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Surface Water Ambient Monitoring Program (SWAMP) Report on the San Dieguito Hydrologic Unit

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SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP) REPORT ON THE SAN DIEGUITO HYDROLOGIC UNIT

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1. ABSTRACT

In order to assess the ecological health of the San Dieguito Hydrologic Unit (San Diego County, CA), water chemistry, water and sediment toxicity, benthic macroinvertebrate communities, and physical habitat were assessed at multiple sites. Water chemistry and toxicity were assessed under SWAMP in 2003, and bioassessment samples were collected under other programs between 1998 and 2005. Although impacts to human health were also assessed, the goal of this monitoring program was to examine impacts to aquatic life in the watershed. Several indicators showed evidence of widespread impacts to the watershed. For example, all sites (n=5) exceeded aquatic life thresholds for water chemistry constituents (up to eight at one site). The number of exceedances increased along a downstream gradient. Toxicity to *S. capricornutum* was evident at all sites, but toxicity to *C. dubia* was only observed at the mainstem site, and toxicity to *H. azteca* was not observed. Bioassessment samples collected at 9 sites were frequently in poor or very poor condition, with only 3 sites producing samples in fair condition. Mean annual IBI scores ranged from 16.3 at Green Valley Creek to 51.4 at Boden Canyon Creek. Physical habitat was very good at all sites, except for the mainstem site, where the mean physical habitat score was 9.8. At all other sites, the mean physical habitat score was above 15. Multiple stressors, such as pollution of water, are likely responsible for the poor health of the watershed. Despite limitations of this assessment (e.g., uncertain spatial and temporal variability, low levels of replication, non-probabilistic sampling, and lack of thresholds for several indicators), multiple lines of evidence support the conclusion that the ecological condition of the San Dieguito watershed is moderately impacted.

2. INTRODUCTION

The San Dieguito hydrologic unit (HU 905) is in San Diego County and is home to about 150,000 people and represents an important water resource in one of the most arid regions of the nation. Despite strong interest in the surface waters of the San Dieguito HU, a comprehensive assessment of the ecological health of these waters has not been conducted at this time. The purpose of this report is to provide such an analysis using data collected in 2003 under the Surface Waters Ambient Monitoring Program (SWAMP), as well as additional sources, such as data collected by National Pollution Discharge Elimination System (NPDES) permittees. SWAMP monitoring efforts rotated among sets of watersheds, ensuring that each HU is monitored once every 5 years (Table 1). These programs collected data to describe water chemistry, water and sediment toxicity, physical habitat, and macroinvertebrate community structure. By examining these data from multiple sources, this report provides a measure of the ecological integrity of the San Dieguito HU.

Table 1. Watersheds monitored under the SWAMP program.

Year (Fiscal year)	Sample collection	Hydrologic unit	HUC
1 (2000-2001)	2002	Carlsbad	904
	2002	Peñasquitos	906
2 (2001-2002)	2002-2003	San Juan	901
	2003	Otay	910
3 (2002-2003)	2003	Santa Margarita	902
	2003	San Dieguito	905
4 (2003-2004)	2004-2005	San Diego	907
	2004-2005	San Luis Rey	903
5 (2004-2005)	2005-2006	Pueblo San Diego	908
	2005-2006	Sweetwater	909
	2005-2006	Tijuana	911

There are two objectives for this assessment: 1) To evaluate the condition of SWAMP sites; and 2) To evaluate the overall condition of the watershed. Evaluations were based on multiple indicators of ecological integrity, including water chemistry, water and sediment toxicity, biological assessment of benthic macroinvertebrate communities, and physical habitat assessment.

This report is organized into four sections. The first section (Introduction) describes the geographic setting in terms of climate, hydrology, and land use within the watershed. The second section (Methods) describes the approach to data collection, assessment indicators, and data analysis. The third section (Results) contains the results of these analyses. The fourth section (Discussion) integrates evidence of impact from multiple indicators, describes the limitations of this assessment, and summarizes the overall health of the watershed.

2.1 Geographic Setting

The San Dieguito HU encompasses the entire watershed of the San Dieguito River, and is located entirely within San Diego county (Figure 1). The river drains approximately 346 mi^2 and ranges from the Volcan Mountains in the interior to the Pacific Coast.

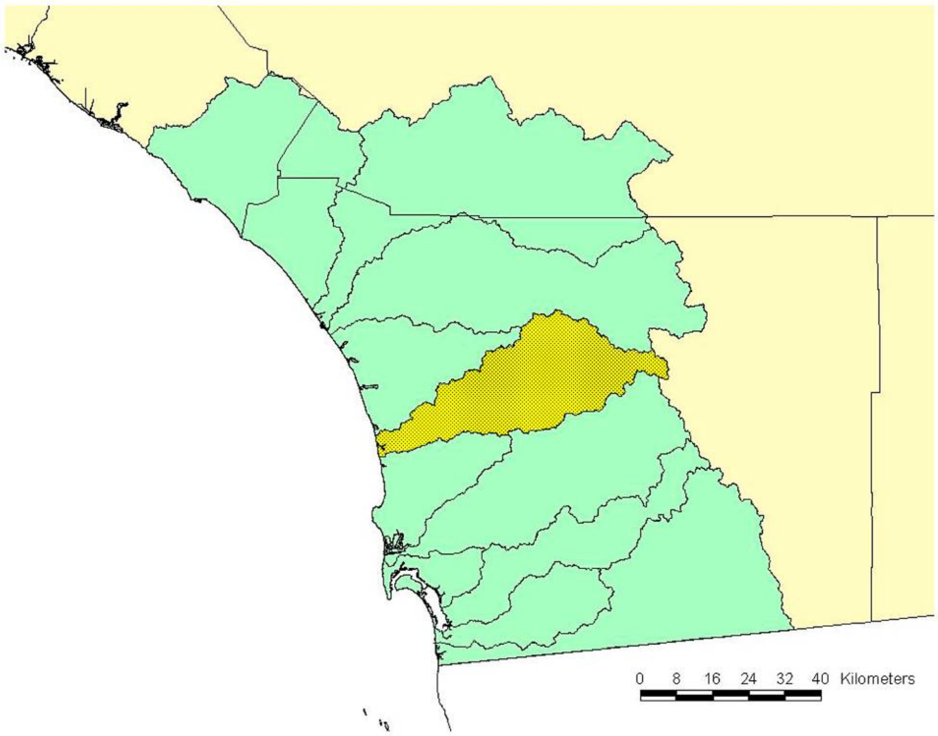


Figure 1. San Diego region (green) includes portions of San Diego, Riverside, and Orange counties. The San Dieguito HU (yellow, shaded) is located entirely within San Diego County.

2.1.1 Climate

The San Dieguito HU, like the entire San Diego region, is characterized by a mediterranean climate, with hot dry summers and cool wet winters. Average monthly rainfalls collected at the Lindberg Airport (SDG) in San Diego, California between 1905 and 2006 show that nearly all rain fell between the months of October and April, with hardly any falling between the months of May and September (California Department of Water Resources 2007). The wettest month was January, with an average rainfall of 2.05"). Average annual rainfall at this station was 10.37". Daily rainfall measured at Julian (high elevation near the eastern end of the watershed), Ramona (in the middle portion of the watershed), and at Miramar (near the coast outside the HU) shows considerable variability in rainfall throughout the HU (National Oceanic and Atmospheric Administration 2007) (Figure 2).

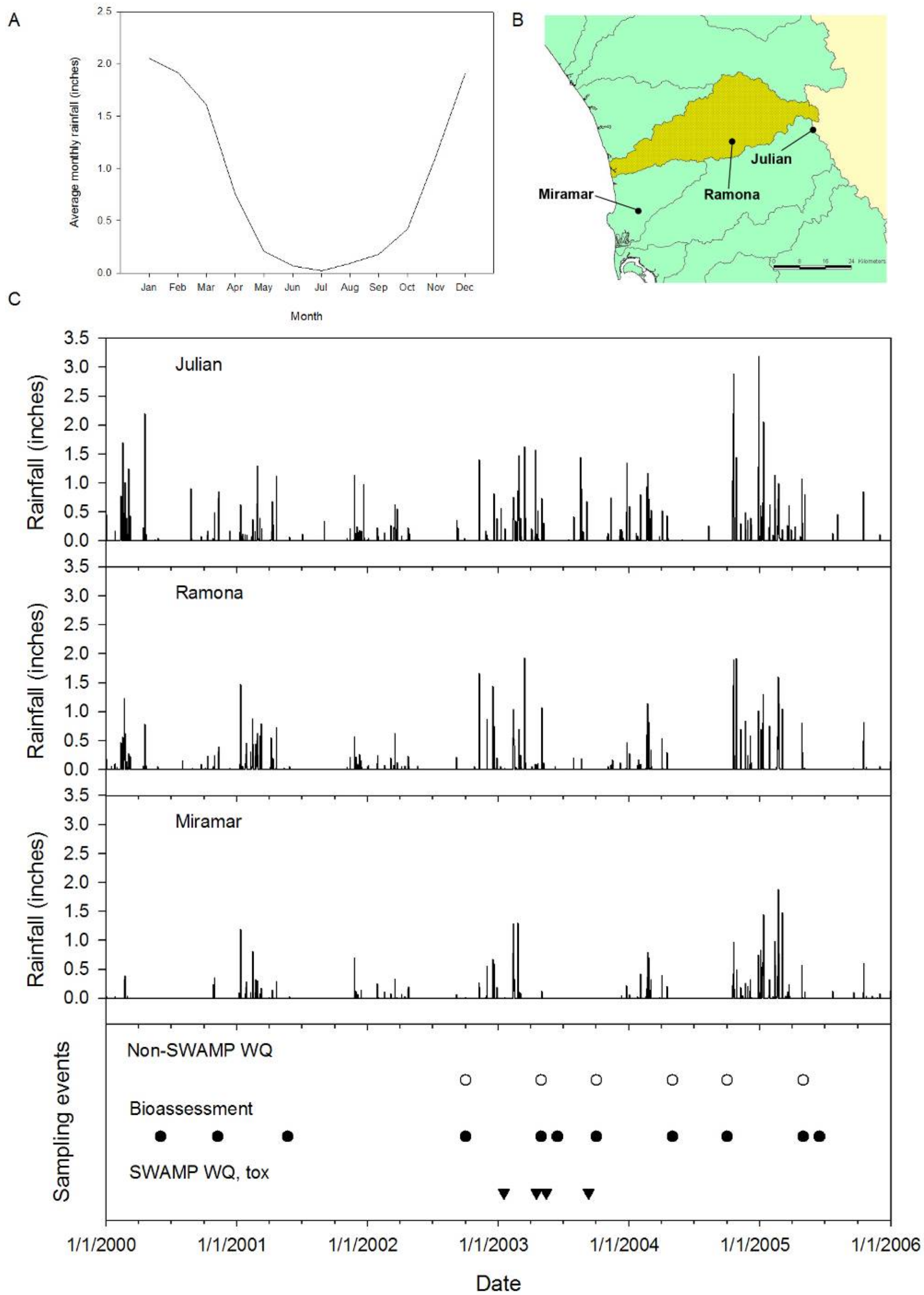


Figure 2. Rainfall and sampling events at three stations in the San Diego region. A. Average precipitation for each month at the Lindberg Station (DWR station code SDG), based on data collected between January 1905 and November 2006. B. Location of the Julian, Ramona, and Miramar gauges. C. Storm events and sampling events in the San Dieguito HU. The top three plots show daily precipitation between 2000 and 2006 at the three stations. The bottom plot shows the timing of sampling events. SWAMP water chemistry and toxicity samples are shown as black triangles. Non-SWAMP water chemistry samples are shown as open circles. Bioassessment samples are shown as closed circles.

2.1.2 Hydrology

The San Dieguito River is the most prominent drainage in the San Dieguito HU. The river traverses over 50 miles and empties into the Pacific Ocean via San Dieguito Lagoon. The Hodges Reservoir, constructed in the early 20th century, is the largest reservoir within the watershed. The smaller San Dieguito Reservoir is downstream of Hodges; all other reservoirs, such as the Sutherland and Poway Reservoirs, are on upstream tributaries. Above Hodges Reservoir, the largest tributary is Santa Ysabel Creek, followed by Santa Maria Creek. Smaller tributaries include Temescal Creek, Kit Carson Creek, Boden Canyon Creek, Black Mountain Creek, and Cloverdale Creek. All of these creeks are south-flowing tributaries that empty into Santa Ysabel Creek or directly into the Hodges Reservoir (Figure 3). Although the dams on the San Dieguito River have altered the ecological condition of the watershed (particularly the stream morphology), this study did not address these impacts and they are not discussed in this report.

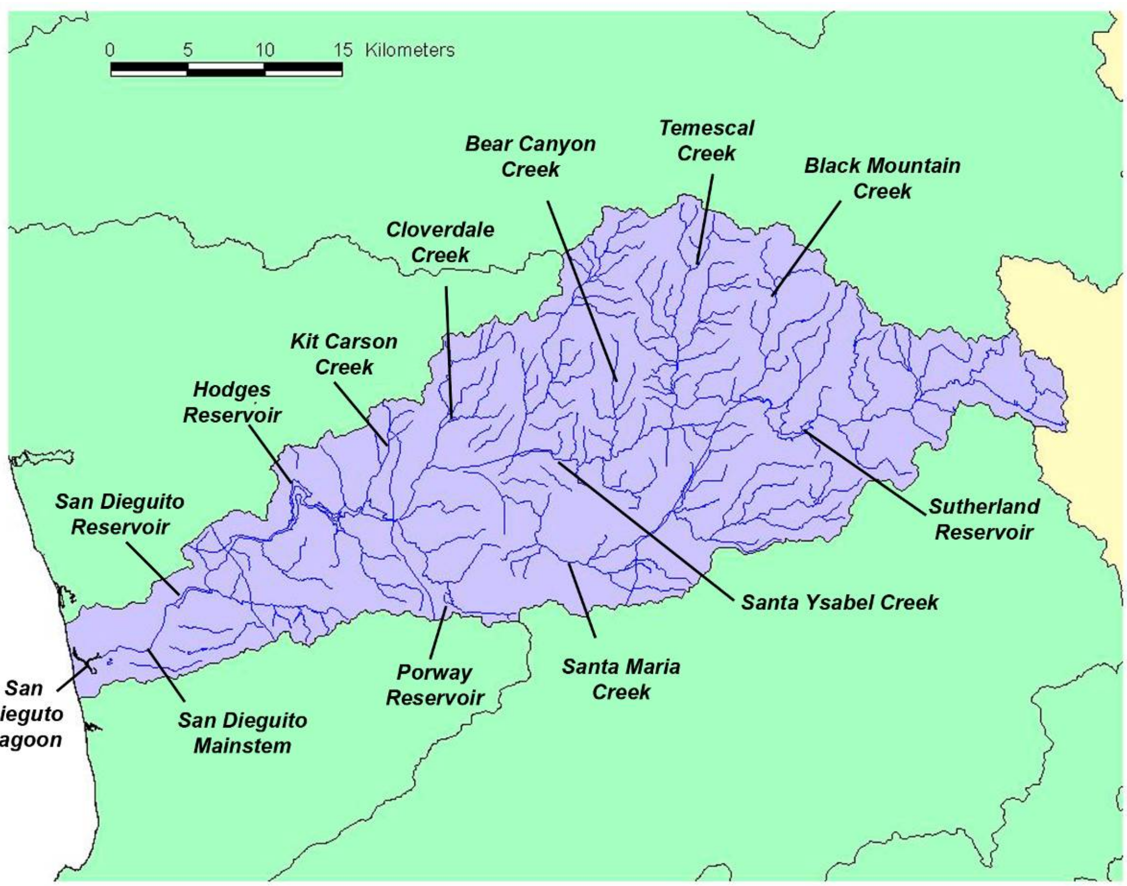


Figure 3. The San Dieguito watershed, including major tributaries (Santa Maria, Santa Ysabel, Cloverdale, Temescal, Boden Canyon, Black Mountain, and Kit Carson Creeks) and reservoirs (San Dieguito, Hodges, Poway, and Sutherland).

2.1.3 Land Use within the Watershed

Several municipalities have jurisdiction over portions of the watershed, although unincorporated parts of San Diego County encompass the largest area of land (79.8% of the watershed). The City of San Diego is the largest municipality within the watershed, covering 12.4%. The cities of Poway (4.1%), Escondido (2.6%), Solana Beach (0.7%) and Del Mar (0.4%) occupy smaller portions. Approximately one-fifth of the watershed has been developed (18%) or is used for agriculture (21%). The remainder (61%) is currently vacant open space, although much of it is zoned for future residential development (Figure 4) (SANDAG 1998).

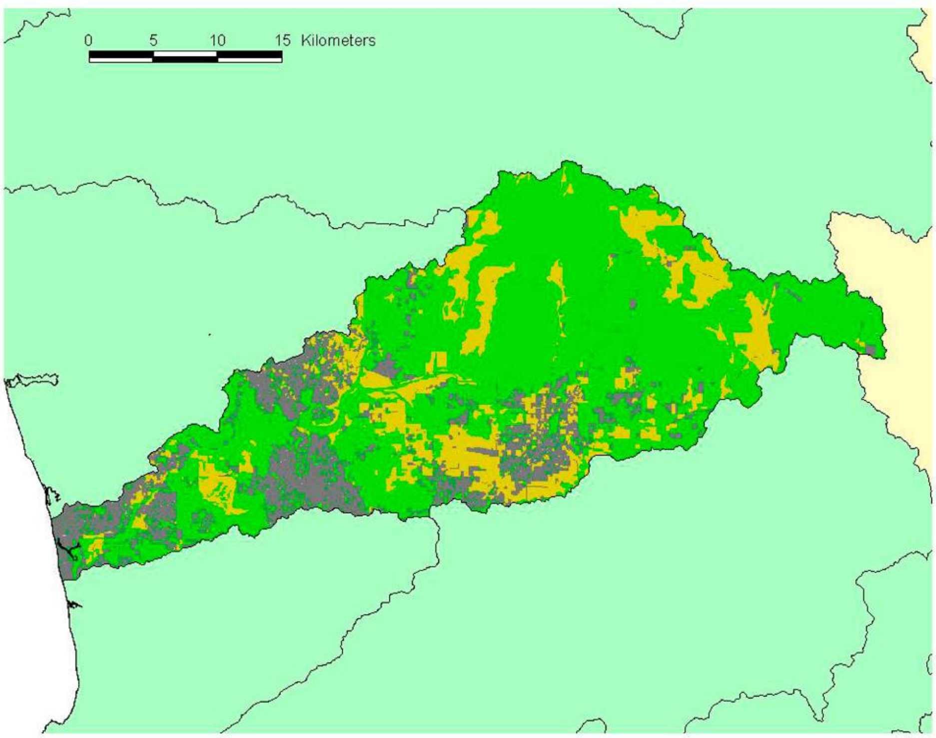


Figure 4. Land use within the San Dieguito HU. Undeveloped open space is shown as green. Agricultural areas are shown as orange. Urban and developed lands are shown as dark gray.

Considerable efforts have gone into protecting open space in the San Dieguito watershed. The San Dieguito River Park is a collection of protected open space along the main river corridor and major tributaries. These parks preserve approximately 100 mi^2 of watershed; major properties within this park include portions of the Cleveland National Forest (managed by the National Forest Service), San Pasqual Valley parks (managed by the City of San Diego), and the Santa Ysabel Ranches (managed by the County of San Diego). Other conservation areas are managed by private non-governmental organizations, such as The Nature Conservancy, the San Dieguito River Valley Conservancy, and the Volcan Mountain Preserve. Other major landowners include Caltrans (which has jurisdiction over freeways and highways), the City of San Diego Water Utilities Department and Olivenhain Water District (which manage lands surrounding the reservoirs), and the Mesa Grande Band of Mission Indians.

2.1.4 Beneficial Uses and Known Impairments in the Watershed

Beneficial uses in the watershed include municipal; agriculture; industrial service and process supply; recreation; special biological habitat; warm and cold freshwater habitat; wildlife habitat; and rare, threatened, or endangered species. Some streams in the San Dieguito HU have been exempted from municipal uses (Appendix I).

Several tributaries in the San Dieguito HU are listed as impaired on the 303(d) list of water quality limited segments, affecting a total of 4.09 stream miles. These streams include the mainstem of the Cloverdale, Felicita, Green Valley, and Kit Carson Creeks. Known stressors include phosphorus, aluminum, chloride, manganese, sulfates, total dissolved solids, and pentachlorophenol (Appendix I).

3. METHODS

This report combines data collected under SWAMP with data from California Department of Fish and Game (CDFG) and NPDES monitoring (Table 2). Five sites of interest were sampled under SWAMP in the San Dieguito HU in 2003 (Table 3; Figure 5). The two sites in Santa Ysabel Creek (905SDSYA4 near Volcan Mountain and 905SDSYA7 further downstream) were designated as reference sites by Regional Board staff. Water chemistry, water and sediment toxicity, and physical habitat was measured at each site. Bioassessment was not included as part of SWAMP monitoring in the San Dieguito HU, but bioassessment data collected by the CDFG Aquatic Bioassessment Laboratory (ABL) and the County of San Diego as part of its NPDES permit (from 2002 to 2005) was used in this report. In addition to bioassessment, conventional water chemistry (e.g., temperature, conductivity, dissolved oxygen) was also measured at sites sampled by San Diego County NPDES. When two non-SWAMP sites were located within 500 meters of each other, they were treated as a single site. This distance was based on published measures of spatial correlation of benthic communities in streams (Gebler 2004). Non-SWAMP samples were collected between 2000 and 2005; in some cases, non-SWAMP sites were very close to SWAMP sites (Table 4; Figure 5).

Table 2. Sources of data used in this report.

Project	Indicators	Years
SWAMP	Water chemistry, toxicity, and fish tissue.	2003
CA Department of Fish and Game	Bioassessment	1998-2000
San Diego County NPDES	Water chemistry, bioassessment	2002-2005

Table 3: SWAMP sampling site locations.

Site		Description	Latitude (°N)	Longitude (°E)
1	905SDCDC4	Cloverdale Creek 4	33.0904	-117.0197
2	905SDGVC2	Green Valley Creek 2	33.0434	-117.0756
3	905SDSDQ9	San Dieguito River 9	32.9788	-117.2351
4	905SDYSA4	Santa Ysabel Creek 4 (reference)	33.1277	-116.6790
5	905SDYSA7	Santa Ysabel Creek 7 (reference)	33.0862	-116.9166

Table 4. Non-SWAMP sampling site locations. W = sites where conventional water chemistry was sampled. B = sites were benthic macroinvertebrates were sampled.

Site	Description	SWAMP site within 500 m	W	B	Sources	Lat (°N)	Long (°E)
1	Boden Canyon Creek (upstream)	None		X	CDFG (905BCN1xx)	33.1053	-116.8931
2	Boden Canyon Creek at Santa Ysabel Creek	None		X	CDFG (905BCN2xx)	33.0925	-116.8958
3	Black Mountain Creek	None		X	CDFG (905BMCCGx)	33.1271	-116.8036
4	Green Valley Creek (reference)	905SDGVC2		X	CDFG (905GVCWBx)	33.0439	-117.0768
			X	X	SD NPDES (GVC-WB)		
5	Kit Carson Creek	None		X	CDFG (905KCCSDx)	33.0676	-117.0661
6	Santa Ysabel Creek at Highway 79	905SDYSA4		X	CDFG (905SYCH79)	33.1217	-116.6775
7	Santa Ysabel Creek (midreach)	905SDYSA7		X	CDFG (905SYCNTx)	33.0861	-116.9167
8	Santa Ysabel Creek (upstream)	None		X	CDFG (905WE0679)	33.1316	-116.6544
9	San Dieguito mainstem below Hodges Reservoir (reference)	None	X	X	SD NPDES (SD-DDH)	33.041	-117.1433

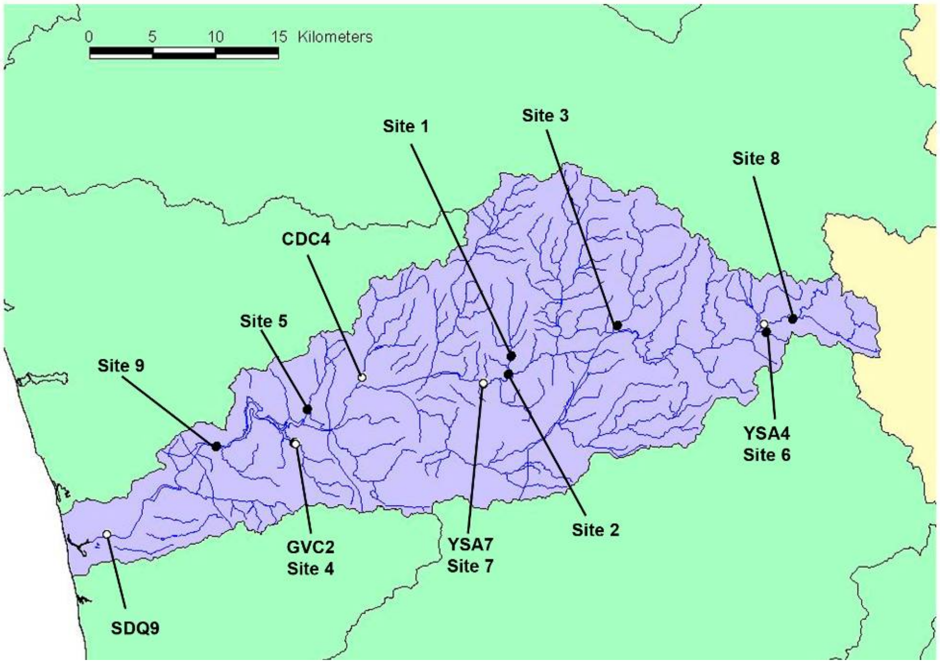


Figure 5. SWAMP (white circles, plain text) and non-SWAMP (black circles, italic text) sampling locations. The SWAMP site prefix designating the hydrologic unit (i.e., 905SD-) has been dropped to improve clarity.

3.1 Indicators

Multiple indicators were used to assess the sites in the San Dieguito HU. Water chemistry, water and sediment toxicity, fish tissues, benthic macroinvertebrate communities, and physical habitat.

3.1.1 Water chemistry

To assess water chemistry, samples were collected at each site. Water chemistry was measured as per the SWAMP Quality Assurance Management Plan (QAMP) (Puckett 2002). Measured indicators included conventional water chemistry (e.g., pH, temperature dissolved oxygen, etc.), inorganics, herbicides, pesticides, polycyclic aromatic hydrocarbons (PAHs), dissolved metals, pesticides, and polychlorinated biphenyls (PCBs). Appendix II contains a complete list of constituents that were measured.

Limited water chemistry was collected under non-SWAMP NPDES monitoring as well. This monitoring was restricted to physical parameters, and followed procedures described in annual reports to California Regional Water Quality Control Board, San Diego Region (e.g., Weston Solutions Inc. 2007).

3.1.2 Toxicity

To evaluate water and sediment toxicity to aquatic life in the San Dieguito HU, toxicity assays were conducted on samples from each site as per the SWAMP QAMP (EPA 1993, Puckett 2002). Water toxicity was evaluated with 7-day exposures on the water flea, *Ceriodaphnia dubia*, and 96-hour exposures to the alga *Selenastrum capricornutum.* Both acute and chronic toxicity to *C. dubia* was measured as decreased survival and fecundity (i.e., eggs per female) relative to controls, respectively. Chronic toxicity to *S. capricornutum* was measured as changes in total cell count relative to controls. Sediment toxicity was evaluated with 10-day exposures on the amphipod *Hyallela azteca.* Both acute and chronic toxicity to *H. azteca* was measured as decreased survival and growth (mg per individual) relative to controls, respectively. Chronic toxicity endpoints (i.e., *C. dubia* fecundity, *H. azteca* growth, and *S. capricornutum* total cell count) were used to develop a summary index of toxicity at each site.

3.1.3 Tissue

Fish tissue was not assessed in the San Dieguito HU.

3.1.4 Bioassessment

To assess the ecological health of the streams in San Dieguito HU, benthic macroinvertebrate samples were collected at 9 sites. Samples were collected using SWAMP-comparable protocols, as per the SWAMP QAMP (Puckett 2002). Three replicate samples were collected from riffles at each site; 300 individuals were sorted and identified from each replicate, creating a total count of 900 individuals per site. Using a Monte Carlo simulation, all samples were reduced to 500 count for calculation of the Southern California Index of Biotic Integrity (IBI; Ode et al. 2005), a composite of seven metrics summed and scaled from 0 (poor condition) to 100 (good condition).

3.1.5 Physical Habitat

Physical habitat was assessed using semi-quantitative observations of 10 components relating to habitat quality, such as embeddedness, bank stability, and width of riparian zone. The assessment protocols are described in The California Stream Bioassessment Procedure (California Department of Fish and Game 2003). Each component was scored on a scale of 0 (highly degraded) to 20 (not degraded). Sites were assessed by the average component score.

3.2 Data Analysis

To evaluate the extent of human impacts to water chemistry in streams in the San Dieguito HU, two frequency-based approaches were employed to detecting impacts. First, established aquatic life and human health thresholds for individual constituents were evaluated for frequency of exceedances. Second, the frequency of detection for anthropogenic constituents (such as PCBs, pesticides, and PAHs) were also evaluated.

To evaluate the overall health of each site and of the watershed, three indicators were selected for analysis: number of constituents exceeding aquatic life water chemistry thresholds; frequency of chronic toxicity to *S. capricornutum, C. dubia,* and *H. azteca*; and mean IBI score. Tissue analysis was excluded because tissue samples were collected at only two sites. Physical habitat assessment was excluded due to lack of agreed-upon thresholds for evaluation of physical habitat scores. These results were plotted on a map of the watershed, indicating the severity and distribution of human impacts.

Although non-SWAMP sources of water chemistry data were used, this report focuses on SWAMP data in order to maintain consistency of sampling methods and parameters measured at each site. Analyses of non-SWAMP water chemistry data is presented separately. In contrast, bioassessment data from multiple sources is analyzed together because of the high compatibility of sampling protocols used in different programs, and because of the limited availability of bioassessment data from a single source. Toxicity, fish tissue, and physical habitat data were only available from SWAMP monitoring.

3.2.1 Thresholds

In order to use the data to assess the health of the watershed, thresholds were established for each indicator: water quality, toxicity, bioassessment, and physical habitat. Exceedance of appropriate thresholds was considered evidence for impact on watershed health.

Water chemistry data from this study were compared to water quality objectives established by state and federal agencies to protect the most sensitive beneficial uses designated in the San Dieguito HU. Therefore, the most stringent water quality objectives (e.g., municipal drinking water, aquatic life, etc.) for the measured constituents were used as thresholds points to evaluate the data.

The Water Quality Control Plan For the San Diego Basin (BP) was the primary source of water chemistry thresholds. Other sources for standards used in water chemistry thresholds included the California Toxics Rule (CTR), the Environmental Protection Agency National Aquatic Life Criteria (EPA), the National Academy of Sciences Health Advisory (NASHA), United States Environmental Protection Agency Integrated Risk Information System (IRIS), and the California Code of Regulations §64449 (CCR). The sources for thresholds used in this study are shown in Table 5.

Table 5. Threshold sources

Indicator	Source	Citation
Water chemistry	Water Quality Control Plan For the San Diego Basin (BP)	California Regional Water Quality Control Board, San Diego Region. 1994. Water quality control plan for the San Diego Region. San Diego, CA. http://www.waterboards.ca.gov/sandiego/programs/basinplan.html
	California Toxics Rule (CTR)	Environmental Protection Agency. 1997. Water quality standards: Establishment of numeric criteria for priority toxic pollutants for the state of California: Proposed Rule. *Federal Register* 62:42159-42208.
	EPA National Aquatic Life Criteria (EPA)	Environmental Protection Agency. 2002. National recommended water quality criteria. EPA-822-R-02-047. Office of Water. Washington, DC.
	National Academy of Sciences Health Advisory (NASHA)	National Academy of Sciences. 1977. Drinking Water and Health. Volume 1. Washington, DC.
	US Environmental Protection Agency Integrated Risk Information System (IRIS)	Environmental Protection Agency (EPA). 2007. Integrated Risk Information System. http://www.epa.gov/iris/index.html. Office of Research and Development. Washington, DC.

Table 5, continued. Threshold sources.

Indicator	Source	Citation
Water chemistry	California Code of Regulations §64449 (CCR)	California Code of Regulations. 2007. Secondary drinking water standards. Register 2007, No. 8. Title 22, division 4, article 16.
Bioassessment	Ode et al. 2005	Ode, P.R., A.C. Rehn and J.T. May. 2005. A quantitative tool for assessing the integrity of southern California coastal streams. *Environmental Management* 35:493-504.

Although human health thresholds (e.g., drinking water standards) were applied to relevant water chemistry data, this report focuses on aquatic life, and does not address the risks to human health in the San Dieguito HU. When multiple thresholds were applicable to a single constituent, the most stringent threshold was used. Water chemistry thresholds for aquatic life and human health standards used in this study are presented in Table 6. Impacts were assessed as the total number of constituents exceeding threshold, as opposed to the fraction of constituents. The fraction of constituents exceeding thresholds is not an ecologically meaningful statistic because the number of constituents below thresholds does not degrade or improve the ecological health of a site.

Table 6. Water chemistry thresholds for aquatic life and human health standards. San Diego Basin Plan (BP); California Toxics Rule (CTR); Environmental Protection Agency National Aquatic Life Standards (EPA); National Academy of Science Health Advisory (NASHA); Environmental Protection Agency Integrated Risk Information System (IRIS); California Code of Regulations §64449 (CCR).

		Aquatic life			Human health		
Category	Constituent	Threshold	Unit	Source	Threshold	Unit	Source
Inorganics	Alkalinity as CaCO3	20000	mg/l	EPA	none	mg/l	none
Inorganics	Ammonia as N	0.025	mg/l	BP	none	mg/l	none
Inorganics	Nitrate + Nitrite as N	10	mg/l	BP	none	mg/l	none
Inorganics	Phosphorus as P,Total	0.1	mg/l	BP	none	mg/l	none
Inorganics	Selenium,Dissolved	5	µg/L	CTR	none	µg/L	none
Inorganics	Sulfate	250	mg/l	BP	none	mg/l	none
Metals	Aluminum,Dissolved	1000	µg/L	BP	none	µg/L	none
Metals	Arsenic,Dissolved	50	µg/L	BP	150	µg/L	CTR
Metals	Cadmium,Dissolved	5	µg/L	BP	2.2	µg/L	CTR
Metals	Chromium,Dissolved	50	µg/L	BP	none	µg/L	none
Metals	Copper,Dissolved	9	µg/L	CTR	1300	µg/L	CTR
Metals	Lead,Dissolved	2.5	µg/L	CTR	none	µg/L	none
Metals	Manganese,Dissolved	0.05	µg/L	none	none	µg/L	none
Metals	Nickel,Dissolved	52	µg/L	CTR	610	µg/L	CTR
Metals	Silver,Dissolved	3.4	µg/L	CTR	none	µg/L	none
Metals	Zinc,Dissolved	120	µg/L	CTR	none	µg/L	none
PAHs	Acenaphthene	none	µg/L	none	1200	µg/L	CTR
PAHs	Anthracene	none	µg/L	none	9600	µg/L	CTR

Table 6, continued Water chemistry thresholds for aquatic life and human health.

		Aquatic life			Human health		
Category	Constituent	Threshold	Unit	Source	Threshold	Unit	Source
PAHs	Benz(a)anthracene	none	µg/L	none	0.0044	µg/L	CTR
PAHs	Benzo(a)pyrene	0.0002	µg/L	BP	0.0044	µg/L	CTR
PAHs	Benzo(b)fluoranthene	none	µg/L	none	0.0044	µg/L	CTR
PAHs	Benzo(k)fluoranthene	none	µg/L	none	0.0044	µg/L	CTR
PAHs	Chrysene	none	µg/L	none	0.0044	µg/L	CTR
PAHs	Dibenz(a,h)anthracene	none	µg/L	none	0.0044	µg/L	CTR
PAHs	Fluoranthene	none	µg/L	none	300	µg/L	CTR
PAHs	Indeno(1,2,3-c,d)pyrene	none	µg/L	none	0.0044	µg/L	CTR
PAHs	Pyrene	none	µg/L	none	960	µg/L	CTR
PCBs	PCBs	0.014	µg/L	CTR	0.00017	µg/L	CTR
Pesticides	Aldrin	3	µg/L	CTR	0.00000013	µg/L	CTR
Pesticides	Ametryn	none	µg/L	none	60	µg/L	EPA
Pesticides	Atrazine	3	µg/L	BP	0.2	µg/L	OEHHA
Pesticides	Azinphos ethyl	none	µg/L	none	87.5	µg/L	NASHA
Pesticides	Azinphos methyl	none	µg/L	none	87.5	µg/L	NASHA
Pesticides	DDD(p,p')	none	µg/L	none	0.00083	µg/L	CTR
Pesticides	DDE(p,p')	none	µg/L	none	0.00059	µg/L	CTR
Pesticides	DDT(p,p')	none	µg/L	none	0.00059	µg/L	CTR
Pesticides	Dieldrin	none	µg/L	none	0.00014	µg/L	CTR
Pesticides	Dimethoate	none	µg/L	none	1.4	µg/L	IRIS
Pesticides	Endosulfan sulfate	none	µg/L	none	110	µg/L	CTR
Pesticides	Endrin	0.002	µg/L	BP	0.76	µg/L	CTR
Pesticides	Endrin Aldehyde	none	µg/L	none	0.76	µg/L	CTR
Pesticides	Endrin Ketone	none	µg/L	none	0.85	µg/L	CTR
Pesticides	Heptachlor	0.0038	µg/L	CTR	0.00021	µg/L	CTR
Pesticides	Heptachlor epoxide	0.0038	µg/L	CTR	0.0001	µg/L	CTR
Pesticides	Hexachlorobenzene	1	µg/L	BP	0.00075	µg/L	CTR
Pesticides	Methoxychlor	40	µg/L	BP	none	µg/L	none
Pesticides	Molinate	20	µg/L	BP	none	µg/L	none
Pesticides	Oxychlordane	none	µg/L	none	0.000023	µg/L	CTR
Pesticides	Simazine	4	µg/L	BP	none	µg/L	none
Pesticides	Thiobencarb	70	µg/L	BP	none	µg/L	none
Physical	Oxygen, Dissolved	5	mg/L	BP	none	mg/L	none
Physical	pH	>6 and <8	pH	BP	none	pH	none
Physical	Specific Conductivity	1600	µS/cm	CCR	none	mS/cm	none
Physical	Turbidity	20	NTU	BP	none	NTU	none

Several anthropogenic water chemistry constituents had no applicable threshold (e.g., malathion), and impacts from these constituents would not be detected using the threshold-based approach described above. To assess the impact from these constituents, the number of organic constituents (i.e., PAHs, PCBs, and pesticides) detected at each site were calculated. The total number of sites at which these compounds were detected was recorded.

Thresholds for toxicity assays were determined by comparing study samples to control samples(non-toxic reference samples). Samples meeting the following criteria were considered toxic: 1) treatment responses significantly different from controls, as determined by a statistical t-test; and 2) endpoints less than 80% of controls. To summarize the toxicity at a site using multiple endpoints, the frequency of toxic samples was calculated. To assign equal weight to all three indicators, a single endpoint of chronic toxicity per indicator was used (*C. dubia*: fecundity, *H. azteca*: growth, and *S. capricornutum*: total cell count).

Thresholds for bioassessment samples were based on a benthic macroinvertebrate index of biological integrity (IBI) that was developed specifically for southern California (Ode et al. 2005). The results of the IBI produces a measure of impairment with scores scaled from 0 to 100, 0 representing the poorest health and 100 the best health. Based on the IBI, samples with scores equal to or below 40 are considered to be in "poor" condition, and samples below 20 are considered to be in "very poor" condition. Therefore, in this study samples with an IBI below 40 were considered impacted.

Thresholds for the evaluation of physical habitat have not been established. Therefore, measurements of physical habitat were excluded from the overall assessment of ecological health. However, because the protocol used to evaluate physical habitat qualitatively assigns scores lower than 10 (out of 20) to streams in poor condition, this number was used to determine sites with severely degraded habitat. Sites with scores below 15 were considered moderately degraded, and those with scores greater than 15 were considered unimpacted (California Department of Fish and Game 2003).

3.2.2 Quality Assurance and Quality Control (QA/QC)

The SWAMP QAMP guided QA/QC for all data collected under SWAMP (See SWAMP QAMP for detailed descriptions of QA/QC protocols, Puckett 2002). QA/QC officers flagged non-compliant physical habitat, water chemistry, toxicity, and tissue results. No chemistry, toxicity, or tissue data were excluded as a result of QA/QC violations. QA/QC procedures for NPDES water chemistry data were similar to those used in SWAMP (Weston Solutions Inc. 2007) Non-SWAMP bioassessment samples were screened for samples containing fewer than 450 individuals. No bioassessment sample was excluded from this analysis.

4. RESULTS

4.1 Water Chemistry

Analysis of water chemistry at SWAMP sites indicated several impacts to water quality from multiple constituents. Across the entire watershed, 14 pesticides and 25 PAHs were detected (Table 7). A very high number of PAHs (i.e., 19) were detected in the uppermost site in Santa Ysabel Creek (905SDYA4), a designated reference site. Fewer PAHs were detected at all other sites, with the mainstem of the San Dieguito (905SDSDQ9) having the second highest number of these constituents detected (i.e., 12). The lowest number of PAHs (i.e., 2) were detected at the downstream Santa Ysabel Creek site (905SDYA7), which was also a designated reference site. PCBs were not detected at any site. One or no pesticides were detected at the two Santa Ysabel sites, but 10 were detected at the mainstem site. Means and standard deviations of all constituents are presented in Appendix II.

Table 7. Number of anthropogenic organic compounds detected at each site in the San Dieguito HU.

	PAHs		PCBs		Pesticides	
Site	Tested	Detected	Tested	Detected	Tested	Detected
905SDCDC4	43	9	50	0	91	5
905SDGVC2	43	9	50	0	91	6
905SDSDQ9	43	12	50	0	91	10
905SDYSA4	43	19	50	0	91	1
905SDYSA7	43	2	50	0	91	0
All sites	43	25	50	0	91	14

Several organic compounds were widespread throughout the watershed (Table 8). For example, the PAHs C2-Dibenzothiophene and C1-Phenanthrene/Anthracene were detected at every site. In fact, approximately two-thirds (31 out of 43) of the PAHs analyzed were detected at one or more sites. In contrast, pesticides were less widespread. Only Diazinon and Oxadiazon were detected at the majority of sites, and more than two-thirds 63 out of 91) were never detected at any site. Pesticides were not frequently detected at reference sites. No PCBs were detected at any site.

Table 8. Frequency of detection of anthropogenic organic compounds in the San Dieguito HU. Constituent not detected at any site (--).

Category	Constituent	Tested	Detected	Frequency
PAHs	Acenaphthene	5	--	--
PAHs	Acenaphthylene	5	--	--
PAHs	Anthracene	5	--	--
PAHs	Benz(a)anthracene	5	--	--
PAHs	Benzo(a)pyrene	5	1	0.2
PAHs	Benzo(b)fluoranthene	5	4	0.8
PAHs	Benzo(e)pyrene	5	1	0.2
PAHs	Benzo(g,h,i)perylene	5	1	0.2
PAHs	Benzo(k)fluoranthene	5	--	--
PAHs	Biphenyl	5	--	--
PAHs	Chrysene	5	--	--
PAHs	Chrysenes, C1 -	5	--	--
PAHs	Chrysenes, C2 -	5	1	0.2
PAHs	Chrysenes, C3 -	5	1	0.2
PAHs	Dibenz(a,h)anthracene	5	--	--
PAHs	Dibenzothiophene	5	--	--
PAHs	Dibenzothiophenes, C1 -	5	4	0.8
PAHs	Dibenzothiophenes, C2 -	5	5	1.0
PAHs	Dibenzothiophenes, C3 -	5	3	0.6
PAHs	Dimethylnaphthalene, 2,6-	5	1	0.2
PAHs	Fluoranthene	5	2	0.4

Table 8, continued, Frequency of detection of anthropogenic organic constituents.

Category	Constituent	Tested	Detected	Frequency
PAHs	Fluoranthene/Pyrenes, C1 -	5	1	0.2
PAHs	Fluorene	5	--	--
PAHs	Fluorenes, C1 -	5	2	0.4
PAHs	Fluorenes, C2 -	5	--	--
PAHs	Fluorenes, C3 -	5	3	0.6
PAHs	Indeno(1,2,3-c,d)pyrene	5	1	0.2
PAHs	Methylnaphthalene, 1-	5	--	--
PAHs	Methylnaphthalene, 2-	5	--	--
PAHs	Methylphenanthrene, 1-	5	1	0.2
PAHs	Naphthalene	5	--	--
PAHs	Naphthalenes, C1 -	5	--	--
PAHs	Naphthalenes, C2 -	5	1	0.2
PAHs	Naphthalenes, C3 -	5	2	0.4
PAHs	Naphthalenes, C4 -	5	2	0.4
PAHs	Perylene	5	--	--
PAHs	Phenanthrene	5	1	0.2
PAHs	Phenanthrene/Anthracene, C1 -	5	5	1.0
PAHs	Phenanthrene/Anthracene, C2 -	5	3	0.6
PAHs	Phenanthrene/Anthracene, C3 -	5	2	0.4
PAHs	Phenanthrene/Anthracene, C4 -	5	1	0.2
PAHs	Pyrene	5	2	0.4
PAHs	Trimethylnaphthalene, 2,3,5-	5	--	--
PCBs	PCBs (49 tested)	5	--	--
Pesticides	Aldrin	5	--	--
Pesticides	Ametryn	5	--	--
Pesticides	Aspon	5	--	--
Pesticides	Atraton	5	--	--
Pesticides	Atrazine	5	--	--
Pesticides	Azinphos ethyl	5	--	--
Pesticides	Azinphos methyl	5	--	--
Pesticides	Bolstar	5	--	--
Pesticides	Carbophenothion	5	--	--
Pesticides	Chlordane, cis-	5	1	0.2
Pesticides	Chlordane, trans-	5	--	--
Pesticides	Chlordene, alpha-	5	--	--
Pesticides	Chlordene, gamma-	5	--	--
Pesticides	Chlorfenvinphos	5	--	--
Pesticides	Chlorpyrifos	5	--	--
Pesticides	Chlorpyrifos methyl	5	--	--
Pesticides	Ciodrin	5	--	--
Pesticides	Coumaphos	5	--	--
Pesticides	Dacthal	5	--	--
Pesticides	DDD(o,p')	5	--	--
Pesticides	DDD(p,p')	5	--	--
Pesticides	DDE(o,p')	5	--	--
Pesticides	DDE(p,p')	5	2	0.4
Pesticides	DDMU(p,p')	5	--	--
Pesticides	DDT(o,p')	5	--	--
Pesticides	DDT(p,p')	5	1	0.2

Table 8, continued, Frequency of detection of anthropogenic organic constituents.

Category	Constituent	Tested	Detected	Frequency
Pesticides	Demeton-s	5	--	--
Pesticides	Diazinon	5	3	0.6
Pesticides	Dichlofenthion	5	--	--
Pesticides	Dichlorvos	5	--	--
Pesticides	Dicrotophos	5	--	--
Pesticides	Dieldrin	5	2	0.4
Pesticides	Dimethoate	5	--	--
Pesticides	Dioxathion	5	--	--
Pesticides	Disulfoton	5	--	--
Pesticides	Endosulfan I	5	1	0.2
Pesticides	Endosulfan II	5	--	--
Pesticides	Endosulfan sulfate	5	1	0.2
Pesticides	Endrin	5	--	--
Pesticides	Endrin Aldehyde	5	--	--
Pesticides	Endrin Ketone	5	--	--
Pesticides	Ethion	5	--	--
Pesticides	Ethoprop	5	--	--
Pesticides	Famphur	5	--	--
Pesticides	Fenchlorphos	5	--	--
Pesticides	Fenitrothion	5	--	--
Pesticides	Fensulfothion	5	--	--
Pesticides	Fenthion	5	--	--
Pesticides	Fonofos	5	1	0.2
Pesticides	HCH, alpha	5	--	--
Pesticides	HCH, beta	5	--	--
Pesticides	HCH, delta	5	1	0.2
Pesticides	HCH, gamma	5	1	0.2
Pesticides	Heptachlor	5	--	--
Pesticides	Heptachlor epoxide	5	2	0.4
Pesticides	Hexachlorobenzene	5	--	--
Pesticides	Leptophos	5	--	--
Pesticides	Malathion	5	--	--
Pesticides	Merphos	5	--	--
Pesticides	Methidathion	5	--	--
Pesticides	Methoxychlor	5	--	--
Pesticides	Mevinphos	5	--	--
Pesticides	Mirex	5	1	0.2
Pesticides	Molinate	5	--	--
Pesticides	Naled	5	--	--
Pesticides	Nonachlor, cis-	5	--	--
Pesticides	Nonachlor, trans-	5	--	--
Pesticides	Oxadiazon	5	3	0.6
Pesticides	Oxychlordane	5	--	--
Pesticides	Parathion, Ethyl	5	--	--
Pesticides	Parathion, Methyl	5	--	--
Pesticides	Phorate	5	--	--
Pesticides	Phosmet	5	--	--
Pesticides	Phosphamidon	5	--	--
Pesticides	Prometon	5	--	--

Table 8, continued, Frequency of detection of anthropogenic organic constituents.

Category	Constituent	Tested	Detected	Frequency
Pesticides	Prometryn	5	--	--
Pesticides	Propazine	5	--	--
Pesticides	Secbumeton	5	--	--
Pesticides	Simazine	5	--	--
Pesticides	Simetryn	5	--	--
Pesticides	Sulfotep	5	--	--
Pesticides	Tedion	5	2	0.4
Pesticides	Terbufos	5	--	--
Pesticides	Terbuthylazine	5	--	--
Pesticides	Terbutryn	5	--	--
Pesticides	Tetrachlorvinphos	5	--	--
Pesticides	Thiobencarb	5	--	--
Pesticides	Thionazin	5	--	--
Pesticides	Tokuthion	5	--	--
Pesticides	Trichlorfon	5	--	--
Pesticides	Trichloronate	5	--	--

Comparison with applicable aquatic life and human health thresholds support the conclusion that water quality is impacted by these constituents at certain sites (Table 9; Figure 6, 7). Ammonia-N, total phosphorus, sulfate, manganese, pH, and specific conductivity frequently exceeded aquatic life thresholds at non-reference sites. In addition, the mainstem of the San Dieguito river exceeded aquatic life thresholds for selenium and turbidity. In contrast, reference sites had fewer exceedances, although ammonia-N, manganese, and pH exceeded thresholds on at least one sampling date at one or both sites. The PAH benzo(a) pyrene exceeded aquatic life thresholds on one sampling date at the upstream reference site.

Table 9. Frequency of water chemistry threshold exceedances. A) Frequency of aquatic life threshold exceedances at SWAMP sites. B) Frequency of human health threshold exceedances at SWAMP sites. C) Frequency of aquatic life threshold exceedances at non-SWAMP sites. No human health thresholds applied to constituents measured at non-SWAMP sites. Freq = Frequency of samples exceeding applicable thresholds at each site. AL = Aquatic life. HH = Human health. -- = Constituent never exceeded threshold. NA = No applicable thresholds at that site. Empty cells indicate that the constituent was not measured at the site.

A. Aquatic life thresholds at SWAMP sites.

				905SDCDC4		905SDGVC2		905SDSDQ9	
Category	Constituent	Threshold	Source	Freq	n	Freq	n	Freq	n
Inorganics	Alkalinity as CaCO3	20000 mg/l	EPA	--	3	--	4	--	4
Inorganics	Ammonia as N	0.025 mg/l	BP	1.00	3	0.75	4	0.50	4
Inorganics	Nitrate + Nitrite as N	10 mg/l	BP	--	3	--	4	--	4
Inorganics	Phosphorus as P,Total	0.1 mg/l	BP	1.00	3	1.00	4	1.00	4
Inorganics	Selenium,Dissolved	5 µg/l	CTR	--	3	--	4	0.75	4
Inorganics	Sulfate	HUC mg/l	BP	1.00	3	0.75	4	1.00	4
Metals	Aluminum,Dissolved	1000 µg/l	BP	--	3	--	4	--	4
Metals	Arsenic,Dissolved	50 µg/l	BP	--	3	--	4	--	4
Metals	Cadmium,Dissolved	5 µg/l	BP	--	3	--	4	--	4
Metals	Chromium,Dissolved	50 µg/l	BP	--	3	--	4	--	4

Table 9, continued. Frequency of water chemistry threshold exceedances.
A, continued. Aquatic life thresholds at SWAMP sites.

				905SDCDC4		905SDGVC2		905SDSDQ9		905SDYSA4		905SDYSA7	
Category	Constituent	Threshold	Source	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Metals	Copper,Dissolved	9 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Lead,Dissolved	2.5 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Manganese,Dissolved	0.05 ug/l*	BP	1.00	3	1.00	4	1.00	4	--	3	0.67	3
Metals	Nickel,Dissolved	52 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Silver,Dissolved	3.4 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Zinc,Dissolved	120 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Benzo(a)pyrene	0.0002 µg/l	BP	--	3	--	4	--	4	0.33	3	--	3
PCBs	PCBs	0.014 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Aldrin	3 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Atrazine	3 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Pesticides	Endrin	0.002 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Pesticides	Heptachlor	0.0038 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Heptachlor epoxide	0.0038 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Hexachlorobenzene	1 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Pesticides	Methoxychlor	40 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Pesticides	Molinate	20 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Pesticides	Simazine	4 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Pesticides	Thiobencarb	70 µg/l	BP	--	3	--	4	--	4	--	3	--	3
Physical	pH	>6 or <8 pH units	BP	0.33	3	0.25	4	0.50	4	1.00	3	0.67	3
Physical	Specific conductivity	1.6 mS/cm	CCR	0.67	3	0.75	4	1.00	4	--	3	--	3
Physical	Turbidity	20 NTU	BP	--	3	--	4	0.25	4	--	3	--	3

Table 9, continued. Frequency of water chemistry threshold exceedances.
B, Human health thresholds at SWAMP sites.

				905SDCDC4		905SDGVC2		905SDSDQ9		905SDYSA4		905SDYSA7	
Category	Constituent	Threshold	Source	Freq	n	Freq	n	Freq	n	Freq	n	Freq	n
Metals	Arsenic,Dissolved	150 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Cadmium,Dissolved	2.2 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Copper,Dissolved	1300 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Metals	Nickel,Dissolved	610 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Acenaphthene	1200 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Anthracene	9600 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Benz(a)anthracene	0.0044 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Benzo(a)pyrene	0.0044 µg/l	CTR	--	3	--	4	--	4	0.33	3	--	3
PAHs	Benzo(b)fluoranthene	0.0044 µg/l	CTR	0.33	3	0.25	4	0.25	4	0.33	3	--	3
PAHs	Benzo(k)fluoranthene	0.0044 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Chrysene	0.0044 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Dibenz(a,h)anthracene	0.0044 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Fluoranthene	300 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PAHs	Indeno(1,2,3-c,d)pyrene	0.0044 µg/l	CTR	--	3	--	4	--	4	0.33	3	--	3
PAHs	Pyrene	960 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
PCBs	PCBs	0.00017 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Aldrin	0.00000013 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Ametryn	60 µg/l	EPA	--	3	--	4	--	4	--	3	--	3
Pesticides	Atrazine	0.2 µg/l	OEHHA	--	3	--	4	--	4	--	3	--	3
Pesticides	Azinphos ethyl	87.5 µg/l	NASHA	--	3	--	4	--	4	--	3	--	3
Pesticides	Azinphos methyl	87.5 µg/l	NASHA	--	3	--	4	--	4	--	3	--	3
Pesticides	DDD(p,p')	0.00083 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	DDE(p,p')	0.00059 µg/l	CTR	--	3	--	4	0.25	4	0.33	3	--	3
Pesticides	DDT(p,p')	0.00059 µg/l	CTR	--	3	--	4	0.25	4	--	3	--	3
Pesticides	Dieldrin	0.00014 µg/l	CTR	0.33	3	0.25	4	--	4	--	3	--	3
Pesticides	Dimethoate	1.4 µg/l	IRIS	--	3	--	4	--	4	--	3	--	3
Pesticides	Endosulfan sulfate	110 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Endrin	0.76 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Endrin Aldehyde	0.76 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Endrin Ketone	0.85 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Heptachlor	0.00021 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Heptachlor epoxide	0.0001 µg/l	CTR	0.33	3	--	4	0.25	4	--	3	--	3
Pesticides	Hexachlorobenzene	0.00075 µg/l	CTR	--	3	--	4	--	4	--	3	--	3
Pesticides	Oxychlordane	0.000023 µg/l	CTR	--	3	--	4	--	4	--	3	--	3

Table 9, continued. Frequency of water chemistry threshold exceedances. C. Aquatic life thresholds at non-SWAMP sites.

				Site 4		Site 9	
Constituent	Units	Threshold	Source	Frequency	n	Frequency	n
Dissolved Oxygen	mg/L	5	BP	0.17	6	--	6
pH	pH units	6 or 8	BP	0.17	6	0.17	6
Specific Conductance	mS/cm	1.6	CCR	1	6	0.83	6
Turbidity	NTU	20	BP	--	1	--	1

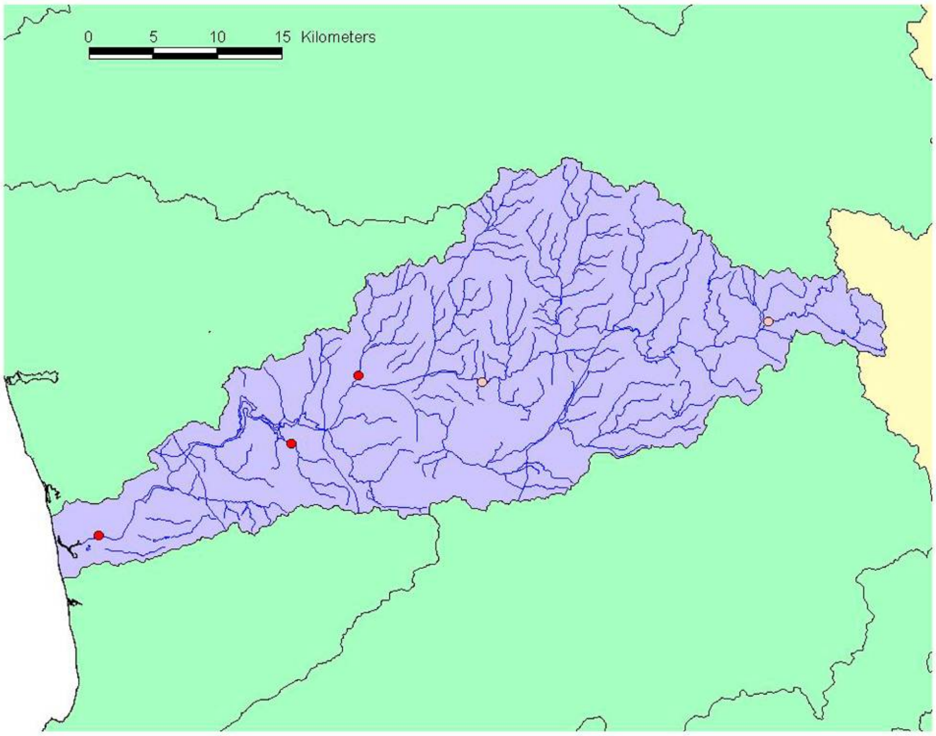


Figure 6. Map of aquatic life threshold exceedances for water chemistry at SWAMP sites. White circles indicate sites with one or fewer exceedances (this value did not occur in this watershed). Pink circles indicate sites with 2 to 5 exceedances. Red circles indicate sites with 6 to 9 exceedances. At all sites, 31 constituents were assessed

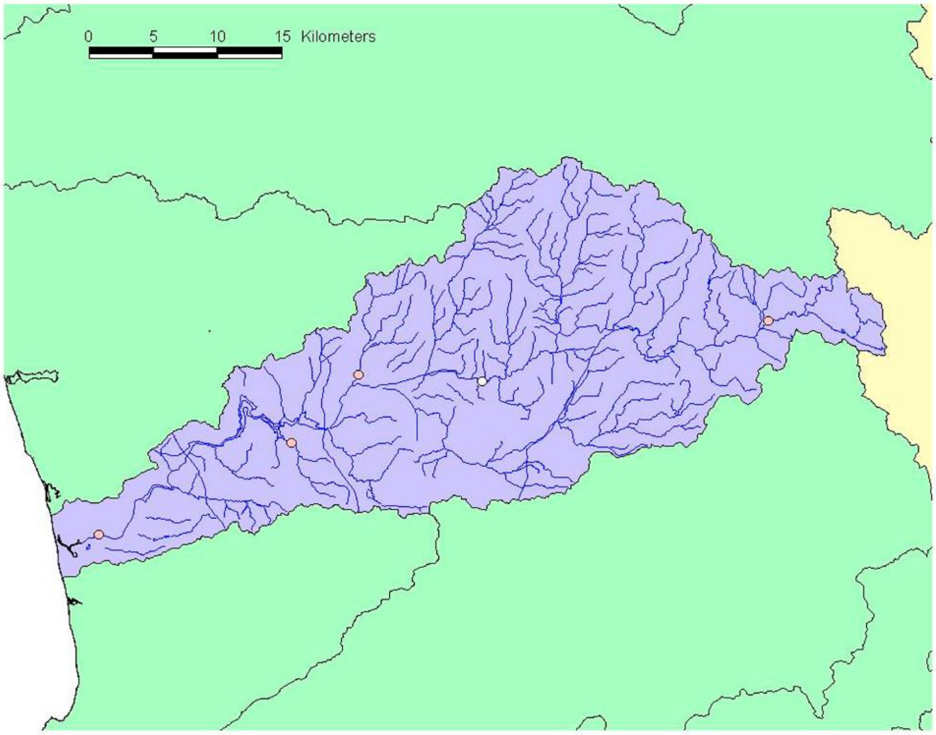


Figure 7. Map of human health exceedances for water chemistry at SWAMP sites. White circles indicate sites with one or fewer exceedances. Pink circles indicate sites with 2 to 5 exceedances. Red circles indicate sites with 6 to 9 exceedances (this value did not occur in this watershed). At all sites, 34 constituents were assessed.

All sites in the San Dieguito HU failed to achieve certain aquatic life and human health thresholds (Table 10, 11; Figure 6, 7). The mainstem had the highest number of exceedances of aquatic life thresholds (i.e., 8), and the reference sites had the lowest number of exceedances (i.e., 3). Sites in the middle portions of the watershed (i.e., Cloverdale Creek and Green Valley Creek) both had an intermediate number of exceedances (i.e., 6), suggesting that water quality deteriorates along a gradient from the headwaters to the mouth of the San Dieguito River (Table 11).

Table 10. Frequency of SWAMP sites with aquatic life and human health threshold exceedances of each constituent. Number of SWAMP sites included in evaluation (n). Constituent never exceeded threshold at any site (--). No applicable threshold for constituent (NA).

Category	Constituent	n	Aquatic life	Human health
Inorganics	Alkalinity as CaCO3	5	--	NA
Inorganics	Ammonia as N	5	1.0	NA
Inorganics	Nitrate + Nitrite as N	5	--	NA
Inorganics	Phosphorus as P,Total	5	0.6	NA
Inorganics	Selenium,Dissolved	5	0.2	NA
Inorganics	Sulfate	5	0.6	NA
Metals	Aluminum,Dissolved	5	--	NA
Metals	Arsenic,Dissolved	5	--	--
Metals	Cadmium,Dissolved	5	--	--

Table 10, continued. Frequency of SWAMP sites with threshold exceedances.

Category	Constituent	n	Aquatic life	Human health
Metals	Chromium,Dissolved	5	--	NA
Metals	Copper,Dissolved	5	--	--
Metals	Lead,Dissolved	5	--	NA
Metals	Manganese,Dissolved	5	0.8	NA
Metals	Nickel,Dissolved	5	--	--
Metals	Silver,Dissolved	5	--	NA
Metals	Zinc,Dissolved	5	--	NA
PAHs	Acenaphthene	5	NA	--
PAHs	Anthracene	5	NA	--
PAHs	Benz(a)anthracene	5	NA	--
PAHs	Benzo(a)pyrene	5	0.2	0.2
PAHs	Benzo(b)fluoranthene	5	NA	0.8
PAHs	Benzo(k)fluoranthene	5	NA	--
PAHs	Chrysene	5	NA	--
PAHs	Dibenz(a,h)anthracene	5	NA	--
PAHs	Fluoranthene	5	NA	--
PAHs	Indeno(1,2,3-c,d)pyrene	5	NA	0.2
PAHs	Pyrene	5	NA	--
PCBs	PCBs	5	--	--
Pesticides	Aldrin	5	--	--
Pesticides	Ametryn	5	NA	--
Pesticides	Atrazine	5	--	--
Pesticides	Azinphos ethyl	5	NA	--
Pesticides	Azinphos methyl	5	NA	--
Pesticides	DDD(p,p')	5	NA	--
Pesticides	DDE(p,p')	5	NA	0.4
Pesticides	DDT(p,p')	5	NA	0.2
Pesticides	Dieldrin	5	NA	0.4
Pesticides	Dimethoate	5	NA	--
Pesticides	Endosulfan sulfate	5	NA	--
Pesticides	Endrin	5	--	--
Pesticides	Endrin Aldehyde	5	NA	--
Pesticides	Endrin Ketone	5	NA	--
Pesticides	Heptachlor	5	--	--
Pesticides	Heptachlor epoxide	5	--	0.4
Pesticides	Hexachlorobenzene	5	--	--
Pesticides	Methoxychlor	5	--	NA
Pesticides	Molinate	5	--	NA
Pesticides	Oxychlordane	5	NA	--
Pesticides	Simazine	5	--	NA
Pesticides	Thiobencarb	5	--	NA
Physical	pH	5	1.0	NA
Physical	SpecificConductivity	5	0.6	NA
Physical	Turbidity	5	0.2	NA

Table 11. Number of constituents exceeding thresholds at each SWAMP site.

Site	Aquatic life	Human health
905SDCDC4	6	3
905SDGVC2	6	2
905SDSDQ9	8	4
905SDYSA4	3	4
905SDYSA7	3	0

Results from NPDES water chemistry monitoring at 2 sites were similar to results from SWAMP (Table 9C). For example, specific conductivity exceeded aquatic life thresholds at nearly every site, and at almost every sampling date. However, pH rarely exceeded thresholds in NPDES monitoring, although SWAMP monitoring found this constituent to be elevated above aquatic life thresholds at all sites on at least one sampling date. NPDES monitoring did not suggest that turbidity and dissolved oxygen were frequently within acceptable thresholds.

4.2 Toxicity

Toxicity was evident at all sites within the watershed, although results varied among sites and indicators (Table 12; Appendix III). Toxicity was most severe at the mainstem of the San Dieguito river, where toxicity to *S. capricornutum* and *C. dubia* were frequently observed. Across the entire watershed, 41% of samples were toxic to at least one indicator of chronic toxicity (Figure 8).

Table 12. Frequency of toxicity detected for each endpoint and at each site. A sample was considered toxic if the percent control of the endpoint was less than 80% of reference samples, and the difference was considered significant at 0.05. Number of samples where the endpoint was evaluated (n). Toxicity not detected in any sample (--). Toxicity not tested (n.t.).

	C. dubia				*H. azteca*				*S. capricornutum*		Multiple indicators	
Site	Survival	n	Young/Female	n	Survival	n	Growth	n	Total cell count	n	Frequency	n
905SDCDC4	--	3	--	3	--	1	--	1	1	3	0.43	7
905SDGVC2	--	4	--	4	--	2	--	2	0.75	4	0.3	10
905SDSDQ9	0.33	3	0.67	3	--	2	--	1	1	4	0.75	8
905SDYSA4	--	3	--	3	--	3	--	3	0.67	3	0.22	9
905SDYSA7	--	3	--	3	n.t.	0	n.t.	0	1	3	0.5	6
All sites	0.06	16	0.13	16	--	8	--	7	0.88	17	0.41	39

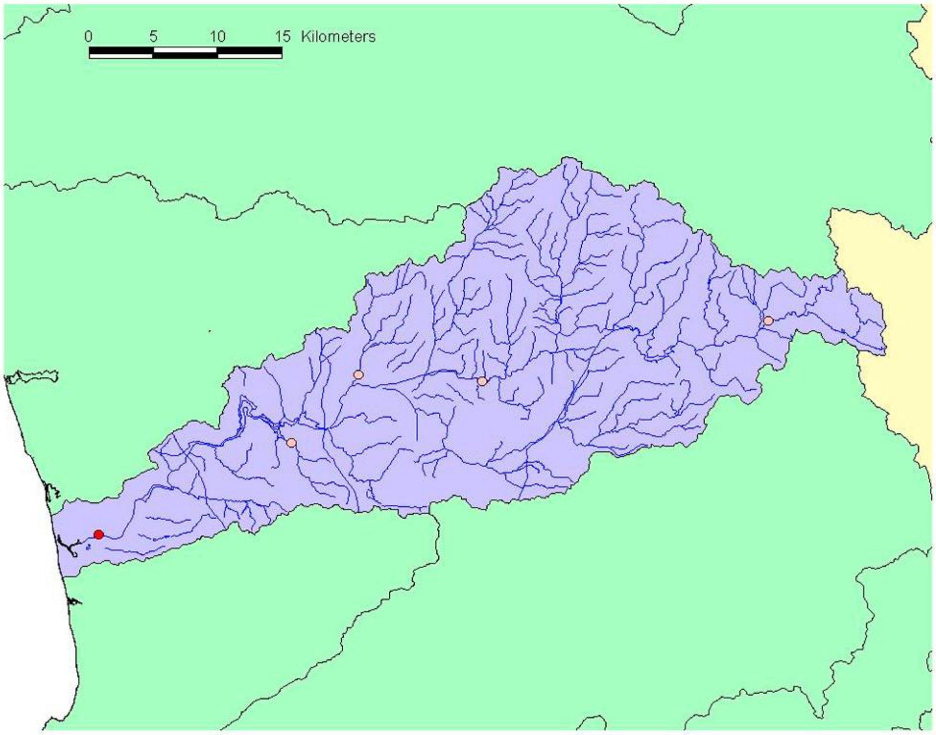


Figure 8. Frequency of toxicity (*C. dubia* fecundity, *H. azteca* growth, and *S. capricornutum* total cell count) at SWAMP sites. White circles indicate low frequency (0.0 to 0.1) of toxicity (this value did not occur in this watershed) . Pink circles indicate moderate frequency (0.1 to 0.5) of toxicity. Red circles indicate high (0.5 to 1.0) frequency of toxicity.

S. capricornutum was the most sensitive indicator, as total cell count was less than 80% of control at most sites in most samples, including reference sites. In fact, toxicity to *S. capricornutum* was observed in every sample from the mainstem, Cloverdale Creek, and the downstream reference site. Green Valley Creek and the upstream reference site were both toxic to *S. capricornutum* on most sampling dates. Across the watershed, 88% of samples were toxic to this indicator.

Toxicity to arthropod indicators was much less frequently observed. Samples from the mainstem were acutely toxic to *C. dubia* on one sampling date, and chronically toxic on two sampling dates. No sediment sample from any site in the San Dieguito watershed showed any evidence of toxicity to *H. azteca* on any sampling date. Sediment toxicity was never evaluated at the downstream reference site.

4.3 Bioassessment

Biological health ranged from poor to very poor at different sites in the San Dieguito HU (Table 13; Figure 9). Only 3 of 27 samples (11%) were in fair condition, and none was in good or very good condition. IBI scores above 40 were found at Boden Canyon Creek (Site 1), Black Mountain Creek (site 3), and

Santa Ysabel Creek (site 6) near the upstream reference site. Very low IBI scores were observed at most other sites, with the lowest mean scores (16.3) at Green Valley Creek (site 4).

Table 13. Mean and standard deviation of IBI scores at bioassessment sites within the San Dieguito HU. Number of samples collected within each season (n). Range from first to last year of sampling at each site (Years). Frequency of poor or very poor IBI scores (IBI <40) at each site and season (Frequency).

				IBI			
Site	Season	n	Years	Mean	SD	Condition	Frequency
1	Spring	1	2001-2001	51.4		Fair	--
2	Spring	1	2001-2001	31.4		Poor	1.00
3	Spring	3	2001-2005	35.2	13	Poor	0.67
4	Average	8	2000-2005	16.3	9.8	Very poor	1.00
4	Fall	4	2000-2004	23.2	7.1	Poor	1.00
4	Spring	4	2003-2005	9.3	4.9	Very poor	1.00
5	Fall	1	2000-2000	20		Poor	1.00
6	Average	4	2000-2003	25.7	16.2	Poor	0.75
6	Fall	1	2000-2000	14.3		Very poor	1.00
6	Spring	3	2000-2003	37.1	12.2	Poor	0.67
7	Spring	1	2001-2001	37.1		Poor	1.00
8	Spring	1	2005-2005	37.1		Poor	1.00
9	Average	6	2002-2005	22.1	3	Poor	1.00
9	Fall	3	2002-2004	24.3	5.7	Poor	1.00
9	Spring	3	2003-2005	20	3.8	Poor	1.00

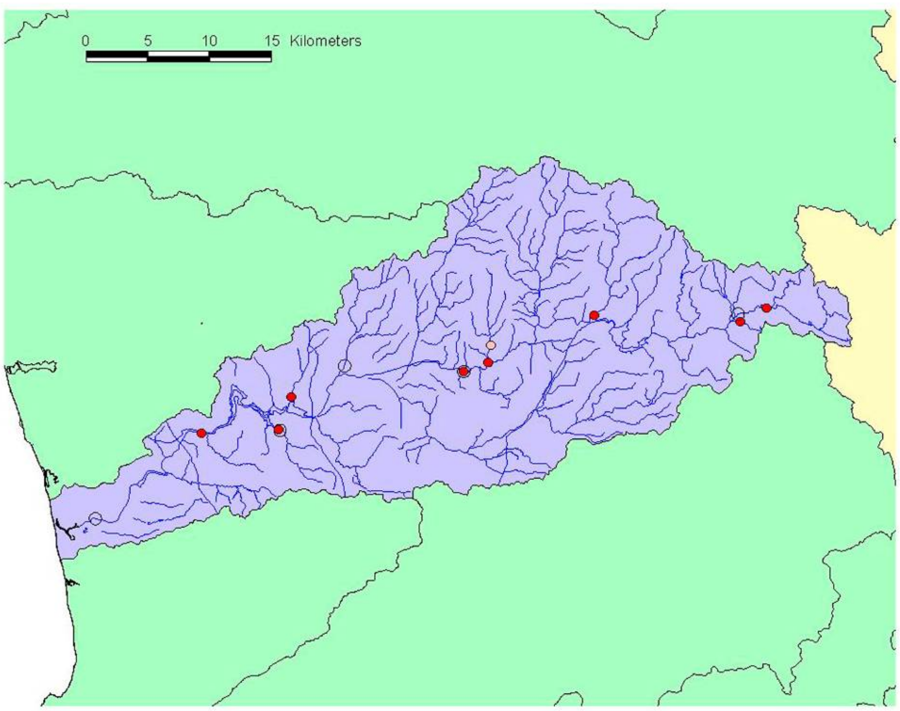


Figure 9. IBI scores at sites in the San Dieguito HU. White circles indicate good or very good (60 to 100) IBI scores (this value did not occur in this watershed). Pink circles indicate fair (40 to 60) IBI scores. Red circles indicate poor (0 to 40) IBI scores. Open circles represent 500-m buffers around SWAMP sites; three of these buffers included bioassessment sites, and two of these buffers did not.

Although scores differed among seasons, no consistent pattern was evident. For example, samples collected in the Fall at Green Valley Creek (site 4) had higher IBI scores than samples collected in the Spring. However, the opposite trend was observed at Santa Ysabel Creek (site 6). At other sites, like the mainstem below Hodges Reservoir (site 9), differences between seasons were slight (Table 13; Figure 10).

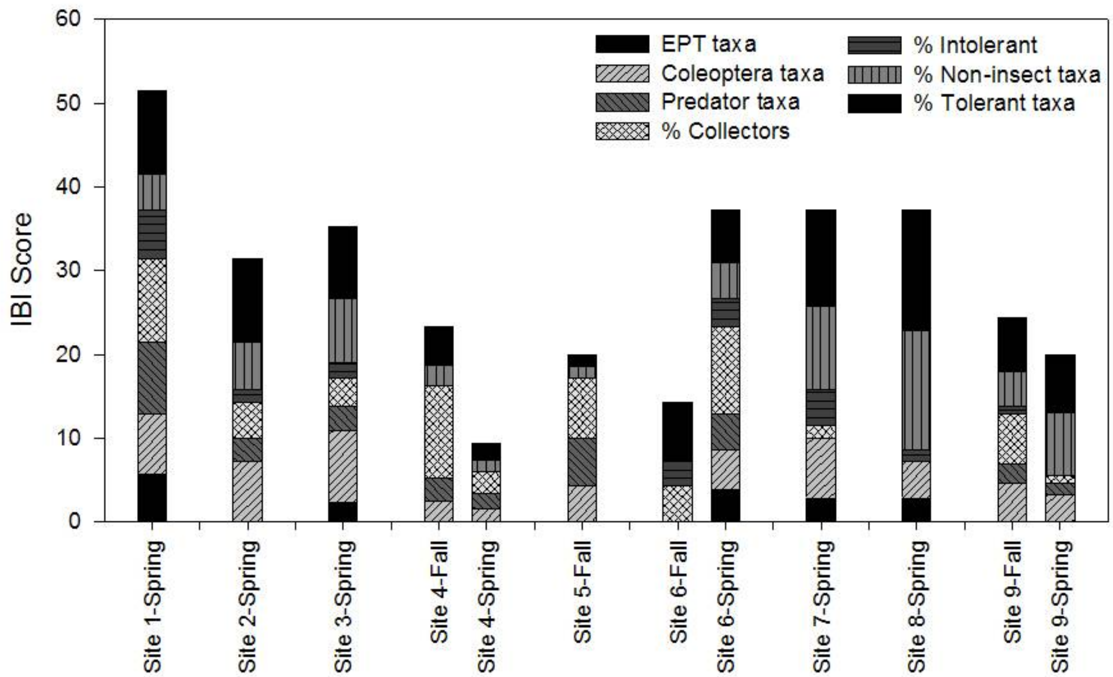


Figure 10. Mean IBI scores at each bioassessment site and each season. The height of the bar indicates the mean IBI score, and the size of each component of the bar represents the contribution of each metric to the IBI.

Mean values of the metrics that make up the IBI indicated very poor biological health. The EPT-taxa metric appeared to be the most sensitive, contributing to IBI scores at only the highest-scoring sites. In general, the % Collectors, % Non-insect taxa, and % tolerant taxa made the largest contributions to IBI scores (Figure 10; Appendix IV).

Examination of IBI scores over time did not indicate a trend towards improving or deteriorating biological condition (Figure 11). Variability among years was high, which may obscure trends in the data. Furthermore, a different set of sites were sampled in the early and late periods of study, increasing spatial variability and obscuring trends.

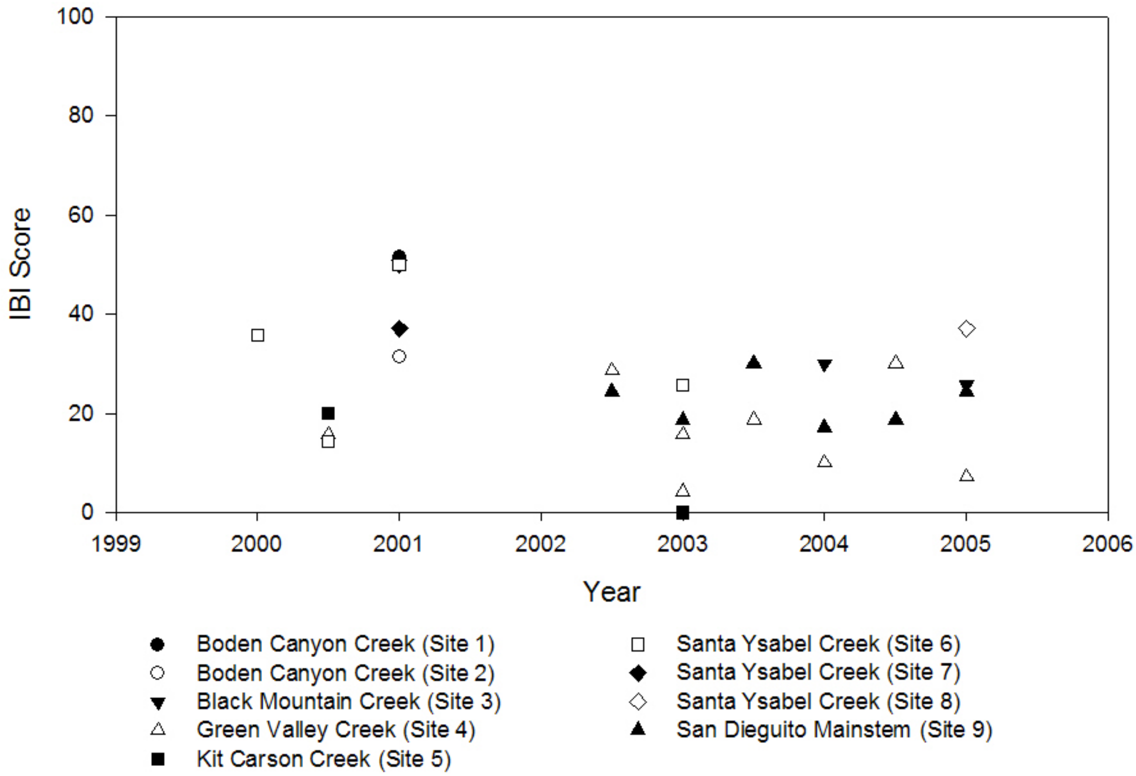


Figure 11. IBI values for each year and site. Each symbol represents a single sample. Spring samples are plotted at the beginning of each year; Fall samples are plotted between years.

None of these sites were monitored under SWAMP, and all bioassessment data came from monitoring efforts by NPDES permittees or the California Department of Fish and Game.

4.4 Physical Habitat

Physical habitat was very good at most sites in the watershed. For example, mean physical habitat scores were above 15 at all sites, except for the mainstem of the San Dieguito River, which had a mean score of 9.4. Although this site received high scores for sediment deposition, channel flow, channel alteration, and vegetation protection, other components of physical habitat received low scores. Some components (i.e., embeddedness and riffle frequency) received scores of 0, suggesting that certain impacts to physical habitat at this site are severe (Table 14; Figure 12).

Table 14. Score and mean for each component of physical habitat. Component range: 0 (heavily impacted habitat) to 20 (unimpacted habitat).

Site	Date	Phab 1 Epifaunal cover	Phab 2 Embeddedness	Phab 3 Velocity-depth regime	Phab 4 Sediment deposition	Phab 5 Channel flow	Phab 6 Channel alteration	Phab 7 Riffle frequency	Phab 8 Bank stability	Phab 9 Vegetation protection	Phab 10 Riparian zone	Mean score
905SDCDC4	12/31/2002	13	1	14	17	18	19	17	19	20	19	15.7
905SDGVC2	12/31/2002	15	2	13	17	18	16	12	20	20	20	15.3
905SDSDQ9	12/31/2002	4	0	6	16	20	15	0	12	16	5	9.4
905SDYSA4	12/30/2002	19	13	15	18	19	19	20	19	20	14	17.6
905SDYSA7	12/30/2002	18	9	8	18	5	19	17	20	20	19	15.3
All sites		13.8	5	11.2	17.2	16	17.6	13.2	18	19.2	15.4	15.4

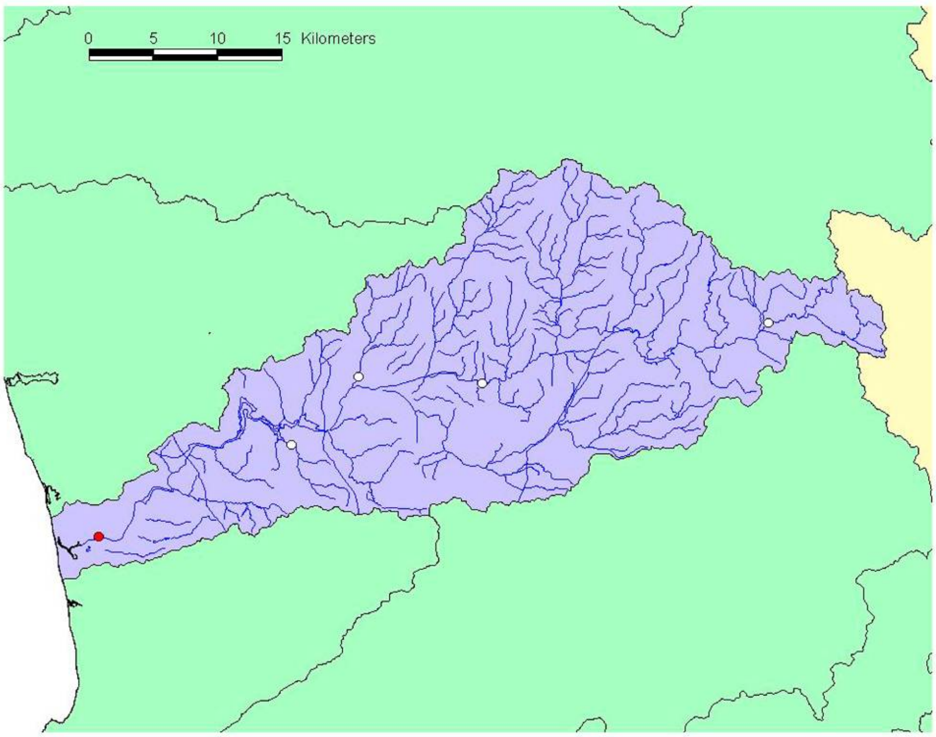


Figure 12. Assessment of physical habitat at SWAMP sites. White circles indicate sites with a mean physical habitat scores between 15 and 20. Pink circles indicate mean scores between 10 and 15 (this value did not occur in this watershed). Red circles indicate mean scores between 0 and 10.

Despite the overall high mean scores at most sites, habitat degradation was observed at nearly every site. For example, embeddedness received very low scores (>10) at all but the upstream reference site. This reference site was the only site in the watershed to receive scores above 10 for all components of physical habitat.

Many components of physical habitat received high scores at most sites, suggesting that the watershed has experienced little habitat degradation. For example, epifaunal cover, sediment deposition, channel alteration, riffle frequency, bank stability, vegetation protection, and riparian zone all received scores greater than 10 at four or five sites. Typically, only the mainstem site received low scores for any of these components of physical habitat. The downstream reference site received lower scores (<10) for velocity-depth regime and channel flow, perhaps reflecting the intermittent nature of this site.

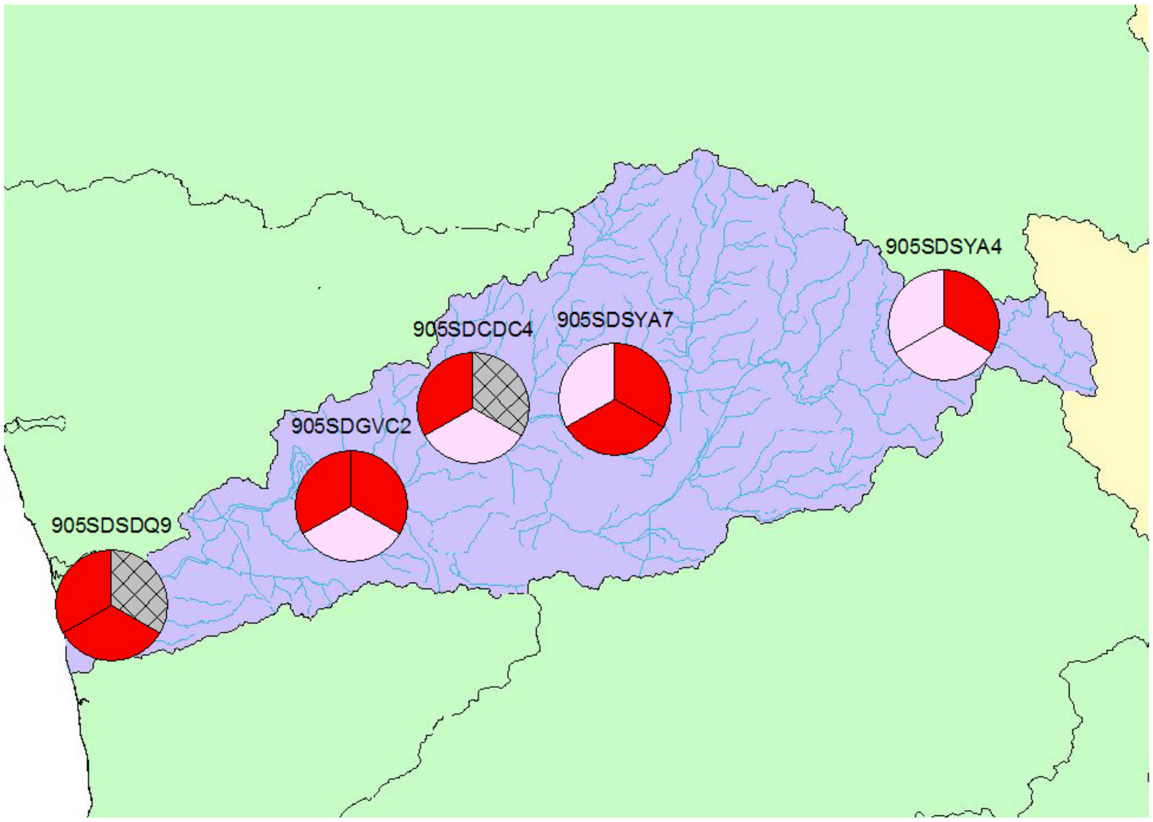
5. DISCUSSION

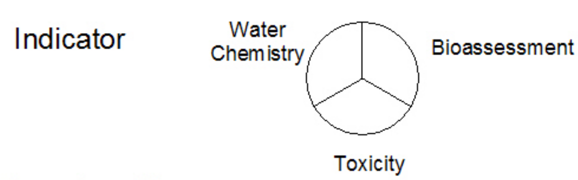
Every site sampled in the San Dieguito HU showed evidence of impact from multiple indicators, although impacts varied from severe to slight (Table 13; Figure 13). In general, downstream sites were more severely impacted than sites higher in the watershed. For example, the two reference sites in Santa Ysabel Creek were located in upper part of the watershed, upstream of Hodges Reservoir. These sites had better water chemistry than sites downstream, with only three constituents exceeding aquatic life thresholds. Furthermore, pesticides were nearly absent from these sites. However, a very high number (i.e., 19) of PAHs were detected in the upstream reference site. The source of these constituents was not clear, and they may be pyrogenic rather than anthropogenic; currently available data are inadequate to determine which source is more likely. However, apart from benzo(a)pyrene, no PAHs exceeded aquatic life thresholds at either reference site. Toxicity was moderate (at the upstream reference site) or high (at the downstream reference site), but toxicity was restricted to *S. capricornutum*. Toxicity to other indicators was not detected. Bioassessment samples collected at these sites were in worse condition than might be expected at reference sites. Although a few samples collected near the upstream reference site were in fair condition, most samples were in poor or very poor condition. The cause of the low IBI scores observed at these sites is not clear from the data, although the values were similar to those observed at other sites in the upper parts of the watershed (such as site 2 in Boden Canyon Creek), suggesting that impacts may be regional rather than local. As with most sites in the San Dieguito watershed, physical habitat was in good condition at both reference sites.

Table 15. Summary of the ecological health for five SWAMP sites in San Dieguito HU. Aquatic life (AL). Human health (HH). Toxicity frequency is frequency of toxicity for three chronic toxicity endpoints: *C. dubia* (fecundity), *H. azteca* (growth), and *S. capricornutum* (total cell count). Biology frequency is the frequency of IBIs below 40. n.t. = Indicator not tested.

	Water chemistry		Toxicity	Biology	Physical habitat
Site	# constituents (AL)	# constituents (HH)	Frequency	Frequency	Mean
905SDCDC4	6	3	0.43	n.t.	15.7
905SDGVC2	6	2	0.30	1.00*	15.3
905SDSDQ9	8	4	0.75	n.t.	9.4
905SDYSA4	3	4	0.22	n.t.	17.6
905SDYSA7	3	0	0.50	1.00*	15.3

* = Estimated from data collected at nearby (within 500 meters) non-SWAMP sites.





Severity of impact

Severity	Water chemistry (# aquatic life exceedences)	Toxicity (Frequency of toxicity)	Bioassessment (IBI Score)
Low	0-1	0.0-0.1	60-100
Moderate	2-5	0.1-0.5	40-60
High	6+	0.5-1.0	0-40
Not tested			

Figure 13. Summary of the ecological health of SWAMP sites in the San Dieguito HU, as determined by water chemistry, toxicity, and bioassessment indicators. Each pie slice corresponds to a specific indicator, as described in the inset, with darker colors corresponding to more degraded conditions (unmeasured indicators are shown in cross-hatched gray). The top-left slice corresponds to the number of water chemistry constituents exceeding aquatic life thresholds. The bottom slice corresponds to the frequency of toxicity among three endpoints: *C. dubia* (fecundity), *H. azteca* (growth), and *S. capricornutum* (total cell count). The top-right slice corresponds to the IBI of bioassessment samples.

Impacts were more evident at downstream sites in the San Dieguito watershed. For example, fewer pesticides and PAHs were detected at the two sites in the middle portions of the watershed (Cloverdale Creek and Green Valley

Creek). A lower (although still high) number of water chemistry constituents exceeded aquatic life thresholds at these sites, compared to the mainstem site. Again, nutrients, sulfate, Manganese, and specific conductivity were the principle causes of these exceedances. The high levels of phosphorus, manganese, and sulfates was consistent with the inclusion of Cloverdale and Green Valley Creeks on the 303(d) list. Toxicity was moderate, and only one indicator (*S. capricornutum*) was sensitive to samples from these sites. Bioassessment samples collected near the Green Valley Creek site (at site 4) were in very poor ecological condition, receiving the lowest mean IBI score of any site in the San Dieguito HU, despite the fact that water chemistry and toxicity were better at this site than at the downstream site, and that physical habitat was in good condition.

The most downstream site in the San Dieguito River appeared to have the most severe impacts in the watershed, as more water chemistry constituents (i.e., 8) exceeded aquatic life thresholds than any other site. Phosphorus, sulfate, Manganese, and specific conductivity exceeded these thresholds at all sampling dates, and pH, Ammonia, and Selenium did so in at least half the sampling dates. Furthermore, the highest number of pesticides in the watershed (i.e., 10) were detected at this site, and the second highest number (i.e., 12) of PAHs. Toxicity was higher at this site than the others in the San Dieguito River, as all samples were toxic to *S. capricornutum*; in addition, only this site produced samples that were toxic to *C. dubia*. Lastly, this site had the most degraded physical habitat, receiving a mean physical habitat score of only 9.4. Three components of physical habitat (i.e., epifaunal cover, embeddedness, and riffle frequency) received scores below 5, and two additional components (i.e., velocity-depth regime and riparian zone) received scores below 10.

This study's assessment of the San Dieguito HU suggests that the ecological health of the watershed is moderately impacted, and that the severity of the impact increases along a downstream gradient. Multiple lines of evidence support this conclusion. Water chemistry showed a clear gradient of increasing degradation from the upstream reference sites to the mainstem site near the mouth of the San Dieguito River. Although physical habitat was very good at most sites in the watershed, all other indicators showed at least some evidence of impact at all sites. The causes of this gradient may relate to increasing agricultural and developed land use at the bottom of the watershed, or operation of dams and reservoirs; however, data collected for this study are inadequate to identify a specific cause.

Despite the strength of the evidence, limitations of this study affect the assessment. These limitations include difficulties integrating data from SWAMP and non-SWAMP sources, the non-randomization of sample sites, small sample size, and the lack of applicable thresholds for several indicators. Although these limitations require that results be interpreted with caution, it is unlikely that they would alter the fundamental finding that the San Dieguito watershed is in moderately poor health, as explained at the end of this section.

The geographical approach to integrating SWAMP and non-SWAMP data relies on assumptions about the spatial and temporal variability of the variables measured by these programs. For example, bioassessment data may have been collected up to 500 meters away and up to 4 years before or 3 years after water chemistry, toxicity, and tissue data were collected. This study assumes that anthropogenic impacts do not change across these distances or over these spans of time. There is little published research on either of these assumptions, although there may be greater support for the assumptions about spatial variability (e.g., Gebler 2004) than for temporal variability (e.g., Sandin and Johnson 2000, Bêche et al. 2006).In this study, bioassessment data were observed to be highly variable, and the use of data collected many years before water chemistry data is questionable.

The targeted selection of sites monitored under the SWAMP program facilitated integration of pre-existing data from non-SWAMP sources, but this non-probabilistic approach severely limits the extrapolation of data from these sites to the rest of the watershed. Non-random sampling violates assumptions underlying most statistical analyses, and the sites selected in this study cannot be assumed to represent the entire watershed (Olsen et al. 1999, Stevens Jr. and Olsen 2004). Although both impacted and reference sites were selected for monitoring in the San Dieguito watershed, it is unclear whether the percentage of reference sites in the study (i.e., 40%) reflects the percentage of unimpacted streams in the entire hydrologic unit.

The small number of sites monitored under SWAMP also limits the certainty of this study's assessment. For example, tissue samples were collected at only two sites; therefore, tissue contamination may have gone undetected in unsampled regions of the watershed. Although SWAMP has produced a wealth of data about the San Dieguito watershed using limited resources, some indicators (especially those with high variability) may require more extensive sampling to produce more precise and accurate assessments.

Thresholds are an essential tool for assessing water quality and ecological health. However, their use is limited to indicators that have been well studied, and they cannot provide a holistic view watershed health. This limitation is exacerbated by the fact that many constituents and indicators lack applicable thresholds. For example, of the 54 water chemistry constituents, 20 (37%) had no applicable water quality objectives that could be used as thresholds for water quality. No thresholds exist for physical habitat scores. Furthermore, thresholds applied to IBI scores and toxicity were based on statistical distributions and professional judgment (respectively), rather than on risks to ecological health. For example, the 80% threshold used to identify toxic samples is based on the assumption that this level is ecologically meaningful, although this assumption has not been verified in the field. The development of biocriteria to establish meaningful thresholds for bioassessment is subject of active interest in California (Bernstein and Schiff 2002).

Despite these limitations, the data gathered under SWAMP and other programs strongly support the conclusion that the health of the San Dieguito HU moderately impacted. Some of these limitations (such as the lack of applicable thresholds and the small sample size) may in fact have caused this assessment to underestimate the severity of degradation in the watershed. All indicators showed signs of human impacts. Multiple stressors, including degraded water quality, sediment, and physical habitat are the likely cause of the impact. Future research (see final report on the SWAMP monitoring program for further study recommendations) is necessary to determine which stressors are responsible for the impacts seen in the watershed.

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7. APPENDICES

APPENDIX I

A. Beneficial uses of streams in the San Dieguito HU (California Regional Water Quality Control Board, San Diego Region 1994). B. Streams on the 303(d) list of impaired water bodies in the San Dieguito HUC. HUC = Hydrologic Unit Code. MUN = Municipal and domestic supply. AGR = Agricultural supply. IND = Industrial service supply. PROC = Industrial process supply. REC1 = Contact recreation. REC2 = Non-contact recreation. BIOL = Preservation of biological habitats of special significance. WARM = Warm freshwater habitat. COLD = Cold freshwater habitat. WILD = Wildlife habitat. RARE = Rare, threatened, or endangered species. SPWN = Spawning, reproduction, and/or early development. X = Exempted from municipal supply. E = Existing beneficial use. P = Potential beneficial use.

A. Beneficial uses of streams in the San Dieguito HU.

San Dieguito HU (905)	HUC	MUN	AGR	IND	PROC	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN
Santa Ysabel Creek	905.54	E	E	E	E	E	E		E	E	E		E
Dan Price Creek	905.54	E	E	E	E	E	E		E	E	E		
Santa Ysabel Creek	905.53	E	E	E	E	E	E		E	E	E		
Witch Creek	905.53	E	E	E	E	E	E		E	E	E		E
Bloomdale Creek	905.53	E	E	E	E	E	E		E	E	E		
Santa Ysabel Creek	905.52	E	E	E	E	E	E		E	E	E	E	
Black Canyon	905.52	E	E	E	E	E	E		E	E	E		E
Scholder Creek	905.52	E	E	E	E	E	E		E	E	E		
Temescal Creek	905.52	E	E	E	E	E	E		E	E	E		
Bear Creek	905.52	E	E	E	E	E	E		E	E	E		
Quail Canyon	905.52	E	E	E	E	E	E		E	E	E		
Carney Canyon	905.52	E	E	E	E	E	E		E	E	E		
Santa Ysabel Creek	905.51	E	E	E	E	E	E		E	E	E		
Boden Canyon	905.51	E	E	E	E	E	E		E	E	E		
Clevenger Canyon	905.51	E	E	E	E	E	E		E	E	E		
Santa Ysabel Creek	905.32	E	E	E	E	P	E		E		E	E	
Tims Canyon	905.32	E	E	E	E	P	E		E		E		
Schoolhouse Canyon	905.32	E	E	E	E	P	E		E		E		
Rockwood Canyon	905.35	E	E	E	E	P	E		E		E		
Guejito Creek	905.35	E	E	E	E	P	E		E		E		
Unnamed intermittent streams	905.36	E	E	E	E	P	E		E		E		
Rockwood Canyon	905.32	E	E	E	E	P	E		E		E		
Santa Maria Creek	905.41	E	E	E	E	E	E		E		E		
Hatfield Creek	905.45	E	E	E	E	E	E		E		E		
Hatfield Creek	905.44	E	E	E	E	E	E		E		E		
Wash Hollow Creek	905.43	E	E	E	E	E	E		E		E		
Wash Hollow Creek	905.44	E	E	E	E	E	E		E		E		
Hatfield Creek	905.42	E	E	E	E	E	E		E		E		
Santa Teresa Valley	905.46	E	E	E	E	E	E		E		E		
Unnamed intermittent streams	905.47	E	E	E	E	E	E		E		E		
Hatfield Creek	905.41	E	E	E	E	E	E		E		E		
Santa Maria Creek	905.32	E	E	E	E	P	E		E		E		
Unnamed intermittent streams	905.33	E	E	E	E	P	E		E		E		
Unnamed intermittent streams	905.34	E	E	E	E	P	E		E		E		
San Dieguito River	905.32	E	E	E	E	P	E		E		E	E	
Unnamed tributary	905.32	E	E	E	E	P	E		E		E	E	
San Dieguito River	905.21	E	E	E	E	E	E	E	E	E	E	E	
Highland Valley	905.31	E	E	E	E	P	E		E		E		
Warren Canyon	905.21	E	E	E	E	E	E		E	E	E		
San Bernardo Valley	905.21	E	E	E	E	E	E		E		E	E	
Unnamed intermittent streams	905.24	E	E	E	E	E	E		E		E		
Unnamed intermittent streams	905.23	E	E	E	E	E	E		E		E		
Unnamed intermittent streams	905.22	E	E	E	E	E	E		E		E		
San Dieguito River	905.11	X	P	P		E	E		E	E	E		E
Lusardi Creek	905.12	X	P	P		E	E		E		E		
Lusardi Creek	905.11	X	P	P		E	E		E		E		
La Zanja Canyon	905.11	X	P	P		E	E		E		E		
Gonzalez Canyon	905.11	X	P	P		E	E		E		E		

Appendix I, continued.
B. 303(d)-listed streams in the San Dieguito HU.

Name	HUC	Stressor	Potential source	Affected length
Cloverdale Creek	905.32	Phosphorus	Urban runoff/storm sewers, unknown nonpoint source, unknown point source	1.2 miles
		Total dissolved solids	Urban runoff/storm sewers, unknown nonpoint source, unknown point source	1.2 miles
Felicita Creek	905.23	Aluminum	Sources unknown	0.92 miles
		Total dissolved solids	Agricultural return flows, urban runoff/storm sewers, flow regulation/modification, unknown nonpoint source, unknown point source	0.92 miles
Green Valley Creek	905.21	Chloride	Sources unknown	0.98 miles
		Manganese	Sources unknown	0.98 miles
		Pentachlorophenol (PCP)	Sources unknown	0.98 miles
		Sulfates	Urban runoff/storm sewers, natural sources, unknown nonpoint source, unknown point source	0.98 miles
Kit Carson Creek	905.21	Pentachlorophenol (PCP)	Sources unknown	0.99 Miles
		Total dissolved solids	Agricultural return flows, urban runoff/storm sewers, flow regulation/modification, unknown nonpoint source, unknown point source	0.99 Miles

APPENDIX II

Means, standard deviations (SD), and number of samples (n) of water chemistry constituents in (A) SWAMP sites and (B) Non-SWAMP (NPDES) sites. The watershed average was calculated as the mean of the site averages. Blank cells indicate that the constituent was not analyzed at that site. -- = Constituent not detected at that site. SWAMP sites were monitored in (2003). Non-SWAMP sites were monitored in Spring and Fall between 2002 and 2005.

A. SWAMP sites

			905SDCDC4			905SDGVC2			905SDSDQ9			905SDYSA4			905SDYSA7			Entire watershed		
Category	Constituent	Units	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Inorganics	Alkalinity as CaCO3	mg/l	342	44	3	240	71	4	335	167	4	70	1	3	251	33	3	247	110	5
Inorganics	Ammonia as N	mg/l	0.3	0.13	3	0.1	0.07	4	0.08	0.09	4	0.05	0.09	3	0.03	0.05	3	0.11	0.11	5
Inorganics	Nitrate + Nitrite as N	mg/l	1.61	0.3	3	0.39	0.22	4	0.27	0.43	4	0.05	0.01	3	0.08	0.02	3	0.48	0.65	5
Inorganics	Nitrate as N	mg/l	1.53	0.32	3	0.37	0.21	4	0.27	0.43	4	0.05	0.01	3	0.08	0.02	3	0.46	0.61	5
Inorganics	Nitrite as N	mg/l	0.09	0.03	3	0.02	0.01	4	0	0	4	--	--	3	0	0	3	0.02	0.04	5
Inorganics	Nitrogen, Total Kjeldahl	mg/l	2.06	0.14	3	1.06	0.16	4	1.64	1.04	4	0.26	0.07	3	0.5	0.1	3	1.1	0.75	5
Inorganics	OrthoPhosphate as P	mg/l	0.35	0.02	3	0.15	0.11	4	0.24	0.2	4	0.02	0	3	0.04	0.01	3	0.16	0.14	5
Inorganics	Phosphorus as P,Total	mg/l	0.44	0.03	3	0.2	0.11	4	0.51	0.66	4	0.04	0.03	3	0.03	0.03	3	0.24	0.22	5
Inorganics	Selenium, dissolved	µg/L	2.3	0.3	3	2.4	1	4	9.7	9.4	4	0.9	0.2	3	1.4	0.5	3	3.3	3.6	5
Inorganics	Sulfate	mg/l	398	47	3	346	114	4	829	520	4	101	9	3	63	13	3	347	307	5
Metals	Aluminum, dissolved	µg/L	1.5	1.5	3	0.3	0.4	4	1.7	1.6	4	8.4	6.7	3	4.7	3.1	3	3.3	3.3	5
Metals	Arsenic, dissolved	µg/L	1.2	0.2	3	2.3	0.3	4	4.7	1.4	4	0.5	0	3	1.1	0.1	3	1.9	1.7	5
Metals	Cadmium, dissolved	µg/L	0.04	0.02	3	0.04	0.01	4	0.05	0.05	4	0.01	0	3	0.02	0	3	0.03	0.02	5
Metals	Chromium, dissolved	µg/L	0.16	0.1	3	0.26	0.04	4	0.35	0.23	4	0.03	0.05	3	0.1	0.09	3	0.18	0.13	5
Metals	Copper, dissolved	µg/L	2.44	0.43	3	4.77	1.54	4	2.58	1.48	4	1.3	0.23	3	0.95	0.13	3	2.41	1.5	5
Metals	Lead, dissolved	µg/L	0.02	0.01	3	0.02	0.02	4	0.01	0.01	4	0.01	0.01	3	0.08	0.04	3	0.03	0.03	5
Metals	Manganese, dissolved	µg/L	277	137	3	225	172	4	92	11	4	3	2	3	102	85	3	140	110	5
Metals	Nickel, dissolved	µg/L	0.5	0.9	3	0.6	0.8	4	0.9	1.2	4	0.8	0	3	0.2	0.4	3	0.6	0.3	5
Metals	Silver, dissolved	µg/L	--	--	3	--	--	4	0	0.01	4	--	--	3	--	--	3	0	0	5
Metals	Zinc, dissolved	µg/L	2.2	0.6	3	4.4	1.7	4	2.2	1.3	4	0.7	0.2	3	0.6	0.5	3	2	1.5	5
PAHs	Acenaphthene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Acenaphthylene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Anthracene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Benz(a)anthracene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Benzo(a)pyrene	µg/L	--	--	3	--	--	4	--	--	4	0.006	0.011	3	--	--	3	0.001	0.003	5
PAHs	Benzo(b)fluoranthene	µg/L	0.005	0.008	3	0.004	0.008	4	0.003	0.006	4	0.004	0.006	3	--	--	3	0.003	0.002	5
PAHs	Benzo(e)pyrene	µg/L	--	--	3	--	--	4	--	--	4	0.006	0.01	3	--	--	3	0.001	0.003	5
PAHs	Benzo(g,h,i)perylene	µg/L	--	--	3	--	--	4	--	--	4	0.061	0.105	3	--	--	3	0.012	0.027	5
PAHs	Benzo(k)fluoranthene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Biphenyl	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Chrysene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Chrysenes, C1 -	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Chrysenes, C2 -	µg/L	0.022	0.038	3	--	--	4	--	--	4	--	--	3	--	--	3	0.004	0.01	5
PAHs	Chrysenes, C3 -	µg/L	--	--	3	--	--	4	--	--	4	0.004	0.007	3	--	--	3	0.001	0.002	5
PAHs	Dibenz(a,h)anthracene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Dibenzothiophene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Dibenzothiophenes, C1 -	µg/L	0.01	0.009	3	0.01	0.011	4	0.004	0.007	4	0.01	0.009	3	--	--	3	0.007	0.005	5
PAHs	Dibenzothiophenes, C2 -	µg/L	0.016	0.014	3	0.016	0.019	4	0.009	0.01	4	0.018	0.017	3	0.01	0.009	3	0.014	0.004	5
PAHs	Dibenzothiophenes, C3 -	µg/L	--	--	3	0.007	0.009	4	0.003	0.005	4	0.012	0.021	3	--	--	3	0.004	0.005	5
PAHs	Dimethylnaphthalene, 2,6-	µg/L	--	--	3	--	--	4	0.008	0.016	4	--	--	3	--	--	3	0.002	0.004	5
PAHs	Fluoranthene	µg/L	0.034	0.059	3	--	--	4	--	--	4	0.008	0.014	3	--	--	3	0.008	0.015	5
PAHs	Fluoranthene/Pyrenes, C1 -	µg/L	--	--	3	--	--	4	--	--	4	0.004	0.006	3	--	--	3	0.001	0.002	5
PAHs	Fluorene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Fluorenes, C1 -	µg/L	--	--	3	0.003	0.005	4	--	--	4	0.004	0.006	3	--	--	3	0.001	0.002	5
PAHs	Fluorenes, C2 -	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Fluorenes, C3 -	µg/L	--	--	3	0.003	0.006	4	0.006	0.007	4	0.005	0.008	3	--	--	3	0.003	0.003	5
PAHs	Indeno(1,2,3-c,d)pyrene	µg/L	--	--	3	--	--	4	--	--	4	0.018	0.03	3	--	--	3	0.004	0.008	5
PAHs	Methylnaphthalene, 1-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Methylnaphthalene, 2-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Methylphenanthrene, 1-	µg/L	--	--	3	--	--	4	0.006	0.012	4	--	--	3	--	--	3	0.001	0.003	5
PAHs	Naphthalene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Naphthalenes, C1 -	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Naphthalenes, C2 -	µg/L	--	--	3	--	--	4	0.012	0.024	4	--	--	3	--	--	3	0.002	0.005	5
PAHs	Naphthalenes, C3 -	µg/L	--	--	3	0.005	0.009	4	--	--	4	0.005	0.009	3	--	--	3	0.002	0.003	5
PAHs	Naphthalenes, C4 -	µg/L	--	--	3	0.003	0.006	4	0.003	0.005	4	--	--	3	--	--	3	0.001	0.001	5

Appendix IIa, continued. Means and standard deviations of water chemistry constituents.

			905SDCDC4			905SDGVC2			905SDSDQ9			905SDYSA4			905SDYSA7			Entire watershed		
Category	Constituent	Units	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
PAHs	Perylene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PAHs	Phenanthrene	µg/L	0.015	0.026	3	--	--	4	--	--	4	--	--	3	--	--	3	0.003	0.007	5
PAHs	Phenanthrene/Anthracene, C1 -	µg/L	0.009	0.008	3	0.004	0.008	4	0.015	0.03	4	0.007	0.012	3	0.004	0.007	3	0.008	0.005	5
PAHs	Phenanthrene/Anthracene, C2 -	µg/L	0.009	0.008	3	--	--	4	0.003	0.006	4	0.008	0.015	3	--	--	3	0.004	0.004	5
PAHs	Phenanthrene/Anthracene, C3 -	µg/L	--	--	3	--	--	4	0.004	0.008	4	0.013	0.023	3	--	--	3	0.003	0.006	5
PAHs	Phenanthrene/Anthracene, C4 -	µg/L	--	--	3	--	--	4	--	--	4	0.004	0.006	3	--	--	3	0.001	0.002	5
PAHs	Pyrene	µg/L	0.114	0.197	3	--	--	4	--	--	4	0.034	0.058	3	--	--	3	0.03	0.049	5
PAHs	Trimethylnaphthalene, 2,3,5-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 005	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 008	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 015	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 018	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 027	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 028	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 029	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 031	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 033	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 044	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 049	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 052	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 056	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 060	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 066	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 070	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 074	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 087	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 095	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 097	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 099	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 101	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 105	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 110	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 114	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 118	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 128	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 137	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 138	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 141	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 149	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 151	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 153	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 156	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 157	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 158	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 170	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 174	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 177	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 180	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 183	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 187	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 189	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 194	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 195	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 200	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 201	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 203	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 206	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCB 209	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
PCBs	PCBs	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Aldrin	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Ametryn	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Aspon	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Atraton	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Atrazine	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5

Appendix IIa, continued. Means and standard deviations of water chemistry constituents.

			905SDCDC4			905SDGVC2			905SDSDQ9			905SDYSA4			905SDYSA7		
Category	Constituent	Units	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Pesticides	Azinphos ethyl	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Azinphos methyl	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Bolstar	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Carbophenothion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlordane, cis-	µg/L	--	--	3	0	0.001	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlordane, trans-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlordene, alpha-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlordene, gamma-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlorfenvinphos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlorpyrifos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Chlorpyrifos methyl	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Ciodrin	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Coumaphos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Dacthal	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	DDD(o,p')	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	DDD(p,p')	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	DDE(o,p')	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	DDE(p,p')	µg/L	--	--	3	--	--	4	0.001	0.001	4	0	0.001	3	--	--	3
Pesticides	DDMU(p,p')	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	DDT(o,p')	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	DDT(p,p')	µg/L	--	--	3	--	--	4	0.001	0.001	4	--	--	3	--	--	3
Pesticides	DDTs	µg/L	--	--	3	--	--	4	0.001	0.002	4	0	0.001	3	--	--	3
Pesticides	Demeton-s	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Diazinon	µg/L	0.014	0.013	3	0.028	0.017	4	0.015	0.012	4	--	--	3	--	--	3
Pesticides	Dichlofenthion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Dichlorvos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Dicrotophos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Dieldrin	µg/L	0	0.001	3	0	0.001	4	--	--	4	--	--	3	--	--	3
Pesticides	Dimethoate	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Dioxathion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Disulfoton	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Endosulfan I	µg/L	--	--	3	--	--	4	0	0.001	4	--	--	3	--	--	3
Pesticides	Endosulfan II	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Endosulfan sulfate	µg/L	--	--	3	--	--	4	0	0.001	4	--	--	3	--	--	3
Pesticides	Endrin	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Endrin Aldehyde	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Endrin Ketone	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Ethion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Ethoprop	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Famphur	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Fenchlorphos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Fenitrothion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Fensulfothion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Fenthion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Fonofos	µg/L	0.009	0.015	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	HCH, alpha	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	HCH, beta	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	HCH, delta	µg/L	--	--	3	--	--	4	0	0.001	4	--	--	3	--	--	3
Pesticides	HCH, gamma	µg/L	--	--	3	0	0.001	4	--	--	4	--	--	3	--	--	3
Pesticides	Heptachlor	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Heptachlor epoxide	µg/L	0	0.001	3	--	--	4	0	0.001	4	--	--	3	--	--	3
Pesticides	Hexachlorobenzene	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Leptophos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Malathion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Merphos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Methidathion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3
Pesticides	Methoxychlor	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3

Appendix IIa, continued. Means and standard deviations of water chemistry constituents.

			905SDCDC4			905SDGVC2			905SDSDQ9			905SDYSA4			905SDYSA7			Entire watershed		
Category	Constituent	Units	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
Pesticides	Mevinphos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Mirex	µg/L	--	--	3	--	--	4	0	0.001	4	--	--	3	--	--	3	0	0	5
Pesticides	Molinate	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Naled	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Nonachlor, cis-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Nonachlor, trans-	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Oxadiazon	µg/L	0.001	0.001	3	0.029	0.019	4	0.008	0.01	4	--	--	3	--	--	3	0.007	0.012	5
Pesticides	Oxychlordane	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Parathion, Ethyl	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Parathion, Methyl	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Phorate	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Phosmet	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Phosphamidon	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Prometon	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Prometryn	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Propazine	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Secbumeton	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Simazine	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Simetryn	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Sulfotep	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Tedion	µg/L	--	--	3	0	0.001	4	0	0.001	4	--	--	3	--	--	3	0	0	5
Pesticides	Terbufos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Terbuthylazine	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Terbutryn	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Tetrachlorvinphos	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Thiobencarb	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Thionazin	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Tokuthion	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Trichlorfon	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5
Pesticides	Trichloronate	µg/L	--	--	3	--	--	4	--	--	4	--	--	3	--	--	3	--	--	5

B. Non-SWAMP sites.

		Site 4			Site 9		
Constituent	**Unit**	**Mean**	**SD**	**n**	**Mean**	**SD**	**n**
Dissolved Oxygen	mg/L	8.9	4.7	6	7.4	2.4	6
pH		7.9	0.2	6	7.8	0.2	6
Specific Conductance	mS/cm	2.2	0.3	6	2.4	0.8	6
Turbidity	NTU	8.8		1	7.2		1
Water Temperature	C	18.7	0.9	6	18.7	1.1	6

APPENDIX III

Results from toxicity assays for each endpoint at each site in the watershed. Mean = mean percent control. SD = standard deviation.

	C. dubia						*H. azteca*						*S. capricornutum*		
	Survival			Young / female			Survival			Growth			Total cell count		
Site	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD	n
905SDCDC4	97	6	3	84	33	3	109		1	117		1	55	20	3
905SDGVC2	100	0	4	106	18	4	98	8	2	145	62	2	78	67	4
905SDSDQ9	58	51	3	84	25	2	100	3	2	99		1	30	29	4
905SDYSA4	97	6	3	92	28	3	101	6	3	134	13	3	74	8	3
905SDYSA7	100	0	3	85	30	3			0			0	71	8	3
Entire watershed	90	25	16	88	32	16	100	6	8	129	32	7	60	38	17

APPENDIX IV

Mean IBI and metric scores for bioassessment sites in the San Dieguito HU. Note that the number listed under IBI is the mean IBI for each site, and not the IBI calculated from the mean metric values.

				IBI		Coleoptera Taxa		EPT Taxa		Predator Taxa		% Collectors		% Intolerant		% Non-insect Taxa		% Tolerant Taxa	
Site	Season	n	Years	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Site 1	Spring	1	2001-2001	51.4		4		5		6		7		4		3		7	
Site 2	Spring	1	2001-2001	31.4		0		5		2		3		1		4		7	
Site 3	Spring	3	2001-2005	35.2	13	1.7	2.9	6	1.7	2	2	2.3	1.5	1.3	1.5	5.3	1.5	6	1
Site 4	Average	8	2000-2005	16.3	9.8	0	0	1.4	0.5	1.6	0.5	4.8	4.2	0	0	1.4	0.5	2.3	1.4
	Fall	4	2000-2004	23.2	7.1	0	0	1.8	1	2	0.8	7.8	2.6	0	0	1.8	1.7	3.3	1.5
	Spring	4	2003-2005	9.3	4.9	0	0	1	0	1.3	1.9	1.8	1.7	0	0	1	0.8	1.3	1.5
Site 5	Average	2	2000-2003	10	14.1	0	0	1.5	2.1	2	2.8	2.5	3.5	0	0	0.5	0.7	0.5	0.7
	Fall	1	2000-2000	20		0		3		4		5		0		1		1	
	Spring	1	2003-2003	0		0		0		0		0		0		0		0	
Site 6	Average	4	2000-2003	25.7	16.2	1.3	1.9	1.7	2.4	1.5	2.1	5.2	3.1	2.2	0.2	1.5	2.1	4.7	0.5
	Fall	1	2000-2000	14.3		0		0		0		3		2		0		5	
	Spring	3	2000-2003	37.1	12.2	2.7	2.3	3.3	0.6	3	2.6	7.3	4.6	2.3	2.3	3	1	4.3	2.1
Site 7	Spring	1	2001-2001	37.1		2		5		0		1		3		7		8	
Site 8	Spring	1	2005-2005	37.1		2		3		0		0		1		10		10	
Site 9	Average	6	2002-2005	22.1	3	0	0	2.8	0.7	1.3	0.5	2.5	2.6	0.3	0.5	4.2	1.6	4.8	0.2
	Fall	3	2002-2004	24.3	5.7	0	0	3.3	0.6	1.7	0.6	4.3	1.2	0.7	0.6	3	1	4.7	0.6
	Spring	3	2003-2005	20	3.8	0	0	2.3	0.6	1	1	0.7	0.6	0	0	5.3	2.5	5	2