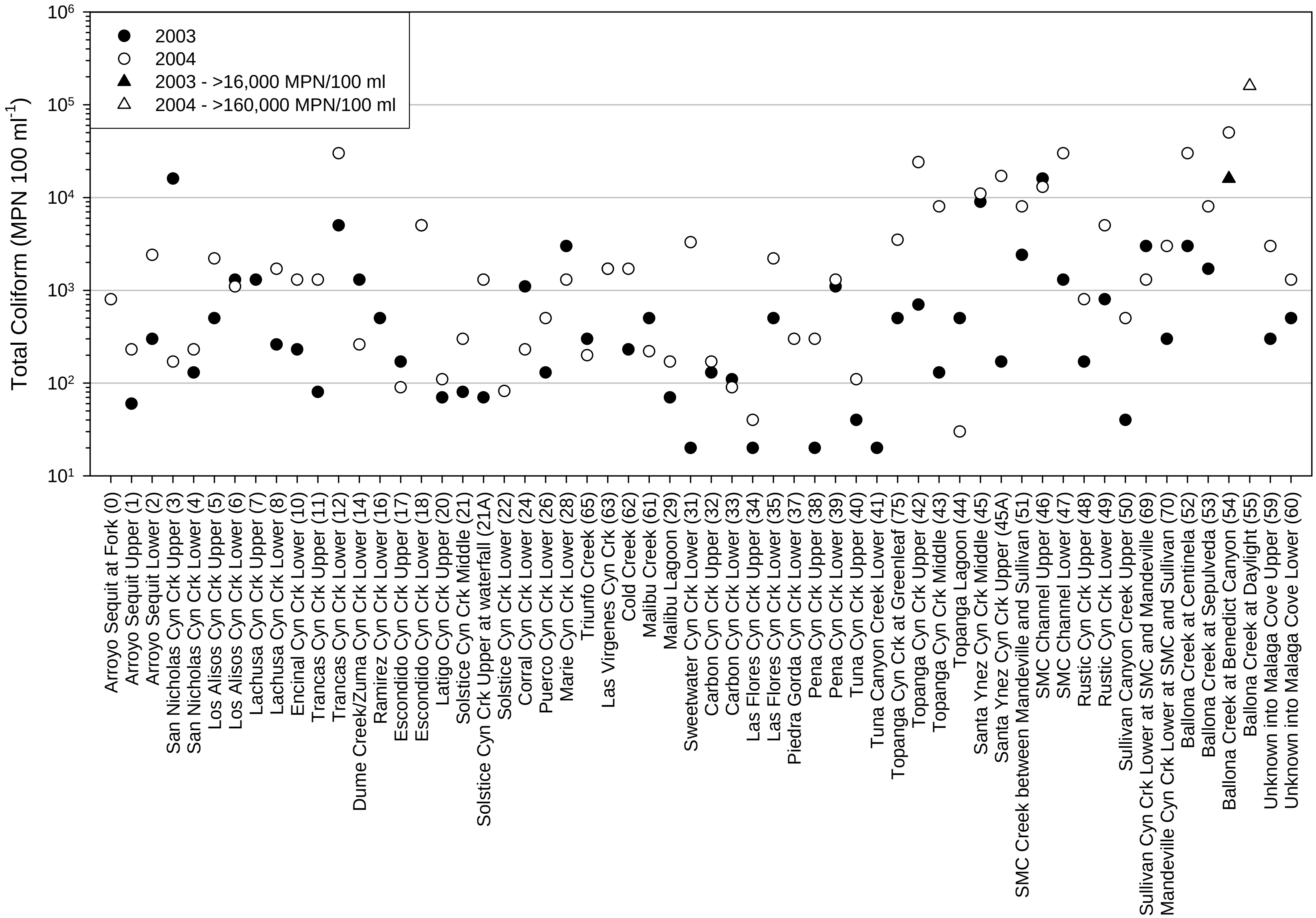

Figure 42. Total coliform at sites in the SMB WMA.

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4.4 Dissolved Metals in Water

Dissolved aluminum ranged from 0.26 to 21.7 µg l^{-1} in the SMB WMA in 2003 (Figure 43). Four values were below the MDL of 0.1 µg l^{-1}. The highest value was from Malibu Creek (61). All values from freshwater sits were below applicable established criteria (Table 13); aluminum is not included in either the California Ocean Plan (SWRCB 2001) or the CTR (USEPA 2000b).

Dissolved arsenic ranged from 0.609 to 11 µg l^{-1} (Figure 44); one value was below the MDL of 0.03 µg l^{-1}. The highest values were from Malibu Lagoon (29) and Upper Unknown into Malaga Cove (59). All values from freshwater and marine sites were below applicable criteria (Tables 13 and 14, respectively). All detected values exceeded the USEPA National Ambient Water Quality criterion for toxicity to humans of 0.018 µg l^{-1} (Marshack 2003). The 0.03 µg l^{-1} MDL is too high to allow meaningful comparison to this last criterion.

Dissolved cadmium ranged from 0.011 to 0.986 µg l^{-1} (Figure 45). The highest value was from Upper Unknown into Malaga Cove (59). All values were below their respective applicable criteria (Tables 13 and 14).

Dissolved chromium ranged from 0.031 to 1.56 µg l^{-1} (Figure 46); eight values were < MDL of 0.03 µg l^{-1}. The highest values were from Lower Puerco Canyon Creek (26), Malibu Lagoon (29), and Upper Unknown into Malaga Cove (59). All values were below their respective applicable criteria (Tables 13 and 14).

Dissolved copper ranged from 1.14 to 13.0 µg l^{-1} (Figure 47). The highest value was from Malibu Lagoon (29) and exceeded the CTR CMC and CCC (USEPA 2000b) and the California Ocean Plan (SWRCB 2001) daily maximum (Table 14). All other values were below the lowest applicable criteria (Tables 13 and 14).

Dissolved lead ranged from 0.005 to 0.35 µg l^{-1} (Figure 48); 11 values were detected, 15 were < MDL of 0.002 µg l^{-1}. The highest value was from Ballona Creek at Centinela (52). All values were below their respective applicable criteria (Tables 13 and 14).

Dissolved manganese ranged from 0.51 to 1028 µg l^{-1} (Figure 49). The highest values were from Lower Puerco Canyon Creek (26), Lower Marie Canyon Creek (28), and Upper Unknown into Malaga Cove (59); these values exceeded the California DHS action level for drinking water (Marshack 2003) (Table 13). Values from another six sites exceeded the California secondary MCL (Marshack 2003). Manganese is not included in either the California Ocean Plan (SWRCB 2001) or the CTR (USEPA 2000b).

Dissolved nickel ranged from 0.946 to 91.8 µg l^{-1} (Figure 50). The highest values were from Lower Puerco Canyon Creek (26), Lower Marie Canyon Creek (28) and Upper Unknown into Malaga Cove (59). All values from freshwater sites were below applicable criteria (Table 13). Values from Malibu Lagoon (29) and Ballona Creek at Centinela (52) exceeded the CTR CCC (USEPA 2000b) (Table 14).

Dissolved selenium ranged from 0.31 to 35.3 µg l^{-1} (Figure 51). The highest values were from Las Virgenes Canyon Creek (63), Malibu Lagoon (29), and Upper Unknown into Malaga Cove (59). Values from the two freshwater sites (Las Virgenes Canyon Creek and Upper Unknown into Malaga Cove) exceeded the NTR 1-h average aquatic life criterion (Marshack 2003) (Table 13). Values from another five sites exceeded the NTR 4-d average aquatic life criterion (Marshack 2003). All values from brackish sites were below applicable marine criteria (Table 14).

Dissolved silver was below the MDL of 0.008 µg l^{-1} at all sites except Santa Monica Canyon Channel Lower (47), which had a value of 0.009 µg l^{-1}. All values were below their respective applicable criteria (Tables 13 and 14).

Dissolved zinc ranged from 1.33 to 15.7 µg l^{-1} (Figure 52). All values were below their respective applicable criteria (Tables 13 and 14).

Table 13. Established or suggested objectives for trace metals in freshwater[1].

Dissolved Metals	Basin Plan	USEPA 1h	USEPA 4d	CTR/NTR Aquatic Life	USEPA Primary MCL	California Primary MCL	California Secondary MCL	California DHS Action Level for Drinking Water	USEPA Natl. Ambient WQ Criteria for toxicity to humans
	(all concentrations in $\mu g\ l^{-1}$)								
Aluminum	1000	750*	87*			1000			
Arsenic	50	340	150		10	50			0.018
Cadmium	5			5.3 is lowest applicable criteria					
Chromium	50			460 is lowest applicable criteria		50			
Copper	not listed			24 is lowest applicable criteria					
Lead	not listed			8.7 is lowest applicable criteria					
Manganese	not listed						50	500	
Nickel	100			140 is lowest applicable criteria					
Selenium	50	20	5						
Silver	not listed			26 is lowest applicable criteria					
Zinc	not listed			320 is lowest applicable criteria					

*Criteria are for total aluminum

[1]Except for objectives from the Basin Plan (CRWQCB LAR 1994), all water quality objectives are from Marshack (2003)

Table 14. Established or suggested objectives for trace metals in marine waters[2].

	California Ocean Plan		CTR	
Dissolved Metals	**Daily Max**	**Instantaneous Max**	**CMC**	**CCC**
	(all concentrations in µg l^{-1})			
Aluminum	not listed		not listed	
Arsenic	32	80	69	36
Cadmium	4	10	42	9.3
Chromium (VI)	8	20	1100	50
Copper	12	30	4.8	3.1
Lead	8	20	210	8.1
Manganese	not listed		not listed	
Nickel	20	50	74	8.2
Selenium	60	150	290	71
Silver	2.8	7	1.9	
Zinc	80	200	90	81

[2]California Ocean Plan (SWRCB 2001); CTR (USEPA 2000b).

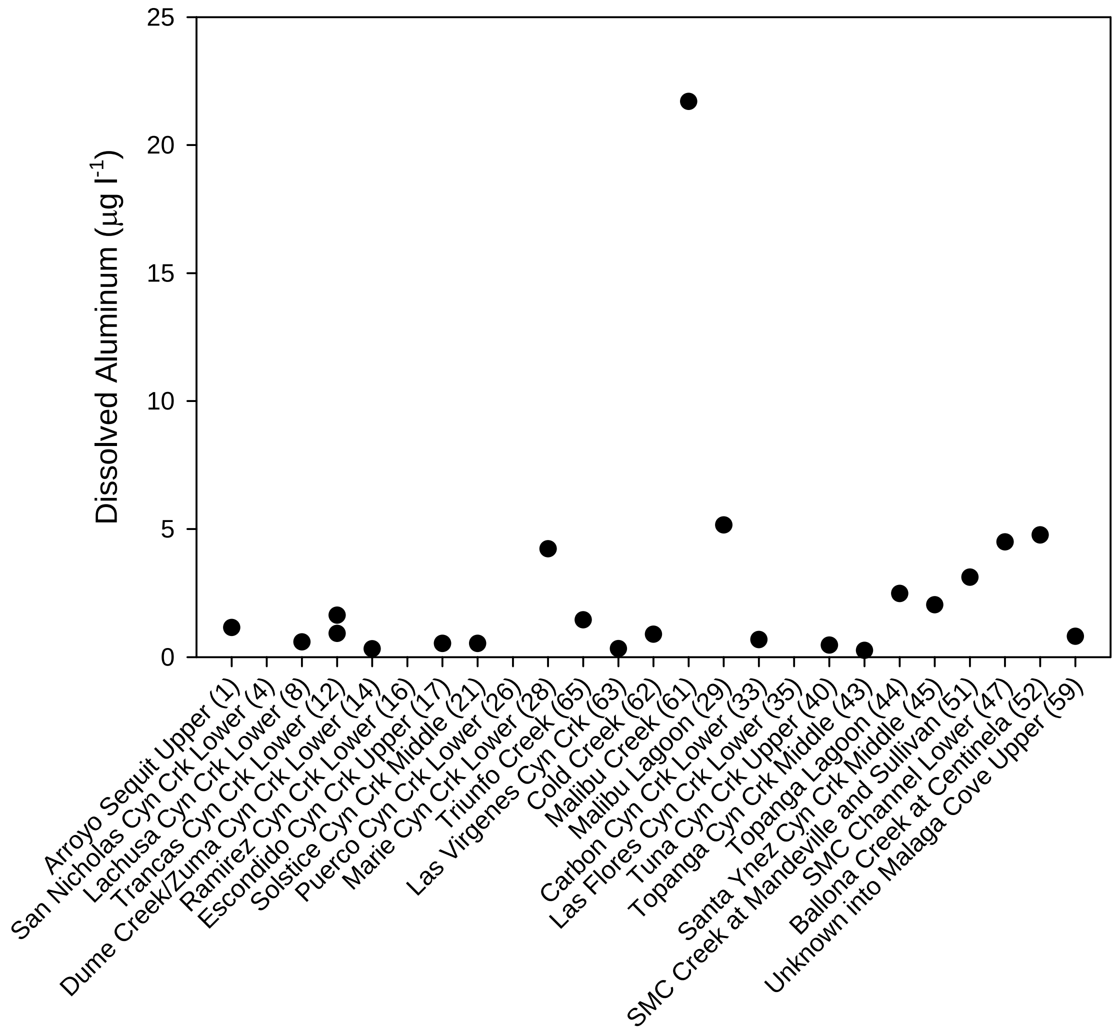

Figure 43. Dissolved aluminum at sites in the SMB WMA.

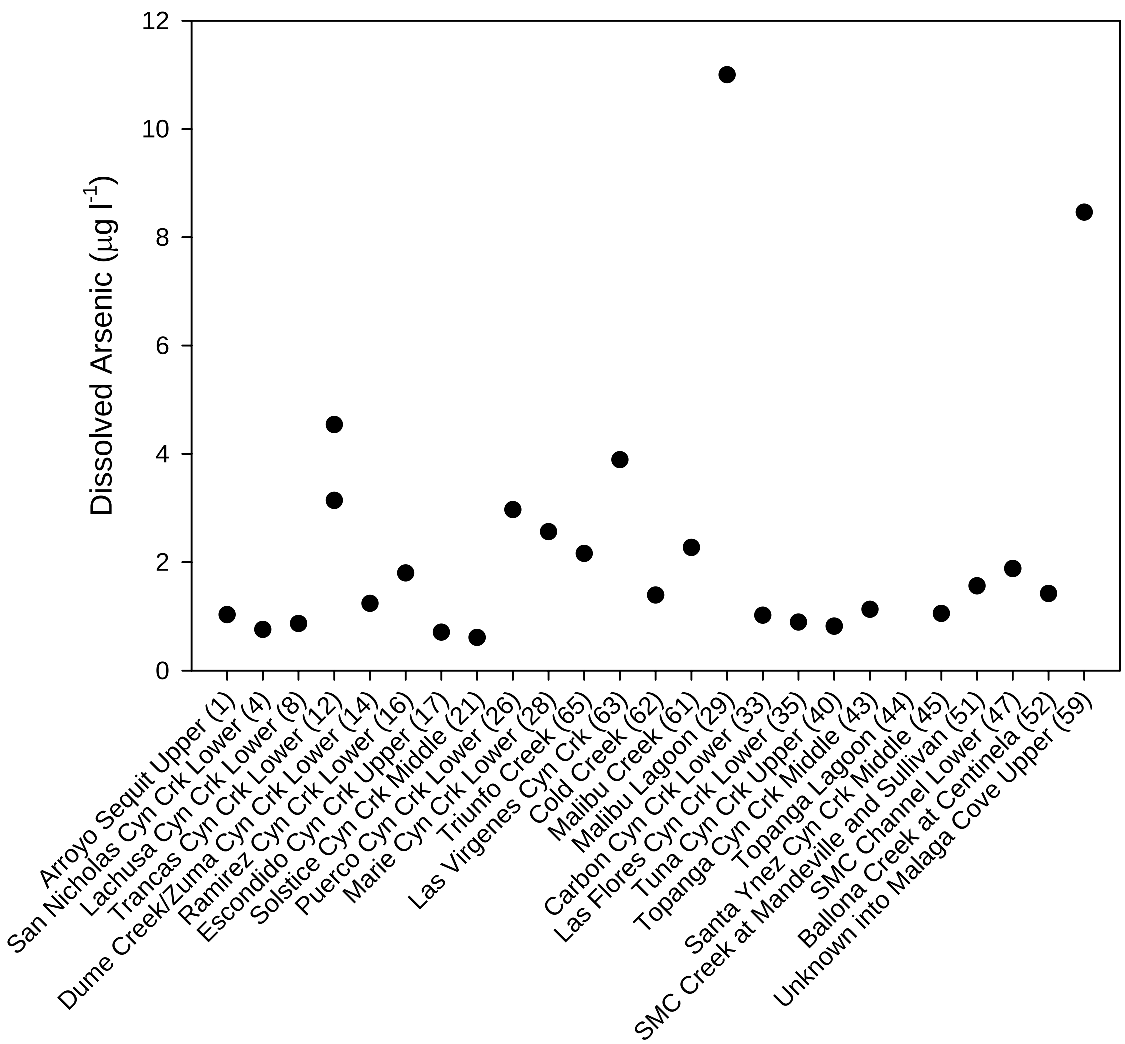

Figure 44. Dissolved arsenic at sites in the SMB WMA.

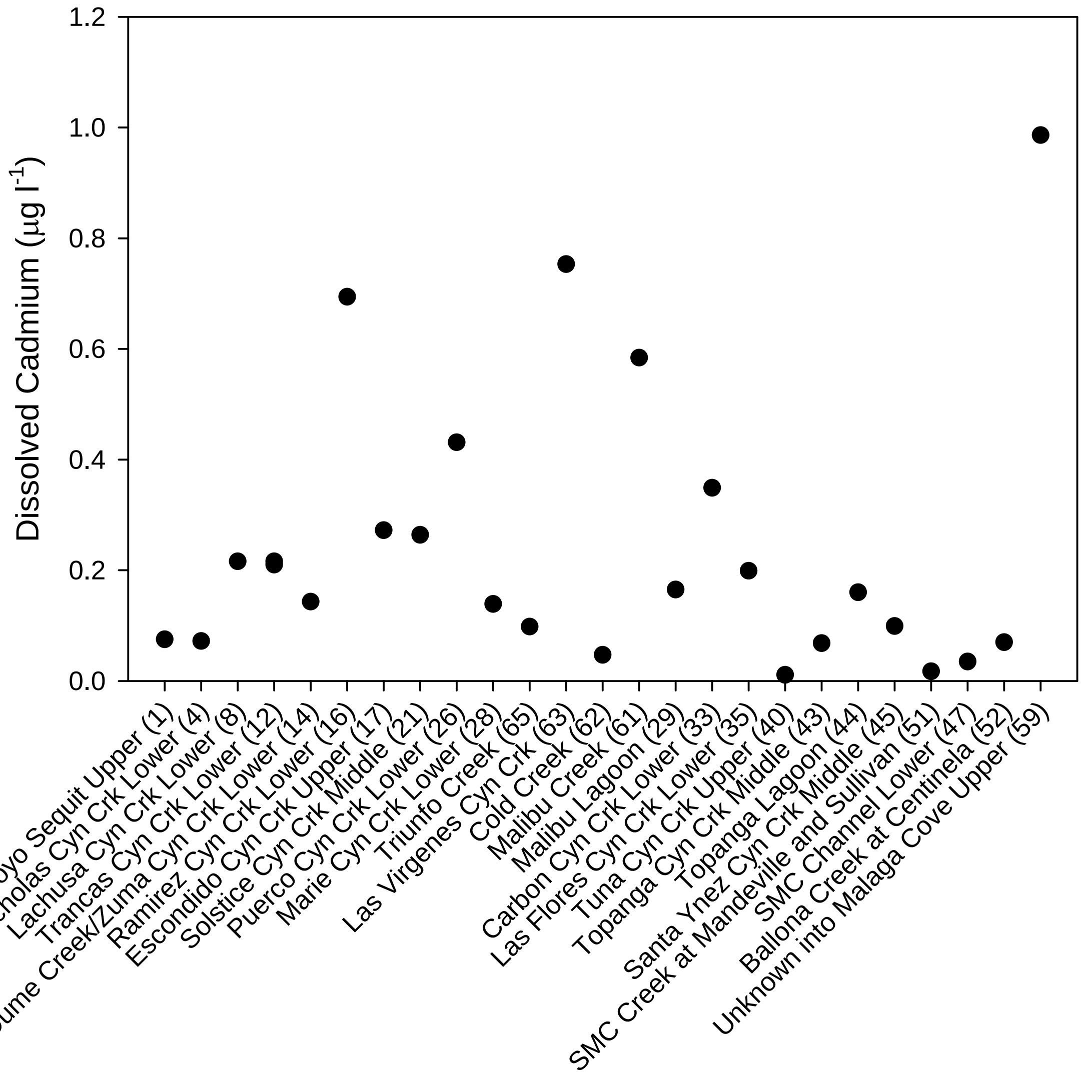

Figure 45. Dissolved cadmium at sites in the SMB WMA.

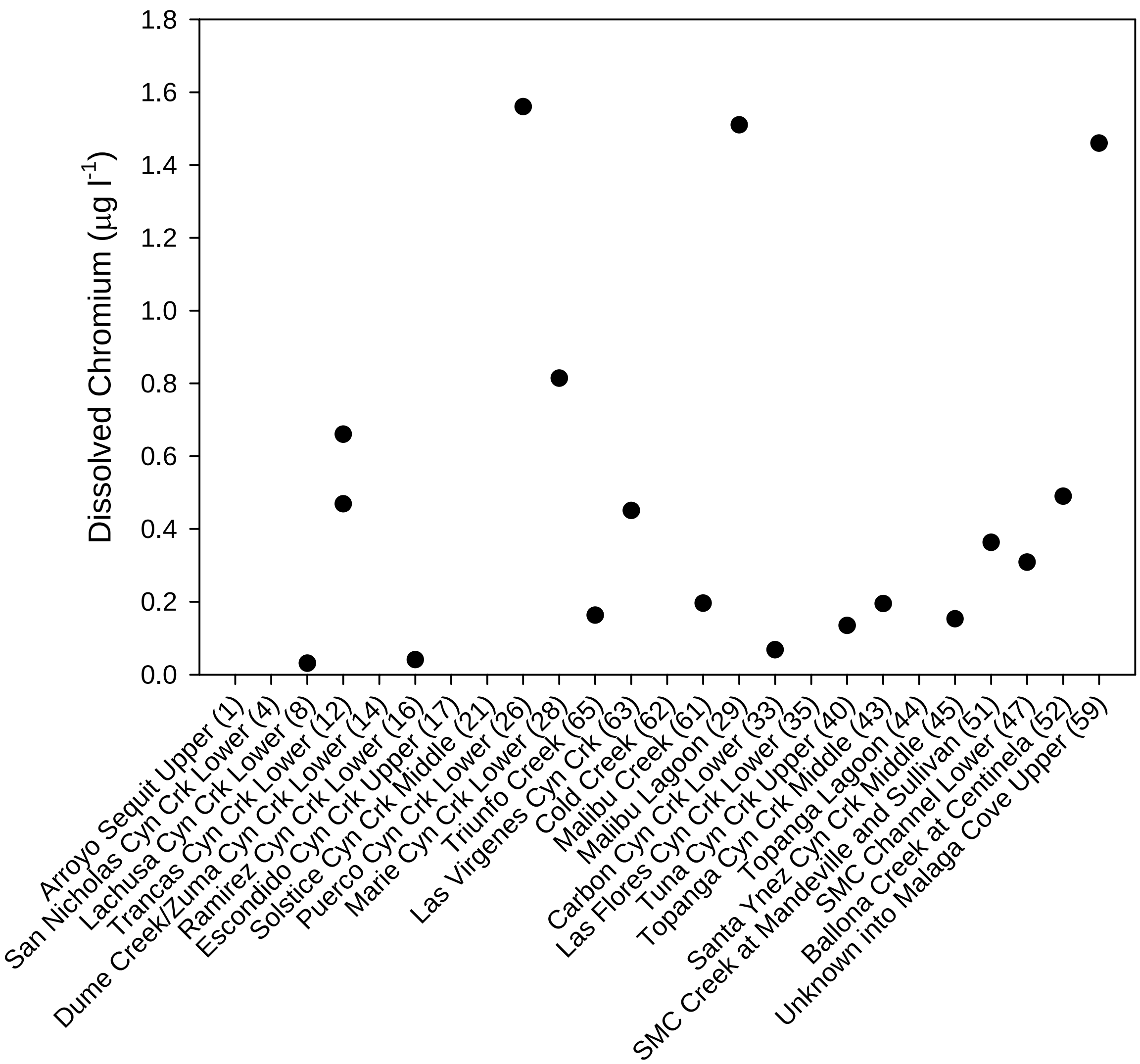

Figure 46. Dissolved chromium at sites in the SMB WMA.

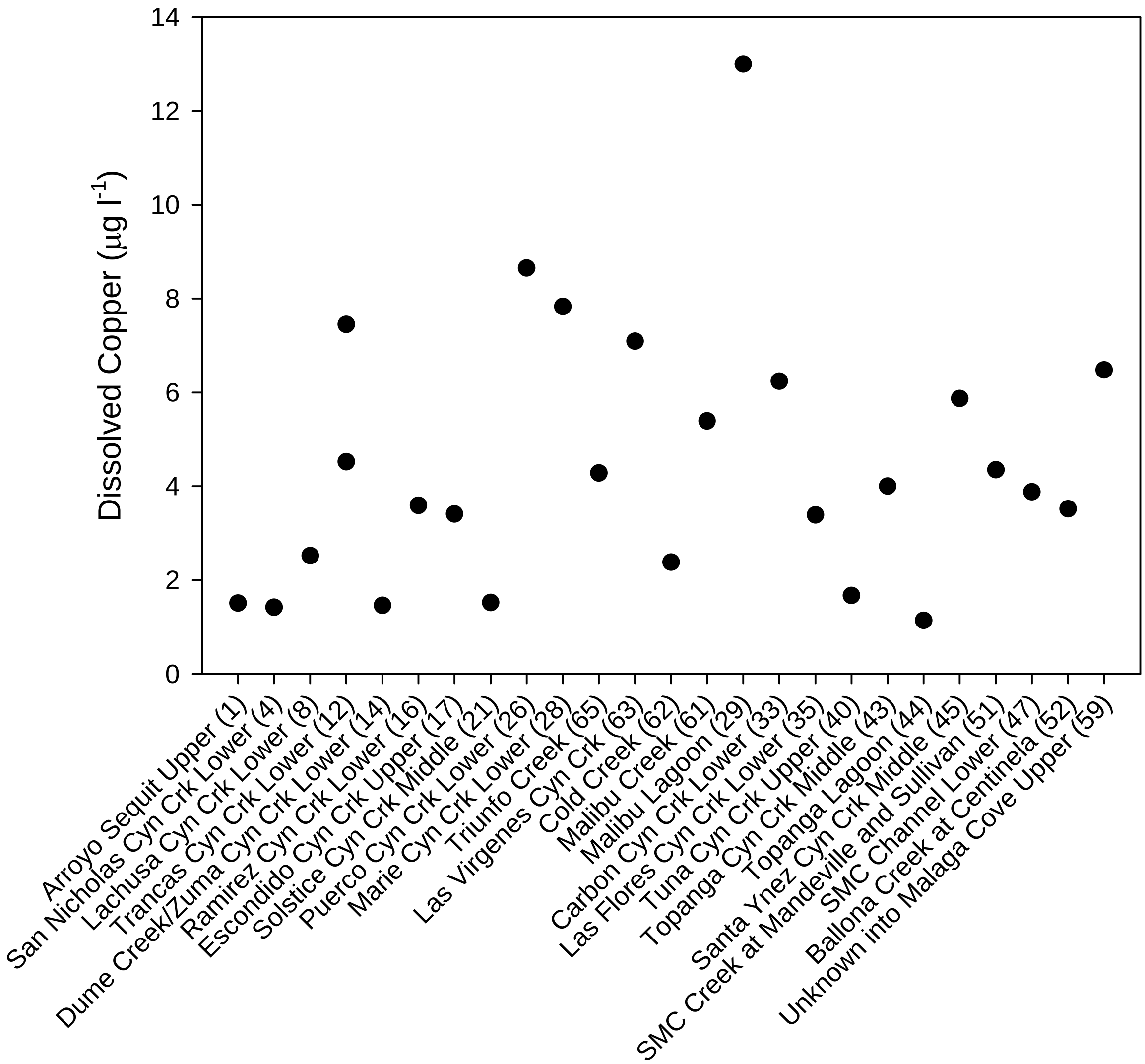

Figure 47. Dissolved copper at sites in the SMB WMA.

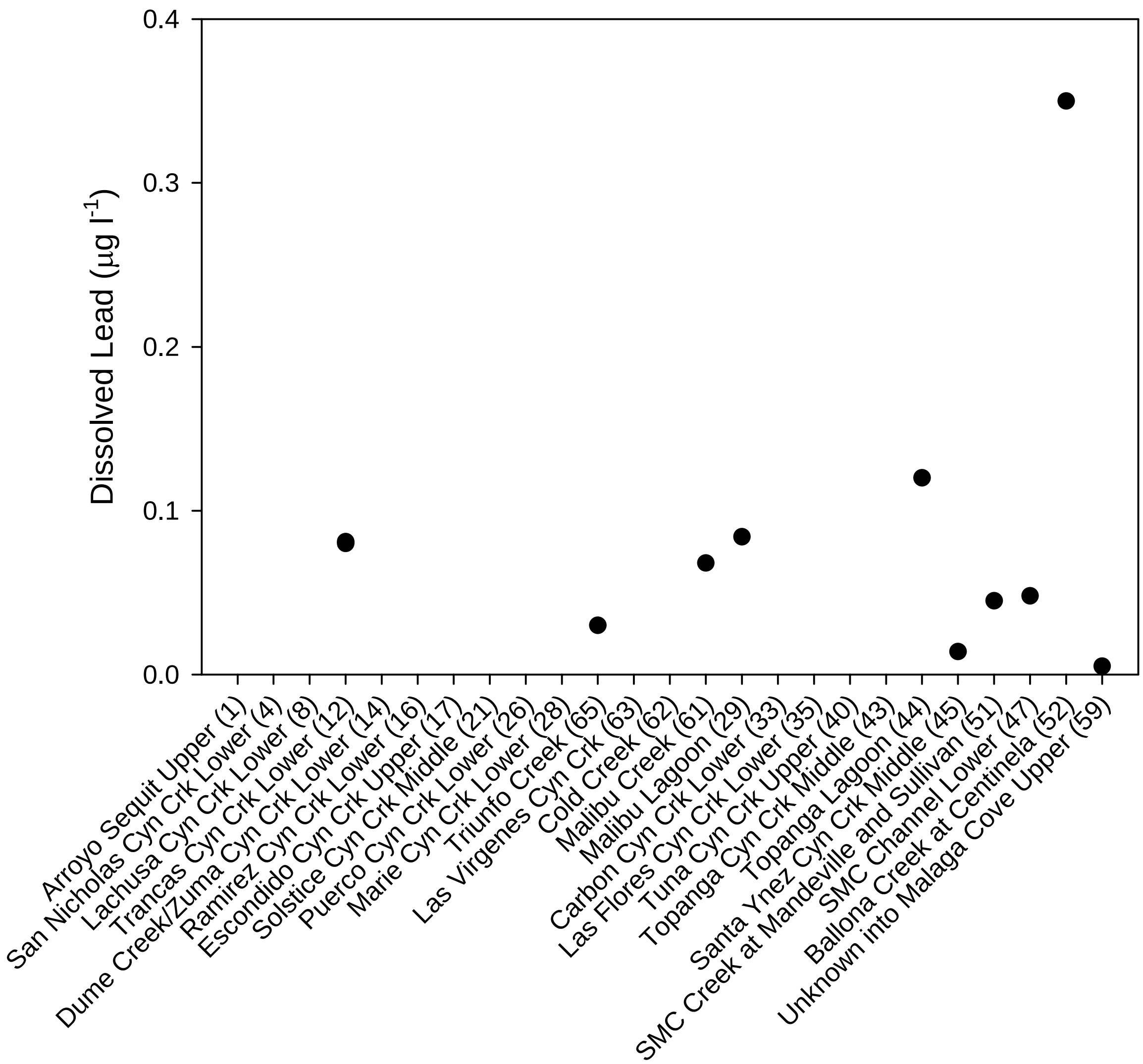

Figure 48. Dissolved lead at sites in the SMB WMA.

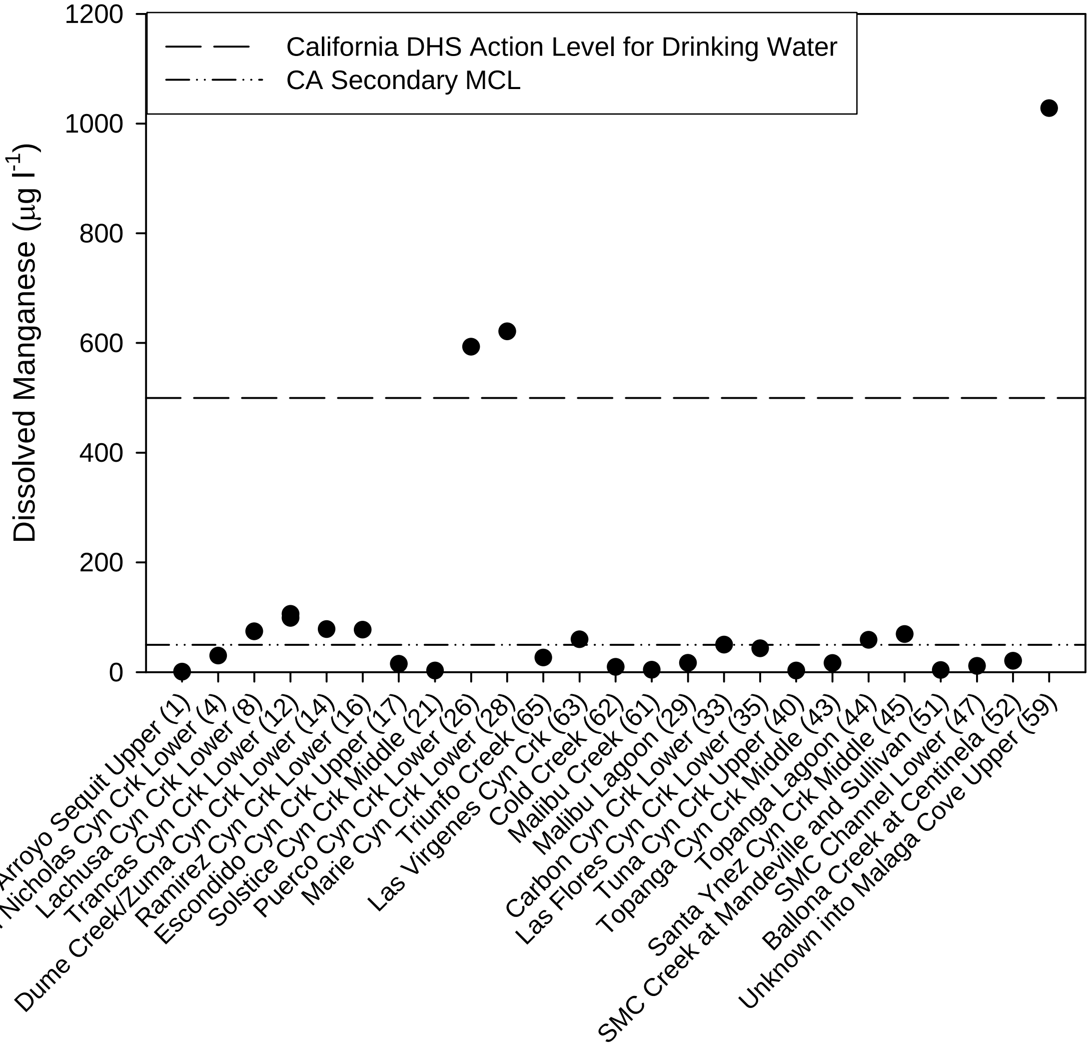

Figure 49. Dissolved manganese at sites in the SMB WMA.

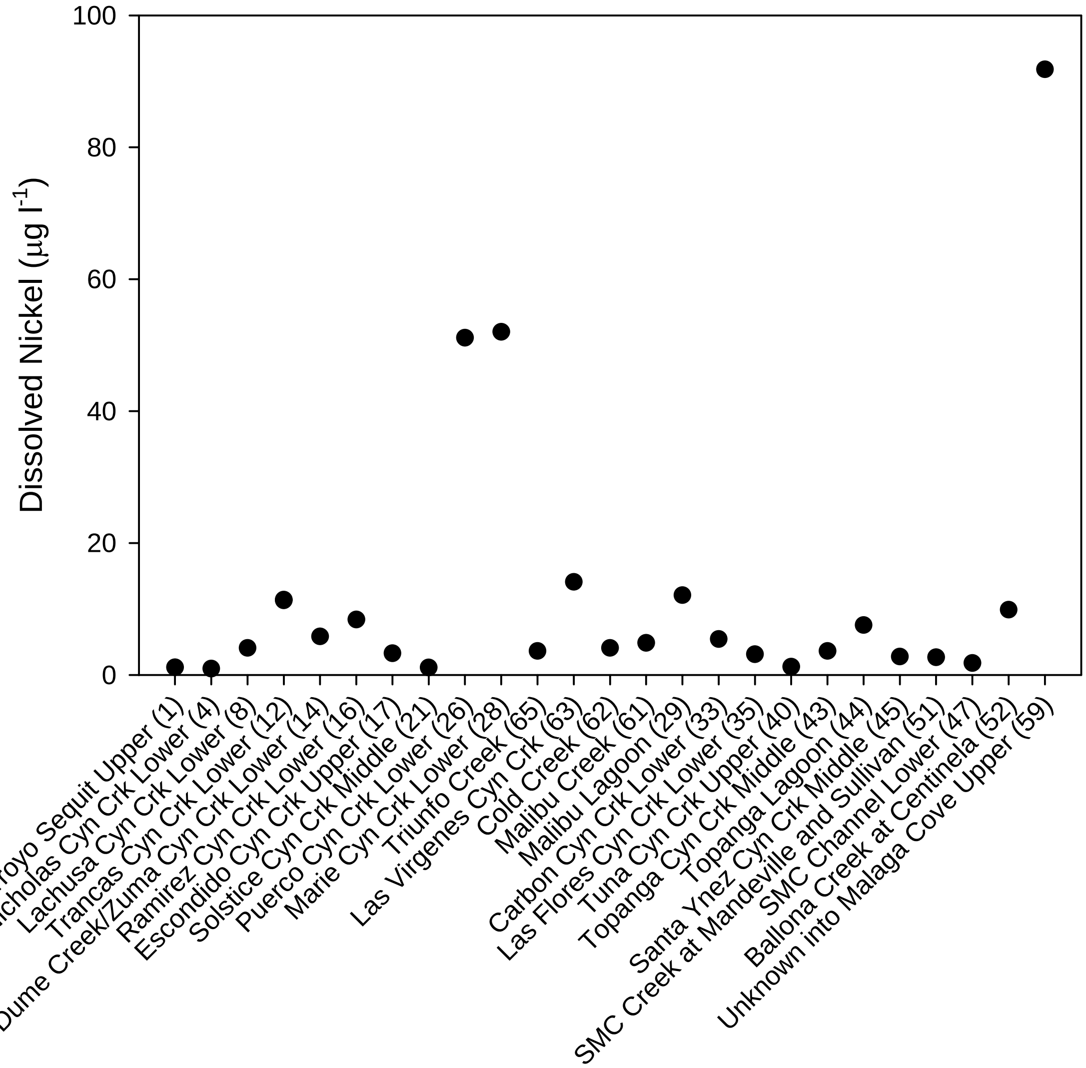

Figure 50. Dissolved nickel at sites in the SMB WMA.

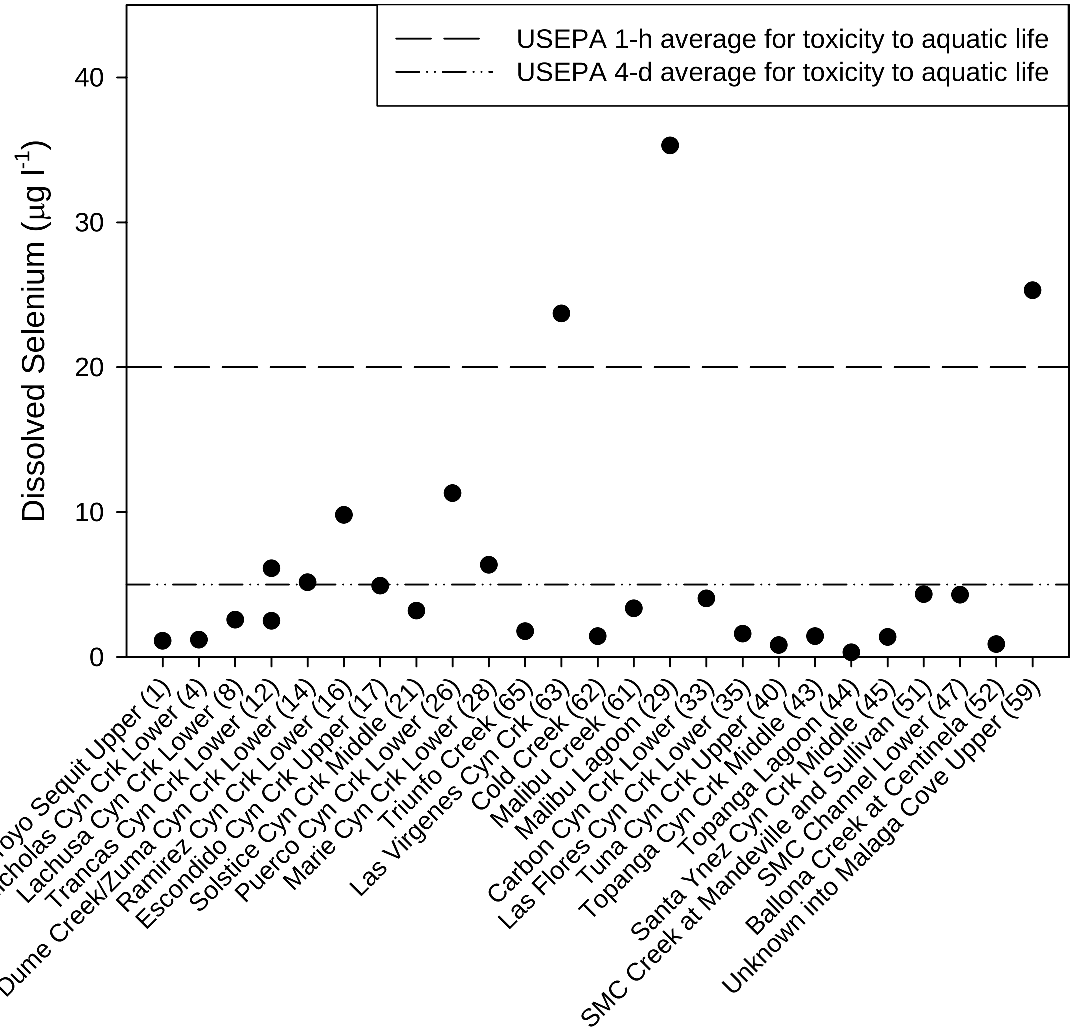

Figure 51. Dissolved selenium at sites in the SMB WMA.

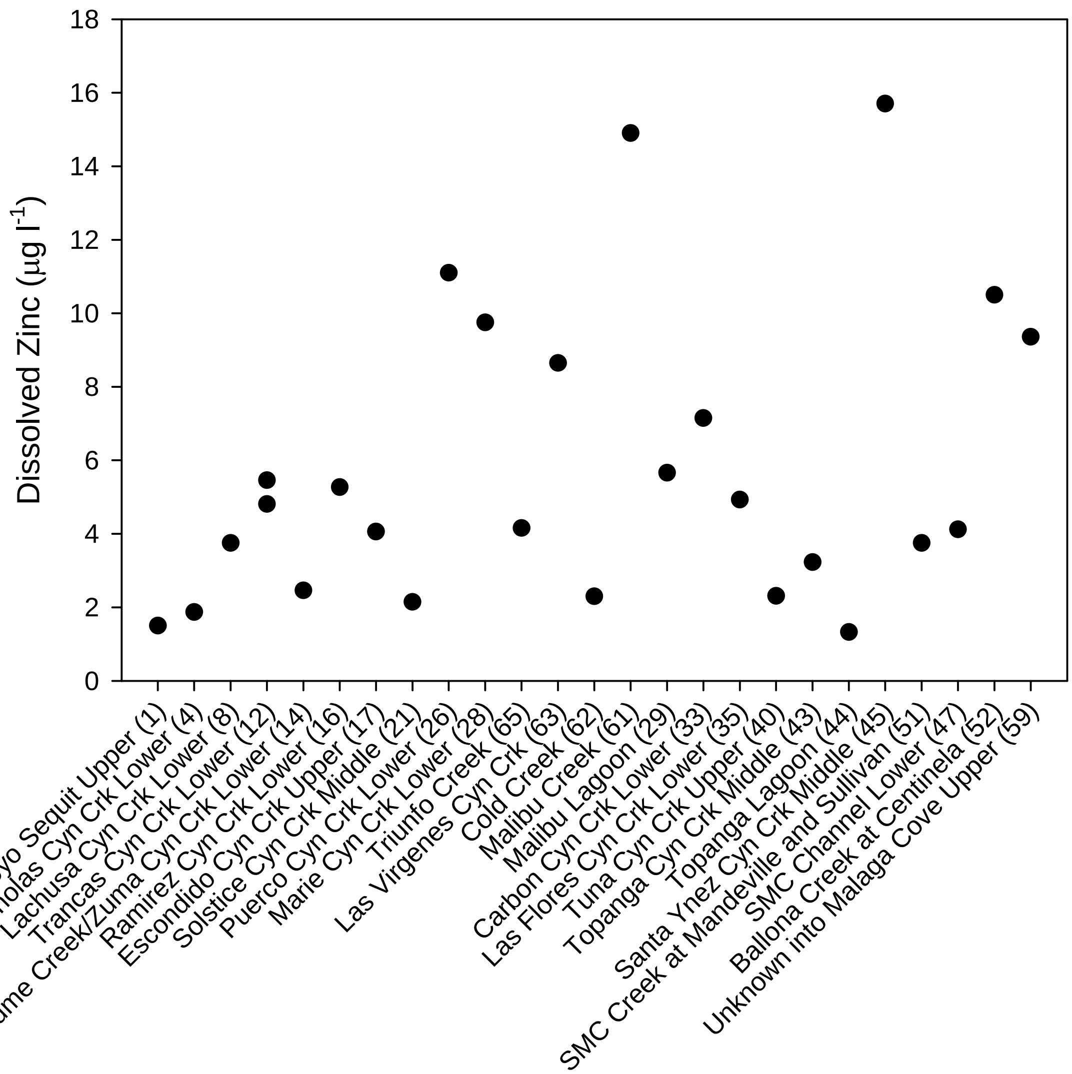

Figure 52. Dissolved zinc at sites in the SMB WMA.

4.5 Trace Organics in Water

Organophosphate pesticides, triazines, volatile organic compounds

Chlorpyrifos was detected at 3 sites and values were between the MDL and the RL (Table 15). The ELISA technique with an MDL of 0.05 µg l^{-1} was used to measure these values. Thus the detectable values automatically exceed the CDFG 1-hour and 4-day average criteria for protection of freshwater aquatic life of 0.02 and 0.014 µg l^{-1} (Marshack 2003), respectively, and the 1-hour and 4-day average criteria for protection of saltwater aquatic life of 0.02 and 0.009 µg l^{-1} (Marshack 2003), respectively (Figure 53). Values at all other sites were below detection limits.

Table 15. Chlorpyrifos values at three sites in the SMB WMA.

Site	Sample Date	Result	Unit	MDL	RL	Method
Malibu Lagoon (29)	12/Mar/2003	0.073	µg/L	0.05	0.1	ELISA SOP 3.3
Rustic Cyn Crk Upper (48)	11/Mar/2003	0.05	µg/L	0.05	0.1	ELISA SOP 3.3
Unknown into Malaga Cover Lower (60)	12/Mar/2003	0.098	µg/L	0.05	0.1	ELISA SOP 3.3

Diazinon was detected at 9 sites (Table 16). Values from three sites exceeded the tentative CDFG 4-day average criterion for protection of freshwater aquatic life of 0.05 µg l^{-1} (Marshack 2003); one of those sites also exceeded the 1-hour average criterion of 0.08 µg l^{-1} (Marshack 2003) (Figure 53). The brackish sites, Malibu Creek (29) and Ballona Creek at Centinela (52), did not exceed the tentative CDFG 1-hour and 4-day average criteria for protection of saltwater aquatic life of 0.82 and 0.40 µg l^{-1} (Marshack 2003); respectively.

Table 16. Diazinon values at nine sites in the SMB WMA. Boldface type indicates values above established criteria.

Site	Sample Date	Result	Unit	MDL	RL	Method
Solstice Cyn Crk Upper at waterfall (21A)	**11/Mar/2003**	**0.051**	**µg/L**	**0.03**	**0.03**	**ELISA SOP 3.3**
Marie Cyn Crk Lower (28)	03/Mar/2003	0.015	µg/L	0.01	0.02	EPA 8141A
Triunfo Crk (65)	03/Mar/2003	0.044	µg/L	0.03	0.03	ELISA SOP 3.3
Malibu Lagoon (29)	12/Mar/2003	0.043	µg/L	0.03	0.03	ELISA SOP 3.3
Las Flores Cyn Crk Upper (34)	11/Mar/2003	0.039	µg/L	0.03	0.03	ELISA SOP 3.3
Santa Ynez Cyn Crk Middle (45)	**26/Mar/2003**	**0.163**	**µg/L**	**0.01**	**0.02**	**EPA 8141A**
Rustic Cyn Crk Upper (48)	11/Mar/2003	0.043	µg/L	0.03	0.03	ELISA SOP 3.3
Ballona Crk at Centinela (52)	06/Mar/2003	0.008	µg/L	0.01	0.02	EPA 8141A
Unknown into Malaga Cover Lower (60)	**12/Mar/2003**	**0.054**	**µg/L**	**0.03**	**0.03**	**ELISA SOP 3.3**

All other OPs, triazines, and VOCs were below the detection limits in all samples (Table 17).

Table 17. Trace organics below detection limits in all samples from the SMB WMA.

Analyte	MDL	RL	Unit	Category
Ametryn	0.02	0.05	µg/L	Triazine
Aspon	0.03	0.05	µg/L	OP
Atraton	0.02	0.05	µg/L	Triazine
Atrazine	0.02	0.05	µg/L	Triazine
Azinphos ethyl	0.03	0.05	µg/L	OP
Azinphos methyl	0.03	0.05	µg/L	OP
Benzene	0.04	0.2	µg/L	VOC
Bolstar	0.03	0.05	µg/L	OP
Carbophenothion	0.03	0.05	µg/L	OP
Chlorfenvinphos	0.03	0.05	µg/L	OP
Chlorpyrifos methyl	0.02	0.05	µg/L	OP
Ciodrin(Crotoxyphos)	0.03	0.05	µg/L	OP
Coumaphos	0.04	0.05	µg/L	OP
Demeton-s	0.04	0.05	µg/L	OP
Dichlofenthion	0.03	0.05	µg/L	OP
Dichlorvos	0.03	0.05	µg/L	OP
Dicrotophos	0.03	0.05	µg/L	OP
Dimethoate	0.03	0.05	µg/L	OP
Dioxathion	0.03	0.05	µg/L	OP
Disulfoton	0.01	0.05	µg/L	OP
Ethion	0.02	0.05	µg/L	OP
Ethoprop	0.03	0.05	µg/L	OP
Ethylbenzene	0.041	0.2	µg/L	VOC
Famphur	0.03	0.05	µg/L	OP
Fenchlorphos	0.03	0.05	µg/L	OP
Fenitrothion	0.03	0.05	µg/L	OP
Fensulfothion	0.03	0.05	µg/L	OP
Fenthion	0.03	0.05	µg/L	OP
Fonofos (Dyfonate)	0.02	0.05	µg/L	OP
Leptophos	0.03	0.05	µg/L	OP
Malathion	0.03	0.05	µg/L	OP
Merphos	0.03	0.05	µg/L	OP
Methidathion	0.03	0.05	µg/L	OP
Mevinphos	0.03	0.05	µg/L	OP
Molinate	0.1	0.2	µg/L	OP
MTBE	0.07	0.2	µg/L	VOC
Naled(Dibrom)	0.03	0.05	µg/L	OP
Parathion, Ethyl	0.03	0.05	µg/L	OP
Parathion, Methyl	0.01	0.05	µg/L	OP
Phorate	0.03	0.05	µg/L	OP

Table non detect organics cont.

Phosmet	0.03	0.05	µg/L	OP
Phosphamidon	0.03	0.05	µg/L	OP
Prometon	0.02	0.05	µg/L	Triazine
Prometryn	0.02	0.05	µg/L	Triazine
Propazine	0.02	0.05	µg/L	Triazine
Secbumeton	0.02	0.05	µg/L	Triazine
Simazine	0.02	0.05	µg/L	Triazine
Simetryn	0.02	0.05	µg/L	Triazine
Sulfotep	0.03	0.05	µg/L	OP
Terbufos	0.03	0.05	µg/L	OP
Terbuthylazine	0.02	0.05	µg/L	Triazine
Terbutryn	0.02	0.05	µg/L	Triazine
Tetrachlorvinphos	0.03	0.05	µg/L	OP
Thiobencarb	0.1	0.2	µg/L	OP
Thionazin	0.04	0.05	µg/L	OP
Tokuthion	0.03	0.05	µg/L	OP
Toluene	0.07	0.2	µg/L	VOC
Trichlorfon	0.03	0.05	µg/L	OP
Trichloronate	0.03	0.05	µg/L	OP

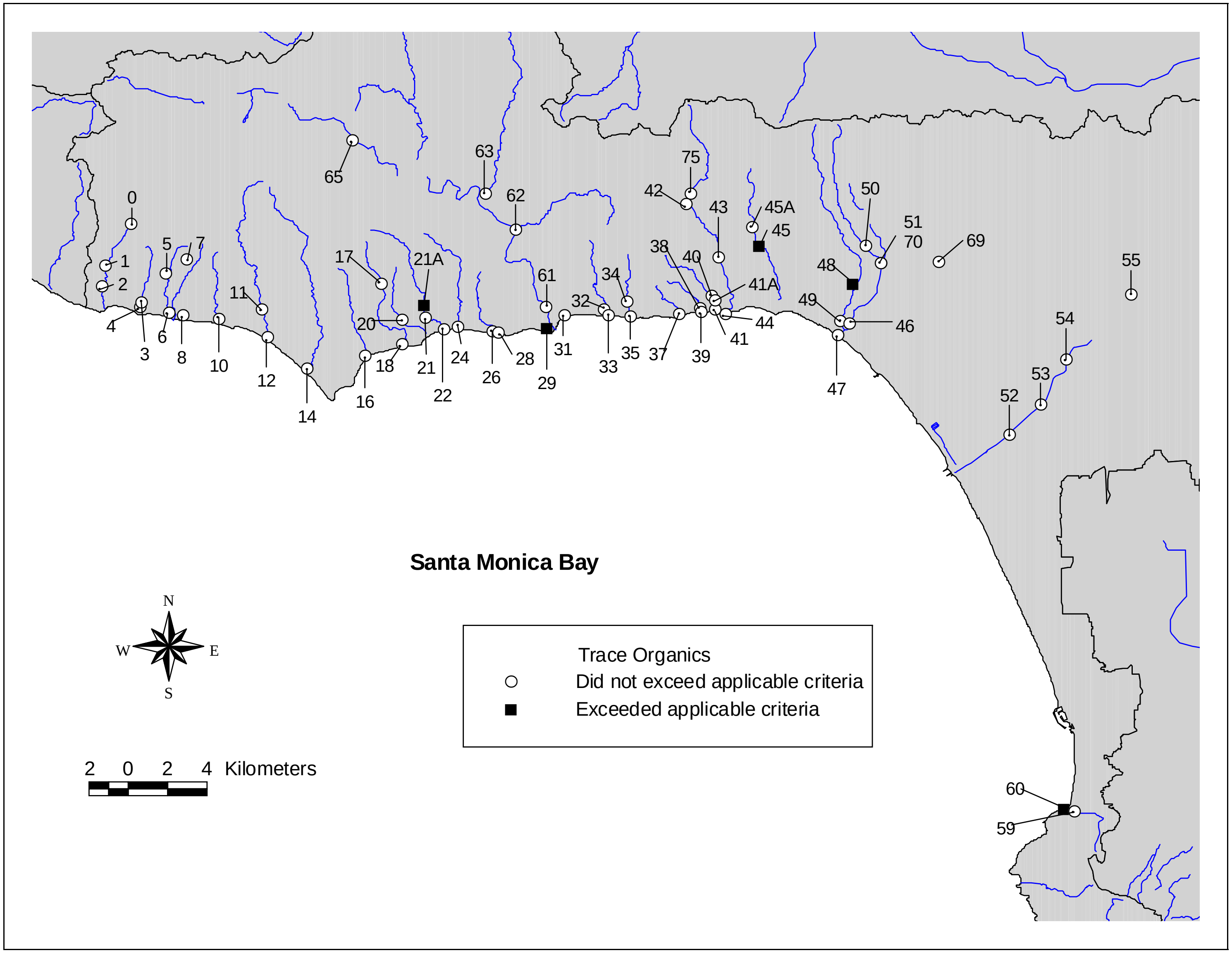

Figure 53. Sites in the SMB WMA where organics were detected or exceeded recommended criteria.

4.6 Toxicity

A total of 20 sites from 20 different sub-watersheds were tested for toxicity. Acute and/or chronic water column toxicity were detected at 6 sites (Figure 54). *Ceriodaphnia dubia* tests indicated acute toxicity at 4 sites: Trancas Canyon Creek Lower (12), Puerco Canyon Creek Lower (26), Marie Canyon Creek Lower (28), and Ballona Creek at Centinela (52). *C. dubia* tests also indicated chronic toxicity for one of those sites, Marie Canyon Creek Lower (28). *Pimephales promelas* tests indicated acute toxicity at 3 sites: Trancas Canyon Creek Lower (12), Ramirez Canyon Creek Lower (16), and Escondido Canyon Creek Upper (17). With the exception of Upper Escondido Canyon Creek (17), all of the sites are in the lower portions of their respective sub-watersheds.

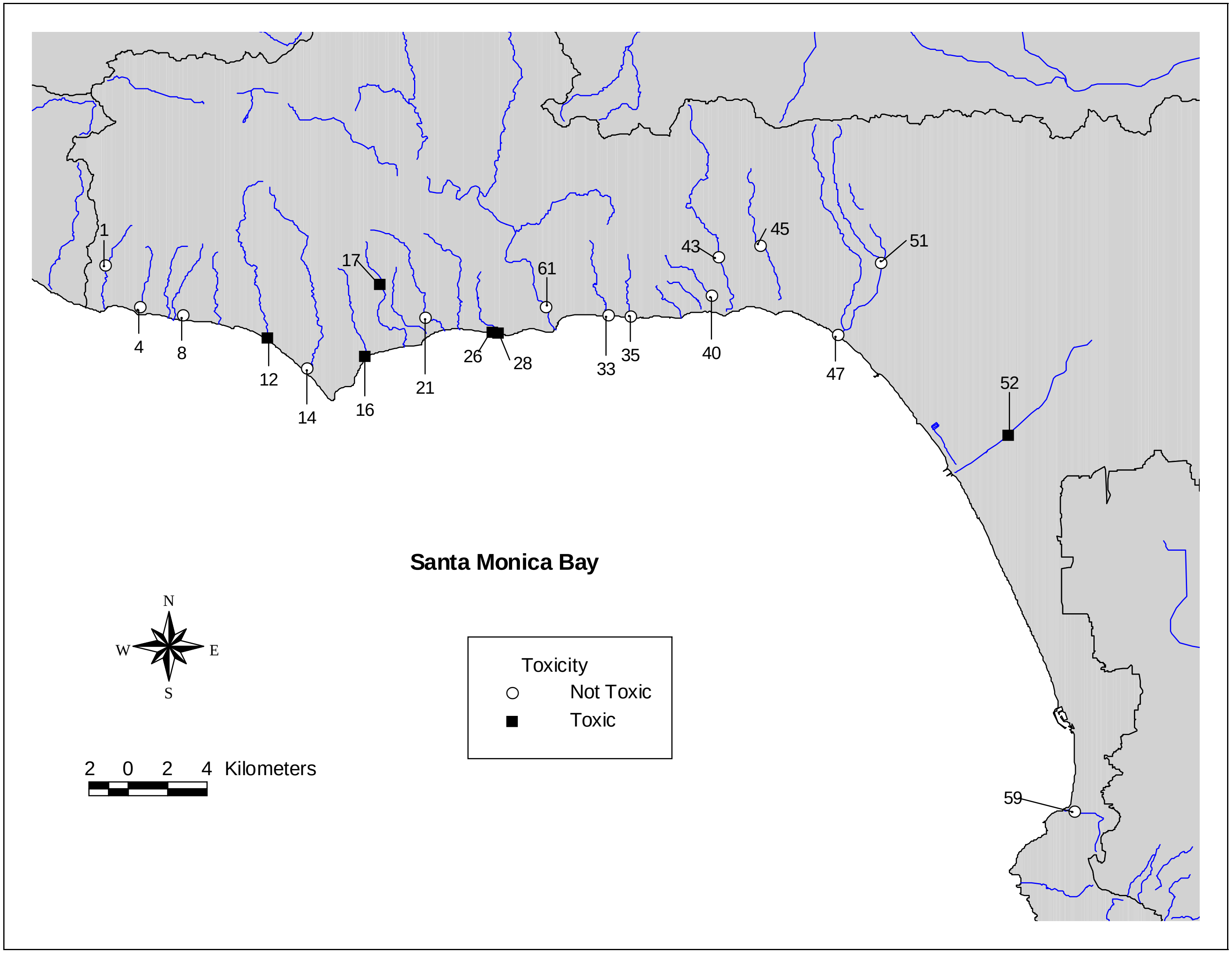

Figure 54. Toxicity in the SMB WMA.

4.7 Bioassessment

Benthic IBI scores ranged from 4 to 78 (Figure 55) and represented four condition categories ranging from Very Poor to Good (Table 18). No sites scored in the Very Good category.

Table 18. Condition category distribution of benthic IBI scores in the SMB WMA.

Numerical Score	Condition Category	% of Values
0-19	Very Poor	17.78
20-39	Poor	28.89
40-59	Fair	26.67
60-79	Good	26.67
80-100	Very Good	0

Below are the bioassessment categorical results by individual sub-watershed. Results are presented graphically in Figure 56.

Arroyo Sequit
Three sites in the Arroyo Sequit watershed were sampled for bioassessment. Arroyo Sequit at Fork (0), the uppermost site, and Arroyo Sequit Upper (1), the middle site, were each sampled twice; Arroyo Sequit Lower (2) was sampled once. Biotic condition was Good both times at Arroyo Sequit at Fork (0), Fair both times at Arroyo Sequit Upper (1), and Poor at Arroyo Sequit Lower (2). The pattern of decrease in biotic condition with distance downstream suggests a gradient in habitat quality.

San Nicholas Canyon
One site in the San Nicholas Canyon watershed was sampled once for bioassessment. Biotic condition at San Nicholas Canyon Creek Lower (4) was Fair.

Los Alisos Canyon
Two sites in the Los Alisos Canyon watershed were each sampled once for bioassessment. Biotic condition was Poor in at Los Alisos Canyon Creek Upper (5) and Fair at Los Alisos Canyon Creek Lower (6). The pattern found in the Los Alisos Canyon watershed is opposite that found in the Arroyo Sequit watershed.

Lachusa Canyon
One site in the Lachusa Canyon watershed was sampled once for bioassessment. Biotic condition was Poor at Lachusa Canyon Creek Lower (8).

Encinal Canyon
One site in the Encinal Canyon watershed was sampled once for bioassessment. Biotic condition was Fair at Encinal Canyon Creek Lower (10).

Trancas Canyon

One site in the Trancas Canyon watershed was sampled twice for bioassessment. Biotic condition was Good at Trancas Canyon Creek Upper (11) both times.

Dume/Zuma Canyon
The Dume Creek/Zume Canyon Creek watershed was not sampled for bioassessment.

Ramirez Canyon
One site in the Ramirez Canyon watershed was sampled once for bioassessment. Biotic condition was Poor at Ramirez Canyon Creek Lower (16), which is a concrete channel.

Escondido Canyon
One site in the Escondido Canyon watershed was sampled once for bioassessment. Biotic condition was Good at Escondido Canyon Creek Upper (17).

Latigo Canyon
One site in the Latigo Canyon watershed was sampled once for bioassessment. Biotic condition was Fair at Latigo Canyon Creek Upper (20).

Solstice Canyon
Three sites in the Solstice Canyon watershed were sampled for bioassessment. Solstice Canyon Creek Upper (21A) and Lower (22) were each sampled once; Solstice Canyon Creek Middle (21) was sampled twice. Biotic condition was Good at each of these sites at each sampling event.

Corral Canyon
One site in the Corral Canyon watershed was sampled once for bioassessment. Biotic condition was Good at Corral Canyon Creek Lower (24).

Puerco Canyon
One site in the Puerco Canyon watershed was sampled once for bioassessment. Biotic condition was Fair at Puerco Canyon Creek Lower (26).

Marie Canyon
One site in the Marie Canyon watershed was sampled once for bioassessment. Biotic condition was Very Poor at Marie Canyon Creek Lower (28), which is a concrete channel.

Malibu Creek
One site in the Malibu Creek watershed was sampled once for bioassessment. Biotic condition was Very Poor at Malibu Lagoon (29), but this result should be interpreted cautiously. This is a lagoonal brackish site and application of a benthic IBI developed for flowing streams may not be appropriate.

Sweetwater Canyon
One site in the Sweetwater Canyon watershed was sampled once for bioassessment. Biotic condition was Fair at Sweetwater Canyon Creek Lower (31), which is a concrete channel.

Carbon Canyon

Two sites in the Carbon Canyon watershed were each sampled once for bioassessment. Biotic condition was Poor at both Carbon Canyon Creek Upper (32) and Lower (33).

Las Flores Canyon

Two sites in the Las Flores Canyon watershed were each sampled once for bioassessment. Biotic condition was Poor at both Las Flores Canyon Creek Upper (34) and Lower (35).

Piedra Gorda Canyon

The Piedra Gorda Canyon Creek watershed was not sampled for bioassessment.

Pena Canyon

One site in the Pena Canyon watershed was sampled once for bioassessment. Biotic condition was Good at Pena Canyon Creek Upper (38).

Tuna Canyon

Two sites in the Tuna Canyon watershed were sampled for bioassessment. Tuna Canyon Creek at Eucalyptus Tree Stand (41A) was sampled twice and Tuna Canyon Creek Lower (41) was sampled once. Biotic condition at Tuna Canyon Creek at Eucalyptus Tree Stand (41A) was Fair in 2003 and Good in 2004. Biotic condition at Tuna Canyon Creek Lower (41) was Fair.

Topanga Canyon

Three sites in the Topanga Canyon watershed were each sampled once for bioassessment. Topanga Canyon Creek at Greenleaf (75) and Upper (42) were each sampled once; Topanga Canyon Creek Middle (43) was sampled twice. Biotic condition was Poor at Topanga Canyon Creek at Greenleaf (75) and Upper (42). Biotic condition at Topanga Canyon Creek Middle (43) was Fair in 2003 and Poor in 2004.

Santa Ynez Canyon

One site in the Santa Ynez Canyon watershed was sampled once for bioassessment. Biotic condition was Very Poor at Santa Ynez Canyon Creek Middle (45).

Santa Monica Canyon

Four sites in the Santa Monica Canyon watershed were each sampled once for bioassessment. biotic condition was Poor at Sullivan Canyon Creek Upper (50), Fair at Rustic Canyon Creek Upper (48), and Very Poor at Rustic Canyon Creek Lower (49) and Santa Monica Canyon Channel Lower (47). Both Rustic Canyon Creek Lower (49) and Santa Monica Canyon Channel Lower (47) are concrete channels.

Ballona Creek

Two sites in the Ballona Creek watershed were each sampled once for bioassessment. Biotic condition was Poor at Ballona Creek at Sepulveda (53) and Very Poor at Ballona Creek at Centinela (52). Both of these sites are concrete channels.

Malaga Cove

Two sites in the Malaga Cove watershed were each sampled once for bioassessment. Biotic condition was Very Poor at both Unknown into Malaga Cove Upper (59) and Lower (60).

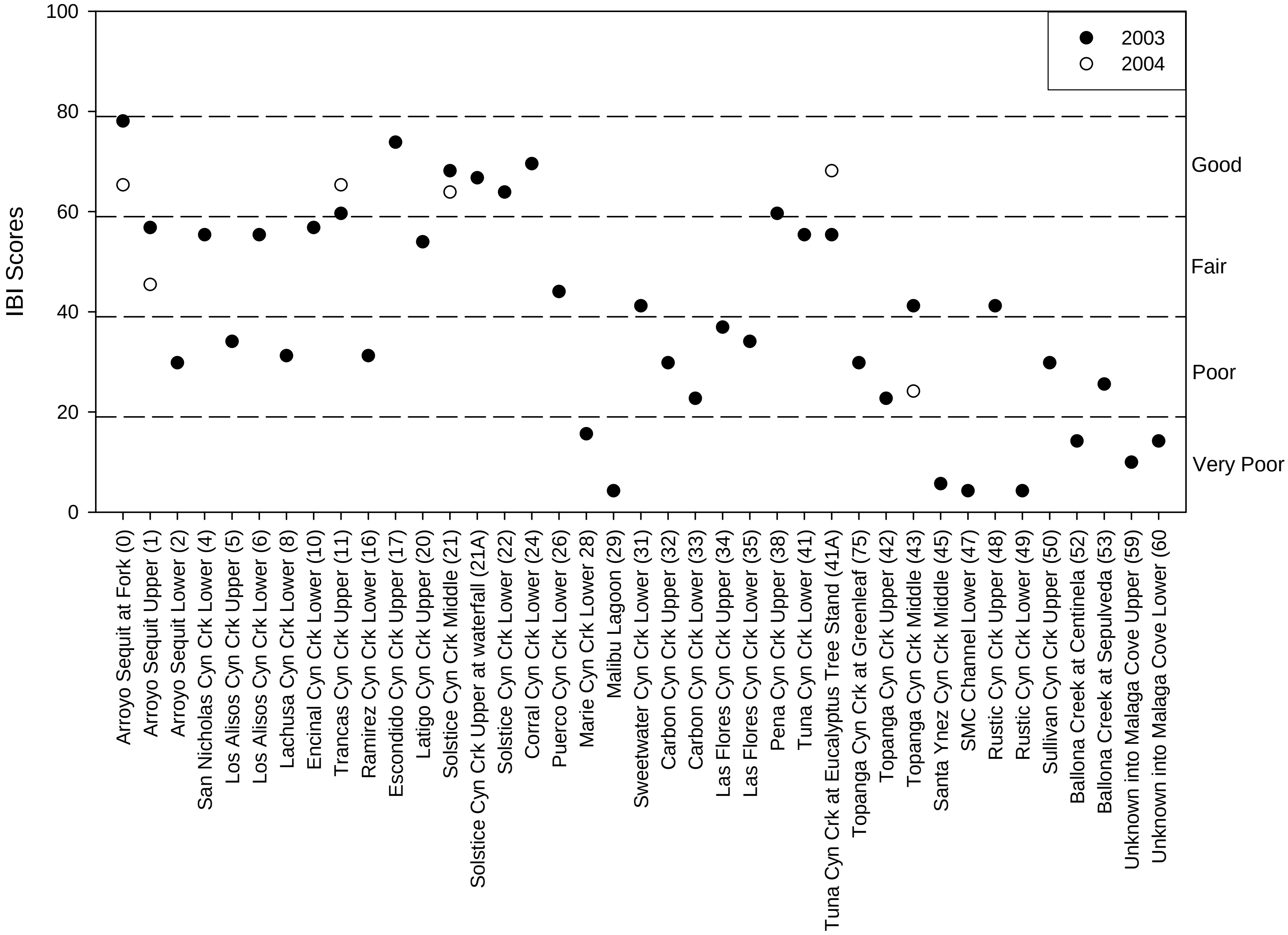

Figure 55. Benthic IBI scores at sites in the SMB WMA.

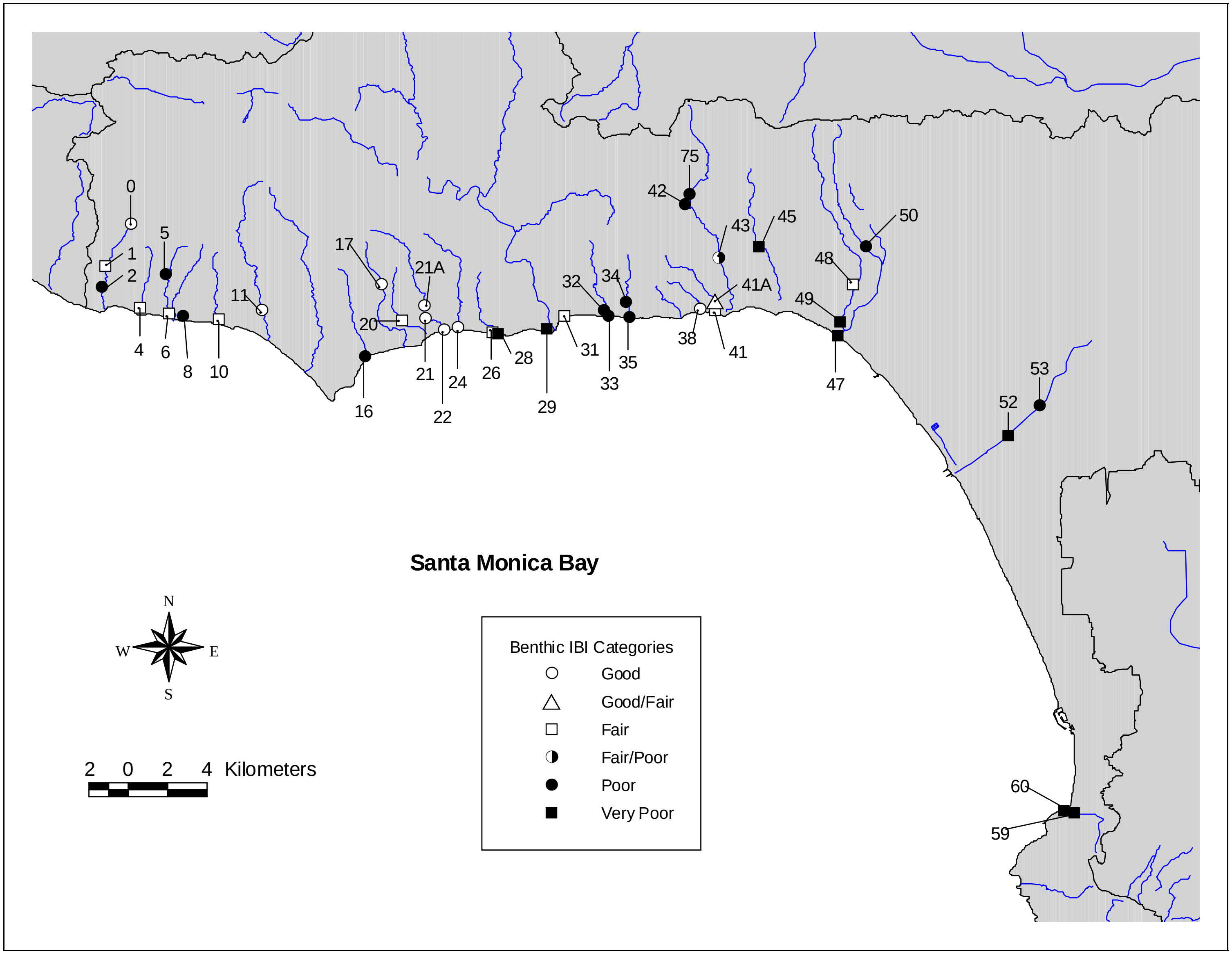

Figure 56. Benthic IBI condition categories in the SMB WMA.

5 LIMITATIONS

Most of the sites in this study were sampled once in 2003 and once in 2004. With such infrequent and limited sampling, no inference about the temporal extent of potential water quality problems at any site can be made, and the representativeness of each sample is unknown. Additional, more frequent sampling would be needed to determine the true nature of any impairment.

The field and laboratory methods employed in this study also limit the usefulness of the data collected. DO was measured in % saturation but Basin Plan criteria are stated in mg l^{-1}. Thus, the DO data collected in this study cannot be compared to established objectives. Current MDLs for several constituents may be too high to allow meaningful comparisons to established criteria. For example, the dissolved arsenic MDL of 0.03 µg l^{-1} is higher than the USEPA National Ambient Water Quality criterion for toxicity to humans of 0.018 µg l^{-1} (Marshack 2003). Similarly, the ELISA technique MDL for chlorpyrifos of 0.05 µg l^{-1} is higher than the California DFG 1-hour and 4-day average criteria for toxicity to aquatic life of 0.02 and 0.014 µg l^{-1} (Marshack 2003), respectively. MDLs that are low relative to established criteria would permit a more conclusive assessment of whether or not impairment exists.

Synthesis of the data is restricted by limited application of the triad approach. When the full suite of water chemistry parameters was analyzed (conventional constituents, metals, OPs) and bioassessment and toxicity testing were conducted, the potential to make inferences about the cause of poor biotic condition or toxicity exists. Conversely, the effect of metals or organics on aquatic life may be detected. However, in the many cases where bioassessment was conducted but toxicity testing was not and metals and OPs were not sampled, our ability to assess water quality and draw conclusions about its effects is limited.

6 SUMMARY

6.1 Santa Monica Bay Watershed Management Area Sub-Watershed Summaries

Table 19 summarizes the results of this study. Toxicity and bioassessment results are listed, and water quality parameters are listed for a site if they did not meet established water quality objectives or may indicate water quality problems. When two possible thresholds were suggested, the most protective threshold was used for comparison. USEPA suggested threshold value for reference conditions in streams in level III ecoregion 6 (USEPA 2000a) were not used in constructing this table because the table is used to highlight possible water quality problems rather than make comparisons to reference conditions.

Summaries of this study by individual sub-watershed are provided below.

Arroyo Sequit (Sites 0, 1 and 2)
More water quality problems were indicated in the lower portion of the Arroyo Sequit

watershed than the upper portion. DO may be of concern at the two uppermost stations, but the number of conventional water column parameters that exceeded objectives (chloride, sulfate, TP, TDS) increased with distance downstream, and biotic condition changed from Good at the uppermost site to Fair at the middle site to Poor at the lowest site. These data may suggest a link between water quality and biotic condition, but additional investigation would be required to determine the cause of degraded biotic condition in the lower watershed. Concentrations of OPs and bacteria did not indicate problems. Trace metals and toxicity were sampled at the middle site and no problems were indicated.

San Nicholas Canyon (Sites 3 and 4)
Similar water quality problems were indicated at the upper and lower sites in the San Nicholas Canyon Creek watershed; however, these sites were located very close together and may not truly represent the upper and lower portions of the watershed. DO, boron, fluoride, TP, sulfate, and TDS exceeded established objectives. Neither OPs nor bacteria appeared to be problematic at either station. Trace metals, bioassessment and toxicity were not sampled at the upper station, preventing comparisons with the lower station where no toxicity was found, biotic condition was Fair, and trace metals were all below established criteria.

Los Alisos Canyon (Sites 5 and 6)
More water quality problems were indicated at the upper site in the Los Alisos Canyon Creek watershed than the lower site. DO and TDS exceeded established objectives at both sites. TP, *E. coli* and fecal coliform also exceeded established objectives at the upper site and biotic condition was Poor. At the lower site, sulfate also exceeded its established objective and biotic condition was Fair. OPs did not appear to be problematic at either site. Neither trace metals nor toxicity were sampled. Factors contributing to degraded biotic condition at the upper site are not clear.

Lachusa Canyon (Sites 7 and 8)
More water quality problems were indicated at the lower site than the upper site in the Lachusa Canyon Creek watershed. At the upper site, only sulfate and TDS exceeded established objectives, while at the lower site, concentrations of DO, chloride, fluoride, sulfate, TDS and manganese indicated problems. Biotic condition was Poor at the lower site, but no toxicity was detected. Trace metals, bioassessment, and toxicity were not sampled at the upper site. Concentrations of OPs and bacteria did not exceed objectives at either site. Factors contributing to degraded biotic condition at the lower site are not clear.

Encinal Canyon (Site 10)
The only water quality problems indicated in the Encinal Canyon Creek watershed were TP, sulfate, and TDS. OPs and bacteria did not appear to be a problem, and biotic condition was Fair. Trace metals and toxicity were not sampled. Only one site was sampled.

Trancas Canyon (Sites 11 and 12)
More water quality problems were indicated at the lower site in the Trancas Canyon Creek watershed than the upper site. At the upper site, only PO_4, TP, and TDS exceeded established objectives. At the lower site, concentrations of DO, chloride, PO_4, TP, sulfate, TDS, *E. coli* and fecal coliform indicated problems. Manganese and selenium also exceeded

established objectives at the lower site, and acute toxicity was detected. Trace metals and toxicity were not sampled at the upper site. Biotic condition at the upper site was Good; bioassessment was not conducted at the lower site. OPs did not appear to be problematic at either site. Further investigation would be necessary to determine whether selenium or another pollutant was the cause of acute toxicity at the lower site.

Dume/Zuma Canyon (Site 14)
Water quality problems indicated in the Dume Creek/Zuma Canyon Creek watershed were TP, sulfate, TDS, manganese, selenium, *E. coli* and fecal coliform. No toxicity was detected and OPs did not appear to be a problem. Bioassessment was not conducted. Only one site was sampled.

Ramirez Canyon (Site 16)
Water quality problems indicated in the Ramirez Canyon Creek watershed were TP, sulfate, TDS, manganese, and selenium. Biotic condition was Poor and acute toxicity was detected. Neither OPP nor bacteria concentrations indicated a problem. Further investigation would be needed to determine whether selenium or another pollutant was the cause of acute toxicity. The site was a concrete channel; this may have contributed to the Poor biotic condition. Only one site was sampled.

Escondido Canyon (Sites 17and 18)
More water quality problems were indicated at the lower site than the upper site in the Escondido Canyon Creek watershed. At the upper site, DO, sulfate and TDS exceeded established objectives. At the lower site, DO, chloride, sulfate, TDS, *E. coli* and fecal coliform indicated problems. At the upper site, concentrations of neither trace metals nor OPs indicated problems, and biotic condition was Good. However, acute toxicity was detected; further investigation would be required to identify the cause. At the lower site, trace metals, bioassessment, and toxicity were not sampled.

Latigo Canyon (Site 20)
Water quality problems indicated in the Latigo Canyon Creek watershed were DO, sulfate and TDS. Concentrations of OPs and bacteria did not indicate problems, and biotic condition was Fair. Trace metals and toxicity were not sampled. Only one site was sampled.

Solstice Canyon (Sites 21, 21A and 22)
Sulfate and TDS exceeded established objectives at all three sites in the Solstice Canyon Creek watershed. DO was of concern at the upper and lower sites, but not the middle site. Diazinon exceeded established objectives at the middle site, but OPs did not appear to be problematic at the upper or lower sites. MTBE was sampled at the lower site and was not even detected. Bacteria concentrations did not indicate problems at any site, and biotic condition was Good at all three sites. At the middle site, trace metals were all below established criteria and no toxicity was detected. Trace metals and toxicity were not sampled at the upper and lower sites.

Corral Canyon (Site 24)
Water quality problems indicated in the Corral Canyon Creek watershed were TP, sulfate and

TDS. Neither OPs nor bacteria appeared to be a problem and biotic condition was Good. Trace metals and toxicity were not sampled. Only one site was sampled.

Puerco Canyon (Site 26)
Water quality problems indicated in the Puerco Canyon Creek watershed were DO, chloride, fluoride, sulfate, TDS, manganese and selenium. Neither OPs nor bacteria appeared to be a problem. Biotic condition was Fair and acute toxicity was detected; further investigation would be needed to determine whether selenium or another pollutant was the cause. Only one site was sampled.

Marie Canyon (Site 28)
Water quality problems indicated in the Marie Canyon Creek watershed were DO, chloride, TP, sulfate, TDS, manganese, selenium and fecal coliform. OPs did not appear to be a problem, but biotic condition was Very Poor and both acute and chronic toxicity were detected. Further investigation would be required to determine whether selenium or another pollutant was the cause of toxicity. The site was a concrete channel, which may have contributed to the Very Poor biotic condition. Only one site was sampled.

Malibu Creek (Sites 61, 62, 63, 65 and 29)
Common water quality problems indicated in the Malibu Creek watershed were DO, TP, sulfate and TDS. More limited problems were pH, chloride, PO_4, copper, manganese, nickel, selenium, chlorpyrifos, *E. coli* and fecal coliform. Toxicity was sampled at one site and none was detected. Biotic condition was assessed in Malibu Lagoon, where it was Very Poor; however the implications of applying a benthic IBI developed for flowing streams to a brackish lagoon setting are unclear and this result should be interpreted cautiously. Because bioassessment and toxicity testing were not conducted at most of the sites in the Malibu Creek watershed, the effects of low DO and elevated levels of conventional constituents and metals on aquatic life is unknown.

Sweetwater Canyon (Site 31)
Water quality problems indicated in the Sweetwater Canyon Creek watershed were boron, chloride, PO_4, TP, sulfate, TDS and fecal coliform. OPs were not problematic and biotic condition was Fair, even though this site was a concrete channel. Trace metals and toxicity were not sampled. Only one site was sampled.

Carbon Canyon (Sites 32 and 33)
Similar water quality problems were indicated at the upper and lower sites in the Carbon Canyon Creek watershed, but these sites were located very close together and may not truly represent the upper and lower portions of the watershed. DO, sulfate and TDS exceeded established objectives at both sites; chloride also exceeded established objectives at the lower site. Biotic condition was Poor at both sites but the cause is unknown. Concentrations of OPs and bacteria did not indicate problems. At the lower site, no toxicity was detected and trace metals were all below established criteria; trace metals and toxicity were not sampled at the upper site.

Las Flores Canyon (Sites 34 and 35)

Similar water quality problems were indicated at the upper and lower sites in the Las Flores Canyon Creek watershed. DO, sulfate and TDS exceeded established objectives at both sites; fecal coliform exceeded established limits at the lower site. Biotic condition was Poor at both sites but the cause is unknown. MTBE was sampled at the lower site and was not even detected. OPP concentrations did not indicate problems. At the lower site, trace metals were all below established criteria and no toxicity was detected; trace metals and toxicity were not sampled at the upper site.

Piedra Gorda Canyon (Site 37)
Water quality problems indicated in the Piedra Gorda Canyon Creek watershed were pH, chloride, sulfate and TDS. Concentrations of OPs and bacteria did not indicate problems. Trace metals, bioassessment and toxicity were not sampled. Only one site was sampled.

Pena Canyon (Sites 38 and 39)
Similar water quality problems were indicated at the upper and lower sites in the Pena Canyon Creek watershed, but these sites were located very close together and may not truly represent the upper and lower portions of the watershed. Boron, fluoride, sulfate and TDS exceeded established objectives at both sites. DO may be of concern at the upper site and *E. coli* exceeded established limits at the lower site. OPs did not appear to be a problem at either site. Biotic condition at the upper site was Good; bioassessment was not conducted at the lower site. Trace metals and toxicity were not sampled.

Tuna Canyon (Sites 40, 41 and 41A)
Water quality problems indicated in the Tuna Canyon Creek watershed were DO, sulfate and TDS. At the upper site, trace metals were all below established criteria and no toxicity was found. OPs and bacteria were not problematic. Biotic condition in the lower portion of the watershed was Fair to Good; bioassessment was not conducted at the upper site.

Topanga Canyon (Sites 42, 43 and 44)
Common water quality problems indicated in the Topanga Canyon Creek watershed were sulfate, TDS, *E. coli* and fecal coliform. More limited problems were DO, PO_4 and TP. OPs did not appear to be a problem at any site. Biotic condition was Poor in the upper portion of the watershed and Fair to Poor in the mid-section but the cause of degraded biotic condition is unknown. In the middle, trace metals were all below established criteria and no toxicity was detected. Trace metals and toxicity were not sampled at the upper sites.

Santa Ynez Canyon (Sites 45 and 45A)
Similar water quality problems were indicated at the upper and middle sites in the Santa Ynez Canyon Creek watershed. PO_4, TP, sulfate, TDS, *E. coli* and fecal coliform exceeded established objectives at both sites. At the middle site, DO may be of concern and manganese and diazinon exceeded established objectives. Biotic condition was Very Poor and the cause is unknown, and no toxicity was detected. Trace metals, bioassessment, and toxicity were not sampled at the upper site.

Santa Monica Canyon (Sites 46, 47, 48, 49, 50, 51, 69 and 70)
Common water quality problems indicated in the Santa Monica Canyon watershed include

DO, pH, sulfate, TDS, *E. coli*, and fecal coliform. Less common problems include chloride, TP, and chlorpyrifos. At two sites, trace metals and toxicity were sampled; trace metals were all below established criteria and no toxicity was detected. Biotic condition ranged from Fair to Very Poor at two sites in the lower portion of the watershed that were concrete channels, which may have contributed to the Very Poor rating.

Ballona Creek (Sites 52, 53, 54, 55)
Common water quality problems indicated in the Ballona Creek watershed include pH, PO_4, TP, and bacteria, particularly *E. coli* and fecal coliform. Less common problems include DO, NH_3, sulfate, TDS, nickel, Enterococcus and total coliform. OPs did not appear to be problematic. Biotic condition at two concrete channel sites was Poor and Very Poor. Acute toxicity was detected at one of these sites but further investigation would be required to determine the cause. Trace metals and toxicity were not sampled at three sites and bioassessment was not conducted at two sites.

Malaga Cove (Sites 59 and 60)
Similar water quality problems indicated at the upper and lower sites in the Malaga Cove watershed were chloride, TP, sulfate and TDS. DO may also be of concern up the upper site, and manganese and selenium exceeded established criteria at this site. No toxicity was found however. Trace metals and toxicity were not sampled at the lower site. OPs were not problematic at the upper site, but at the lower site, chlorpyrifos and diazinon concentrations exceeded established criteria. Biotic condition was Very Poor at both sites but the cause is unknown. The upper and lower sites in this sub-watershed were also relatively close together and may not truly represent the upper and lower portions of the watershed.

6.2 Santa Monica Bay Watershed Management Area Overall Conclusions

The most common water quality problem indicated overall in the SMB WMA was TDS. TDS exceeded established criteria at 54 sites. The next most common problem was sulfate, which exceeded established objectives at 49 sites. The third most common problem is the possibility of low DO at 34 sites. Additional water quality problems indicated at multiple sites in the SMB WMA area include TP (24 sites), fecal coliform (22 sites), *E. coli* (21 sites) chloride (14 sites), PO_4 (12 sites), selenium (7 sites), fluoride (6 sites), toxicity (6 sites), chlorpyrifos and/or diazinon (5 sites), and boron (5 sites). Biotic condition was Poor or Very Poor at 21 sites on at least one sampling occasion.

The results presented in this study are consistent with results of previous studies. Impairments in the Malibu Creek watershed determined from previous sampling efforts include nutrients and nutrient-related effects, coliform and coliform-related effects, trash and metals (CRWQCB LAR 2001). This study confirms that nutrients, DO, which could potentially be a nutrient-related effect, metals, and bacteria are problematic in the Malibu Creek watershed. Impairments in the Ballona Creek watershed determined from previous sampling efforts include coliform and coliform-related effects, trash, PCBs and historical pesticides and their effects, and metals and their effects (toxicity) (CRWQCB LAR 2001). This study confirms that bacteria, metals and toxicity exceeded established objectives in the

Ballona Creek watershed. Impairment in the other small, urban watersheds in the SMB WMA identified in previous sampling efforts include DO, ammonia, lead and copper and their effects (toxicity), trash and bacteria (CRWQCB LAR 2001). This study confirms that DO and bacteria are problematic throughout the SMB WMA. However, this study also identified a number of water quality parameters that exceeded established objectives and may cause impairments not previously described.

Likely causes of toxicity cannot be identified from the data. At four of the six sites where toxicity was detected, selenium exceeded NTR criteria. At two sites where toxicity was detected, selenium levels were below established objectives, and at one site where selenium exceeded established objectives, no toxicity was detected. There are no additional patterns in the data to suggest another cause of toxicity, and further investigation would be required to determine whether or not selenium was the cause of toxicity at the four sites mentioned.

Similarly, it is not possible to definitively determine the cause of degraded biotic condition from these data. We have identified three potential contributing factors (physical habitat, OPs, toxic substances), but inconsistencies in the data preclude us from making any conclusions. First, at seven sites with Poor or Very Poor biotic condition, the site was a concrete channel. However, there were 14 other sites that were not concrete channels at which biotic condition was Poor or Very Poor, and one concrete channel site at which biotic condition was Fair. While there is an association between concrete channels and degraded biotic condition, there may be factors other than the concrete substrate that are responsible for the degraded biotic condition. Second, at the five sites where chlorpyrifos and diazinon exceeded established objectives, biotic condition was Very Poor at 3 sites but Fair and Good at the other two sites. Thus, there does not appear to be an association between OPs and biotic condition in the SMB WMA. Third, at the limited number of sites that were sampled for bioassessment and toxicity, there was no apparent evidence that a toxic substance contributed to degraded biotic condition. At sites where toxicity was detected, biotic condition ranged from Good to Very Poor, and conversely biotic condition ranged from Good to Very Poor at sites that had no toxicity. The ability to speculate as to the causes of degraded biotic condition is further limited by the sampling design. At a number of sites where bioassessment was conducted, water chemistry analysis was limited to conventional constituents; trace metals and the full suite of OPs were not analyzed. Additionally, physical environmental factors not recorded by the SWAMP program may contribute.

There were no discernible patterns between years for any of the parameters, but there were differences between upper and lower sites within individual watersheds. However, differences were not consistent among watersheds. In several watersheds, more water quality problems were indicated in the lower portions. For example, in the Arroyo Sequit, Lachusa Canyon Creek, Trancas Canyon Creek and Escondido Canyon Creek watersheds, the number of conventional water column parameters that exceeded objectives generally increased with distance downstream. In the Solstice Canyon Creek and Topanga Canyon Creek watersheds, conditions were similar at all three sites. The same was true for sites in the San Nicholas Canyon Creek, Carbon Canyon Creek, Las Flores Canyon Creek, and Pena Canyon Creek watersheds; however in each of these watersheds; the upper and lower sites were located very close together and may not truly represent the upper and lower portions of the watershed. In the Los Alisos Canyon Creek watershed, more water quality problems were indicated at the upper site than the lower site. In the Malibu Creek, Santa Monica Canyon Creek and Ballona Creek watersheds, conditions varied throughout without clear spatial patterns. The ability to compare conditions in the upper versus lower portions of watersheds and make generalizations about spatial patterns in water quality within watersheds is limited by the lack of consistent sampling among sites within a watershed. In many cases, trace metals, toxicity, and bioassessment were sampled at one site within a watershed but not at the other.

6.3 Study Evaluation: Achievements and Limitations

This study identified a number of potential concerns in the SMB watershed and covered the four activities intended by SWAMP listed on page 1 of this report:

- This study is part of a larger, comprehensive environmental monitoring program. The information provided by this study will assist in effective management of the State's water resources.
- Sampling methods, analytical procedures, DQOs and data reporting were consistent within the Los Angeles Region and consistent with Regions throughout the state.
- Spatial trends in water quality within the SMB WMA were analyzed. With additional future sampling, temporal trends will be analyzed. When used with other data from the state, regional and statewide spatial analysis will be possible.
- Data collected in this study will be used in the 303(d) process.

The sampling conducted contributes to the goals and expected end-products of SWAMP:

- This sampling was conducted under a long term sampling strategy that encompasses each hydrologic unit in the region at least once every five years. In combination with the other regions, every hydrologic unit in the state will be monitored at least once every 5 years. Consistent sampling and analytical methods, data quality assurance protocols, and centralized data management were used.
- Ambient water quality conditions in potentially clean and polluted areas were documented.
- Specific water quality problems were identified. These problems may prevent the SWRCB, RWQCBs, and the public from realizing beneficial uses of these waterbodies.
- These data can be used to evaluate the overall effectiveness of water quality regulatory programs in protecting beneficial uses of state waterbodies.

Specific goals for monitoring in the SMB WMA were met:

- obtain an overall view of the condition of the watershed;
- obtain baseline information on smaller streams within the watershed that have not been sampled previously;
- provide information can be used to identify potential reference sites in the watershed;
- provide information can be used to determine beneficial use attainment or non-attainment

However, the deterministic sampling design used in the SMB WMA study does not have the statistical power necessary for making conclusions with regard to the watershed as a whole. Thus, the results of this study cannot contribute to answering the questions the LARWQCB originally posed regarding the percentage of streams in the watershed or region that support beneficial uses, and how that percentage is changing over time. Additionally, the original study design for the SMB WMA called for locating two sites in a sub-watershed, one site in the upper watershed and the other in the lower watershed near its intersection with Pacific Coast Highway. However, due to the ability to find sites with running water and access, sites designated "Upper" were not always in the true upper portion of the watershed, and in some cases were located in close proximity to the "Lower" sites. Thus, not all paired Upper and Lower sites in this study represent a true comparison of the characteristics of the upper and lower portions of the watersheds. However, this may be virtually impossible due to the ephemeral nature of southern California streams. Lastly, in the future, a more complete view of this watershed, or others, could be gained if the triad approach was used at every site and if water chemistry included all the available analyses.

Table 19. Summary of water chemistry, bioassessment, and toxicity testing in the SMB watershed. Water column constituents are listed if they did not meet water quality objectives or may indicate problems. ✓=sampled, did not exceed established objective; NS=not sampled.

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB000	Arroyo Sequit at Fork	DO	✓	NS	✓	NS	✓	Good	NS
404SMB001	Arroyo Sequit Upper	DO	TDS	✓	✓	NS	✓	Fair	No Toxicity
404SMB002	Arroyo Sequit Lower	✓	Chloride, TP, Sulfate, TDS	NS	✓	NS	✓	Poor	NS
404SMB003	San Nicholas Canyon Creek Upper	DO	Boron, Fluoride, TP, Sulfate, TDS	NS	✓	NS	✓	NS	NS
404SMB004	San Nicholas Canyon Creek Lower	DO	Boron, Fluoride, TP, Sulfate, TDS	✓	✓	NS	✓	Fair	No Toxicity
404SMB005	Los Alisos Canyon Creek Upper	DO	TP, TDS	NS	✓	NS	E. coli, Fecal	Poor	NS
404SMB006	Los Alisos Canyon Creek Lower	DO	Sulfate, TDS	NS	✓	NS	✓	Fair	NS

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB007	Lachusa Canyon Creek Upper	✓	Sulfate, TDS	NS	✓	NS	✓	NS	NS
404SMB008	Lachusa Canyon Creek Lower	DO	Chloride, Fluoride, Sulfate, TDS	Manganese	✓	NS	✓	Poor	No Toxicity
404SMB010	Encinal Canyon Creek Lower	✓	TP, Sulfate, TDS	NS	✓	NS	✓	Fair	NS
404SMB011	Trancas Canyon Creek Upper	✓	PO_4, TP, TDS	NS	✓	NS	✓	Good	NS
404SMB012	Trancas Canyon Creek Lower	DO	Chloride, PO_4, TP, Sulfate, TDS	Manganese, Selenium	✓	NS	E. coli, Fecal	NS	Acute Toxicity
404SMB014	Dume Creek/Zuma Canyon Creek Lower	✓	TP, Sulfate, TDS	Manganese, Selenium	✓	NS	E. coli, Fecal	NS	No Toxicity
404SMB016	Ramirez Canyon Creek Lower	✓	TP, Sulfate, TDS	Manganese, Selenium	✓	NS	✓	Poor	Acute Toxicity
404SMB017	Escondido Canyon Creek Upper	DO	Sulfate, TDS	✓	✓	NS	✓	Good	Acute Toxicity

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB018	Escondido Canyon Creek Lower	DO	Chloride, Sulfate, TDS	NS	✓	NS	E. coli, Fecal	NS	NS
404SMB020	Latigo Canyon Creek Upper	DO	Sulfate, TDS	NS	✓	NS	✓	Fair	NS
404SMB21A	Solstice Canyon Creek Upper at waterfall	DO	Sulfate, TDS	NS	Diazinon	NS	✓	Good	NS
404SMB021	Solstice Canyon Creek Middle	✓	Sulfate, TDS	✓	✓	NS	✓	Good	No Toxicity
404SMB022	Solstice Canyon Creek Lower	DO	Sulfate, TDS	NS	✓	✓	✓	Good	NS
404SMB024	Corral Canyon Creek Lower	✓	TP, Sulfate, TDS	NS	✓	NS	✓	Good	NS
404SMB026	Puerco Canyon Creek Lower	DO	Chloride, Fluoride, Sulfate, TDS	Manganese, Selenium	✓	NS	✓	Fair	Acute Toxicity
404SMB028	Marie Canyon Creek Lower	DO	Chloride, TP, Sulfate, TDS	Manganese, Selenium	✓	NS	Fecal	Very Poor	Acute and Chronic Toxicity
404SMB065	Triunfo Creek	DO	TP, Sulfate, TDS	✓	✓	NS	✓	NS	NS

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB063	Las Virgenes Canyon Creek	DO	Chloride, PO_4, TP, Sulfate, TDS	Manganese, Selenium	✓	NS	E. coli, Fecal	NS	NS
404SMB062	Cold Creek	DO	Sulfate, TDS	✓	✓	NS	Fecal	NS	NS
404SMB061	Malibu Creek	✓	PO_4, TP, Sulfate, TDS	✓	✓	NS	✓	NS	No Toxicity
404SMB029	Malibu Lagoon	DO,pH	✓	Copper, Nickel	Chlorpyrifos	NS	✓	Very Poor	NS
404SMB031	Sweetwater Canyon Creek Lower	✓	Boron, Chloride, PO_4, TP, Sulfate, TDS	NS	✓	NS	Fecal	Fair	NS
404SMB032	Carbon Canyon Creek Upper	DO	Sulfate, TDS	NS	✓	NS	✓	Poor	NS
404SMB033	Carbon Canyon Creek Lower	DO	Chloride, Sulfate, TDS	✓	✓	NS	✓	Poor	No Toxicity
404SMB034	Las Flores Canyon Creek Upper	DO	Sulfate, TDS	NS	✓	NS	✓	Poor	NS
404SMB035	Las Flores Canyon Creek Lower	DO	Sulfate, TDS	✓	✓	✓	Fecal	Poor	No Toxicity

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB037	Piedra Gorda Canyon Creek Lower	pH	Chloride, Sulfate, TDS	NS	✓	NS	✓	NS	NS
404SMB038	Pena Canyon Creek Upper	DO	Boron, Fluoride, Sulfate, TDS	NS	✓	NS	✓	Good	NS
404SMB039	Pena Canyon Creek Lower	✓	Boron, Fluoride, Sulfate, TDS	NS	✓	NS	E. coli	NS	NS
404SMB040	Tuna Canyon Creek Upper	DO	Sulfate, TDS	✓	✓	NS	✓	NS	No Toxicity
404SMB041	Tuna Canyon Creek Lower	DO	Sulfate, TDS	NS	✓	NS	✓	Fair	NS
404SMB41A	Tuna Canyon Creek at Eucalyptus Tree Stand	✓	NS	NS	✓	NS	NS	Fair/Good	NS
404SMB075	Topanga Canyon Creek at Greenleaf	✓	Sulfate, TDS	NS	✓	NS	E. coli	Poor	NS
404SMB042	Topanga Canyon Creek Upper	✓	PO_4, TP, Sulfate, TDS	NS	✓	NS	E. coli, Fecal	Poor	NS
404SMB043	Topanga Canyon Creek Middle	DO	Sulfate, TDS	✓	✓	NS	E. coli, Fecal	Fair/Poor	No Toxicity
404SMB044	Topanga Lagoon	✓	✓	✓	✓	NS	✓	NS	NS

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
405SMB45A	Santa Ynez Canyon Creek Upper	✓	PO_4, TP, Sulfate, TDS	NS	✓	NS	E. coli, Fecal	NS	NS
405SMB045	Santa Ynez Canyon Creek Middle	DO	PO_4, TP, Sulfate, TDS	Manganese	diazinon	NS	E. coli, Fecal	Very Poor	No Toxicity
405SMB051	Santa Monica Canyon Creek at confluence between Mandeville and Sullivan	DO,pH	TP, Sulfate, TDS	✓	✓	NS	E. coli, Fecal	NS	No Toxicity
405SMB046	Santa Monica Canyon Channel Upper	pH	Sulfate, TDS	NS	✓	NS	E. coli, Fecal	NS	NS
405SMB047	Santa Monica Canyon Channel Lower	pH	Chloride, TP, Sulfate, TDS	✓	✓	NS	E. coli, Fecal	Very Poor	No Toxicity
405SMB048	Rustic Canyon Creek Upper	DO	Sulfate, TDS	NS	Chlorpyrifos	NS	✓	Fair	NS
405SMB049	Rustic Canyon Creek Lower	✓	Sulfate, TDS	NS	✓	NS	E. coli	Very Poor	NS
405SMB050	Sullivan Canyon Creek Upper	DO	Chloride, Sulfate, TDS	NS	✓	NS	✓	Poor	NS

Site	Site Name	Field Measurements	Conventional water chemistry	Trace metals	Organophosphates (Chlorpyrifos and diazinon tested at minimum)	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
405SMB069	Sullivan Canyon Creek Lower at confluence with SMC and Mandeville	✓	Sulfate, TDS	NS	✓	NS	E. coli, Fecal	NS	NS
405SMB070	Mandeville Canyon Creek Lower at confluence with SMC and Sullivan	DO,pH	Sulfate, TDS	NS	✓	NS	E. coli, Fecal	NS	NS
405SMB052	Ballona Creek at Centinela	DO	✓	Nickel	✓	NS	Enterococcus, Fecal, Total Coliform	Very Poor	Acute Toxicity
405SMB053	Ballona Creek at Sepulveda	pH	PO_4, TP, TDS	NS	✓	NS	E. coli, Fecal	Poor	NS
405SMB054	Ballona Creek at Benedict Canyon	pH	PO_4, TP, Sulfate, TDS	NS	✓	NS	E. coli, Fecal	NS	NS
405SMB055	Ballona Creek at Daylight	pH	NH_3, PO_4, TP	NS	✓	NS	E. coli, Fecal	NS	NS
405SMB059	Unknown into Malaga Cove Upper	DO	Chloride, TP, Sulfate, TDS	Manganese, Selenium	✓	NS	✓	Very Poor	No Toxicity
405SMB060	Unknown into Malaga Cove Lower	✓	Chloride, PO_4, TP, Sulfate, TDS	NS	Chlorpyrifos, Diazinon	NS	E. coli	Very Poor	NS

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APPENDIX A. SAMPLING INFORMATION

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Table 1. Sampling detail for sites in the Santa Monica Bay watershed. ✓s indicate analyses that were conducted.

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB000	Arroyo Sequit at Fork	04/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
		16/Mar/2004									✓	
404SMB001	Arroyo Sequit Upper	04/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
		16/Mar/2004									✓	
404SMB002	Arroyo Sequit Lower	04/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
404SMB003	San Nicholas Canyon Creek Upper	26/Mar/2003	✓	✓				✓		✓		
		01/Mar/2004	✓	✓						✓		
404SMB004	San Nicholas Canyon Creek Lower	04/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		26/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB005	Los Alisos Canyon Creek Upper	05/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
404SMB006	Los Alisos Canyon Creek Lower	04/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB007	Lachusa Canyon Creek Upper	25/Mar/2003	✓	✓				✓		✓		
404SMB008	Lachusa Canyon Creek Lower	05/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB009	Encinal Canyon Creek Upper	Not Sampled-Dry										
404SMB010	Encinal Canyon Creek Lower	04/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB011	Trancas Canyon Creek Upper	05/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB012	Trancas Canyon Creek Lower	05/Mar/2003	✓	✓		✓	✓			✓		✓
		12/Mar/2003	✓	✓		✓	✓					✓
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB014	Dume Creek/Zuma Canyon Creek Lower	05/Mar/2003	✓	✓		✓	✓			✓		✓
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB016	Ramirez Canyon Creek Lower	05/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB017	Escondido Canyon Creek Upper	11/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		25/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB018	Escondido Canyon Creek Lower	04/Mar/2003	✓	✓				✓		✓		
		24/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
404SMB020	Latigo Canyon Creek Upper	11/Mar/2003	✓	✓				✓		✓	✓	
		24/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB21A	Solstice Canyon Creek Upper at waterfall	11/Mar/2003	✓	✓				✓		✓	✓	
		25/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
404SMB021	Solstice Canyon Creek Middle	11/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		25/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB022	Solstice Canyon Creek Lower	11/Mar/2003	✓	✓				✓	✓	✓	✓	
		25/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB024	Corral Canyon Creek Lower	12/Mar/2003	✓	✓				✓		✓	✓	
		25/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB026	Puerco Canyon Creek Lower	03/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		25/Mar/2003			✓							
		01/Mar/2004	✓	✓						✓		
404SMB028	Marie Canyon Creek Lower	03/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		25/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB065	Triunfo Creek	03/Mar/2003	✓	✓		✓		✓		✓		
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB063	Las Virgenes Canyon Creek	03/Mar/2003	✓	✓		✓		✓		✓		
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB062	Cold Creek	03/Mar/2003	✓	✓		✓		✓		✓		
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB061	Malibu Creek	12/Mar/2003	✓	✓		✓	✓			✓		✓
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB029	Malibu Lagoon	12/Mar/2003	✓	✓		✓		✓		✓	✓	
		26/Mar/2003			✓							
		24/Feb/2004	✓	✓						✓		
404SMB031	Sweetwater Canyon Creek Lower	12/Mar/2003	✓	✓				✓		✓	✓	
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB032	Carbon Canyon Creek Upper	11/Mar/2003	✓	✓				✓		✓	✓	
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB033	Carbon Canyon Creek Lower	11/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB034	Las Flores Canyon Creek Upper	11/Mar/2003	✓	✓				✓		✓	✓	
		27/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB035	Las Flores Canyon Creek Lower	11/Mar/2003	✓	✓		✓	✓		✓	✓	✓	✓
		27/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB037	Piedra Gorda Canyon Creek Lower	02/Mar/2004	✓	✓						✓		
404SMB038	Pena Canyon Creek Upper	10/Mar/2003	✓	✓						✓	✓	
		27/Mar/2003			✓							
		02/Mar/2004	✓	✓						✓		
404SMB039	Pena Canyon Creek Lower	25/Mar/2003	✓	✓				✓		✓		
		02/Mar/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB040	Tuna Canyon Creek Upper	10/Mar/2003	✓	✓		✓	✓			✓		✓
		27/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB041	Tuna Canyon Creek Lower	10/Mar/2003	✓	✓				✓		✓	✓	
		27/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
404SMB41A	Tuna Canyon Creek at Eucalyptus Tree Stand	27/Mar/2003	✓					✓			✓	
		17/Mar/2004									✓	
404SMB075	Topanga Canyon Creek at Greenleaf	04/Mar/2003	✓	✓				✓		✓	✓	
		26/Mar/2003			✓							
		23/Feb/2004	✓	✓						✓		
404SMB042	Topanga Canyon Creek Upper	04/Mar/2003	✓	✓				✓		✓	✓	
		27/Mar/2003			✓							
		23/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
404SMB043	Topanga Canyon Creek Middle	03/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		27/Mar/2003			✓							
		23/Feb/2004	✓	✓						✓		
		17/Mar/2004									✓	
404SMB044	Topanga Lagoon	04/Mar/2003	✓	✓		✓		✓		✓		
		26/Mar/2003			✓							
		25/Feb/2004	✓	✓						✓		
405SMB45A	Santa Ynez Canyon Creek Upper	05/Mar/2003	✓	✓				✓		✓		
		26/Mar/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB045	Santa Ynez Canyon Creek Middle	26/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		23/Feb/2004	✓	✓						✓		
405SMB051	Santa Monica Canyon Creek at confluence between Mandeville and Sullivan	10/Mar/2003	✓	✓		✓	✓			✓		✓
		03/Apr/2003			✓							
		25/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
405SMB046	Santa Monica Canyon Channel Upper	05/Mar/2003	✓	✓				✓		✓		
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB047	Santa Monica Canyon Channel Lower	05/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB048	Rustic Canyon Creek Upper	11/Mar/2003	✓	✓				✓		✓	✓	
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB049	Rustic Canyon Creek Lower	05/Mar/2003	✓	✓				✓		✓	✓	
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB050	Sullivan Canyon Creek Upper	10/Mar/2003	✓	✓				✓		✓	✓	
		03/Apr/2003			✓							
		25/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
405SMB069	Sullivan Canyon Creek Lower at confluence with SMC and Mandeville	10/Mar/2003	✓	✓				✓		✓		
		03/Apr/2003			✓							
		25/Feb/2004	✓	✓						✓		
405SMB070	Mandeville Canyon Creek Lower at confluence with SMC and Sullivan	10/Mar/2003	✓	✓				✓		✓		
		03/Apr/2003			✓							
		25/Feb/2004	✓	✓						✓		
405SMB052	Ballona Creek at Centinela	06/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB053	Ballona Creek at Sepulveda	06/Mar/2003	✓	✓				✓		✓	✓	
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB054	Ballona Creek at Benedict Canyon	06/Mar/2003	✓	✓				✓		✓		
		03/Apr/2003			✓							
		23/Feb/2004	✓	✓						✓		

Site	Site Name	Sample Date	Field measurements	Conventional water chemistry	Repeat sampling-chl a and limited anions	Trace metals	Full organophosphate scan (including chlorpyrifos and diazinon)	Chlorpyrifos & Diazinon only	MTBE & BTEX	Bacteriology	Biological assessment	Toxicity testing
405SMB055	Ballona Creek at Daylight	25/Mar/2003	✓	✓				✓		✓		
		23/Feb/2004	✓	✓						✓		
405SMB056	Agua Amarga into Lunada Bay Lower	Not Sampled-Dry										
405SMB059	Unknown into Malaga Cove Upper	12/Mar/2003	✓	✓		✓	✓			✓	✓	✓
		27/Mar/2003			✓							
		23/Feb/2004	✓	✓						✓		
405SMB060	Unknown into Malaga Cove Lower	12/Mar/2003	✓	✓				✓		✓	✓	
		27/Mar/2003			✓							
		23/Feb/2004	✓	✓						✓		

APPENDIX B. ANALYTICAL INFORMATION

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Table 1. Samplewater analytes with laboratory agency, method, method detection limit (MDL), reporting limit (RL), and units. Year is noted if any of the categories differed year to year. If year is not noted, categories were identical between years.

Analyte	Laboratory Agency	Method	MDL	RL	Unit	Year
Alkalinity as $CaCO_3$	DFG-WPCL	QC 10303311A	3	8	mg/L	2004
Alkalinity as $CaCO_3$	DFG-WPCL	QC 10303311A	3	10	mg/L	2003
Aluminum,Dissolved	MPSL-DFG	EPA 1638M	0.1	0.3	µg/L	
Aluminum,Total	MPSL-DFG	EPA 1638M	0.14	0.42	µg/L	2003
Aluminum,Total	MPSL-DFG	EPA 1638M	0.1	0.5	µg/L	2005
Ametryn	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Ammonia as N	DFG-WPCL	EPA 350.3	0.04	0.1	mg/L	2004
Ammonia as N	DFG-WPCL	EPA 350.3	0.05	0.1	mg/L	2003
Arsenic,Dissolved	MPSL-DFG	EPA 1638M	0.1	0.3	µg/L	
Arsenic,Total	MPSL-DFG	EPA 1638M	0.03	0.09	µg/L	2003
Arsenic,Total	MPSL-DFG	EPA 1638M	0.1	0.5	µg/L	2005
Aspon	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Atraton	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Atrazine	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Azinphos ethyl	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Azinphos methyl	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Benzene	DFG-WPCL	EPA 8260	0.04	0.2	µg/L	
Bolstar	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Boron	SFL	SM 4500BB	0.02	0.1	mg/L	
Cadmium,Dissolved	MPSL-DFG	EPA 1638M	0.002	0.05	µg/L	
Cadmium,Total	MPSL-DFG	EPA 1638M	0.003	0.009	µg/L	2003
Cadmium,Total	MPSL-DFG	EPA 1638M	0.01	0.03	µg/L	2005
Carbophenothion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Chlorfenvinphos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Chloride	DFG-WPCL	EPA 300.0	0.2	0.25	mg/L	2003
Chloride	DFG-WPCL	EPA 300.0	0.2	0.35	mg/L	2004
Chlorophyll a	MPSL-DFG	EPA 445.0M	0.045	-88	µg/L	
Chlorpyrifos	DFG-WPCL	EPA 8141A	0.02	0.05	µg/L	2003
Chlorpyrifos	UCD-GC	ELISA SOP 3.3	0.05	0.05	µg/L	2003
Chlorpyrifos methyl	DFG-WPCL	EPA 8141A	0.02	0.05	µg/L	
Chromium,Dissolved	MPSL-DFG	EPA 1638M	0.03	0.09	µg/L	
Chromium,Total	MPSL-DFG	EPA 1638M	0.004	0.012	µg/L	2003
Chromium,Total	MPSL-DFG	EPA 1638M	0.03	0.1	µg/L	2005
Ciodrin(Crotoxyphos)	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Copper,Dissolved	MPSL-DFG	EPA 1638M	0.003	0.01	µg/L	
Copper,Total	MPSL-DFG	EPA 1638M	0.03	0.09	µg/L	2003
Copper,Total	MPSL-DFG	EPA 1638M	0.01	0.03	µg/L	2005
Coumaphos	DFG-WPCL	EPA 8141A	0.04	0.05	µg/L	
Demeton-s	DFG-WPCL	EPA 8141A	0.04	0.05	µg/L	
Diazinon	DFG-WPCL	EPA 8141A	0.005	0.02	µg/L	
Diazinon	UCD-GC	ELISA SOP 3.3	0.03	0.03	µg/L	
Dichlofenthion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Dichlorvos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	

Dicrotophos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Dimethoate	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Dioxathion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Disulfoton	DFG-WPCL	EPA 8141A	0.01	0.05	µg/L	
Ethion	DFG-WPCL	EPA 8141A	0.02	0.05	µg/L	
Ethoprop	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Ethylbenzene	DFG-WPCL	EPA 8260	0.041	0.2	µg/L	
Famphur	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Fenchlorphos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Fenitrothion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Fensulfothion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Fenthion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Fluoride	DFG-WPCL	EPA 340.2	0.01	0.02	mg/L	
Fluoride	DFG-WPCL	SM 4500-F-C	0.02	0.05	mg/L	
Fonofos (Dyfonate)	DFG-WPCL	EPA 8141A	0.02	0.05	µg/L	
Hardness as $CaCO_3$	DFG-WPCL	SM 2340C	1	1	mg/L	
Lead,Dissolved	MPSL-DFG	EPA 1638M	0.002	0.05	µg/L	
Lead,Total	MPSL-DFG	EPA 1638M	0.01	0.03	µg/L	
Leptophos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Malathion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Manganese,Dissolved	MPSL-DFG	EPA 1638M	0.003	0.01	µg/L	
Manganese,Total	MPSL-DFG	EPA 1638M	0.01	0.03	µg/L	
Merphos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Methidathion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Mevinphos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Molinate	DFG-WPCL	EPA 8141A	0.1	0.2	µg/L	
MTBE	DFG-WPCL	EPA 8260	0.07	0.2	µg/L	
Naled(Dibrom)	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Nickel,Dissolved	MPSL-DFG	EPA 1638M	0.006	0.018	µg/L	
Nickel,Total	MPSL-DFG	EPA 1638M	0.03	0.09	µg/L	2003
Nickel,Total	MPSL-DFG	EPA 1638M	0.01	0.05	µg/L	2005
Nitrate as N	DFG-WPCL	QC 10107041B	0.005	0.01	mg/L	
Nitrite as N	DFG-WPCL	QC 10107041B	0.005	0.01	mg/L	
Nitrogen, Total Kjeldahl	DFG-WPCL	QC 10107062E	0.12	0.25	mg/L	2004
Nitrogen, Total Kjeldahl	DFG-WPCL	QC 10107062E	0.12	0.5	mg/L	2003
OrthoPhosphate as P	DFG-WPCL	QC 10115011M	0.005	0.01	mg/L	
Parathion, Ethyl	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Parathion, Methyl	DFG-WPCL	EPA 8141A	0.01	0.05	µg/L	
Phorate	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Phosmet	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Phosphamidon	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Phosphorus, Total as P	DFG-WPCL	EPA 365.3	0.03	0.05	mg/L	2003
Phosphorus, Total as P	DFG-WPCL	QC 10115011D	0.015	0.05	mg/L	2004
Phosphorus, Total as P	DFG-WPCL	QC 10115011D	0.03	0.05	mg/L	2003
Prometon	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Prometryn	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Propazine	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Secbumeton	MPSL-DFG	EPA 619	0.02	0.05	µg/L	

Selenium,Dissolved	MPSL-DFG	EPA 1638M	0.1	0.3	µg/L	
Selenium,Total	MPSL-DFG	EPA 1638M	0.01	0.03	µg/L	2003
Selenium,Total	MPSL-DFG	EPA 1638M	0.1	0.5	µg/L	2005
Silver,Dissolved	MPSL-DFG	EPA 1638M	0.008	0.1	µg/L	
Silver,Total	MPSL-DFG	EPA 1638M	0.03	0.09	µg/L	2003
Silver,Total	MPSL-DFG	EPA 1638M	0.01	0.05	µg/L	2005
Simazine	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Simetryn	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Solids,Total Dissolved	DFG-WPCL	SM 2540C	10	10	mg/L	2004
Solids,Total Dissolved	DFG-WPCL	SM 2540C	10	12	mg/L	2003
Sulfate	DFG-WPCL	EPA 300.0	0.4	1	mg/L	
Sulfate	DFG-WPCL	EPA 300.0	0.5	0.7	mg/L	
Sulfotep	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Terbufos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Terbuthylazine	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Terbutryn	MPSL-DFG	EPA 619	0.02	0.05	µg/L	
Tetrachlorvinphos	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Thiobencarb	DFG-WPCL	EPA 8141A	0.1	0.2	µg/L	
Thionazin	DFG-WPCL	EPA 8141A	0.04	0.05	µg/L	
Tokuthion	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Toluene	DFG-WPCL	EPA 8260	0.07	0.2	µg/L	
Trichlorfon	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Trichloronate	DFG-WPCL	EPA 8141A	0.03	0.05	µg/L	
Xylene-m/p	DFG-WPCL	EPA 8260	0.043	0.2	µg/L	
Xylene-o	DFG-WPCL	EPA 8260	0.048	0.2	µg/L	
Zinc,Dissolved	MPSL-DFG	EPA 1638M	0.02	0.06	µg/L	
Zinc,Total	MPSL-DFG	EPA 1638M	0.02	0.06	µg/L	2003
Zinc,Total	MPSL-DFG	EPA 1638M	0.1	0.3	µg/L	2005