

Assessing the Status of Aquatic Life Use in South San Francisco Bay Area Creeks

The Utility and Challenges of a Using a Sediment Quality Triad Approach in Lotic Systems

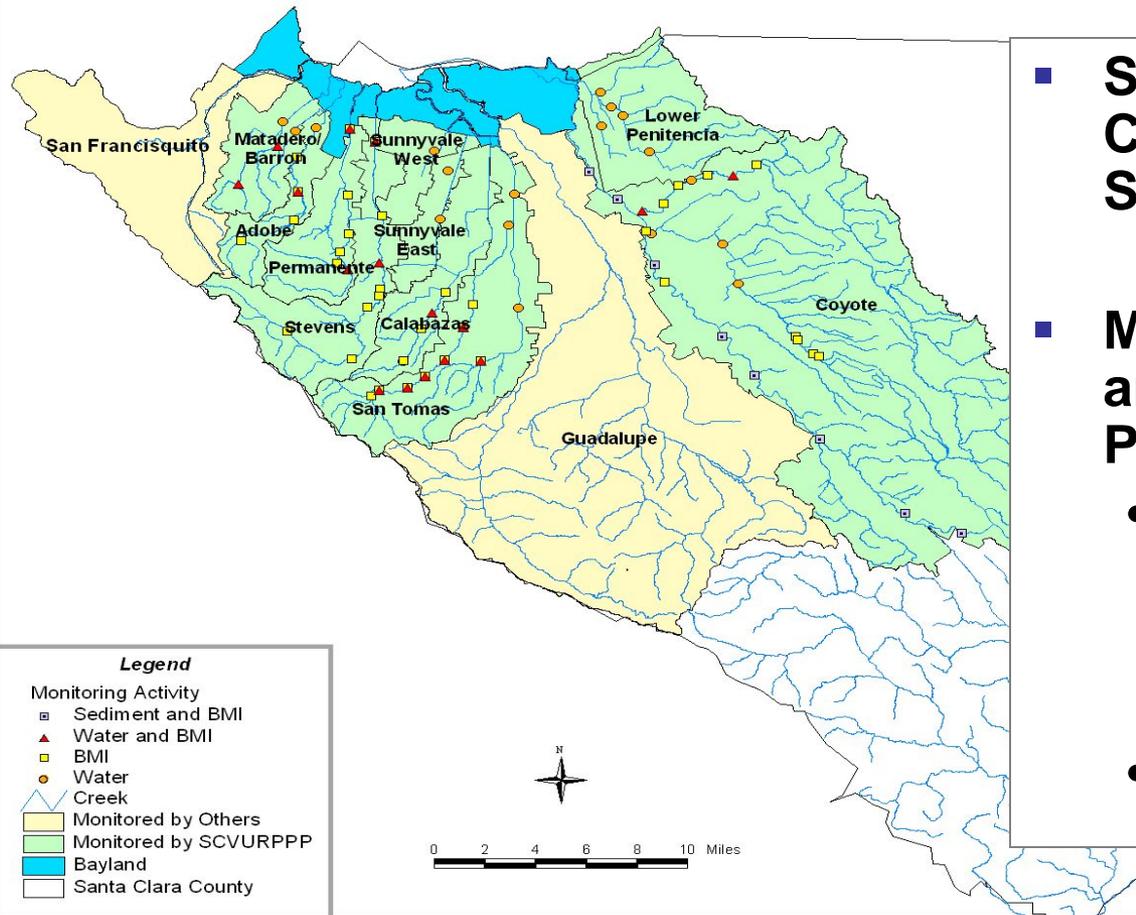
*California Aquatic Bioassessment Workgroup
November 19, 2008*

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Managing Scientist

Presentation Outline

- I. Lessons learned from previous water quality sampling and impetus for using SQT in creeks
- II. Introduction to the Sediment Quality Triad
- III. Development of SQT condition categories
- IV. Results, conclusions, and lessons learned
- V. Remaining questions and planned next steps

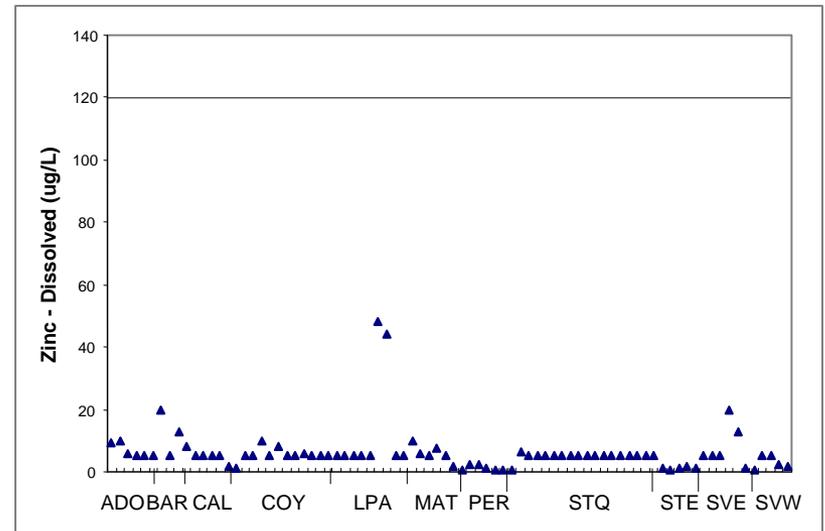
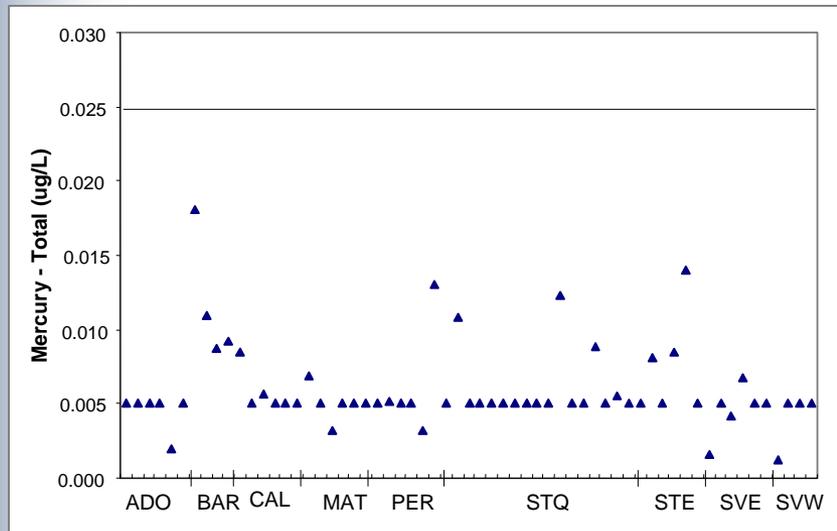
Non-Storm Event Sampling SCVURPPP (2002-2007)



- **Santa Clara Countywide Municipal Stormwater Program**
- **Multi-year Monitoring and Assessment Program**
 - Targeted Design
 - Bioassessment
 - Chemical WQ
 - Water Toxicity
 - 70+ sites

Non-storm Event Sampling Lessons Learned

Contaminant concentrations (metal and organics) during **non-storm events** have low variability and are consistently below water quality objectives



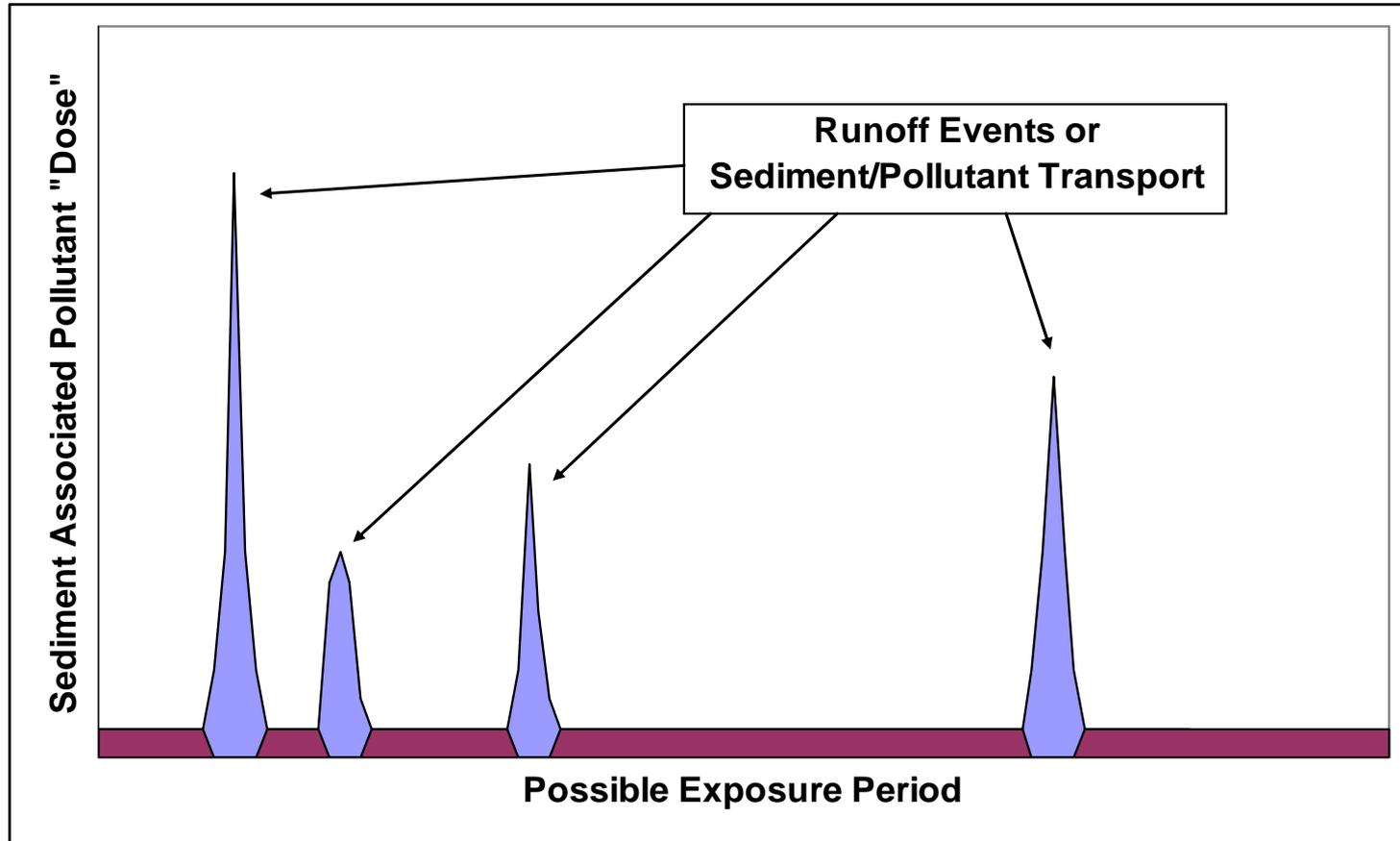
Lessons Learned

Many Agencies over the Last Decade

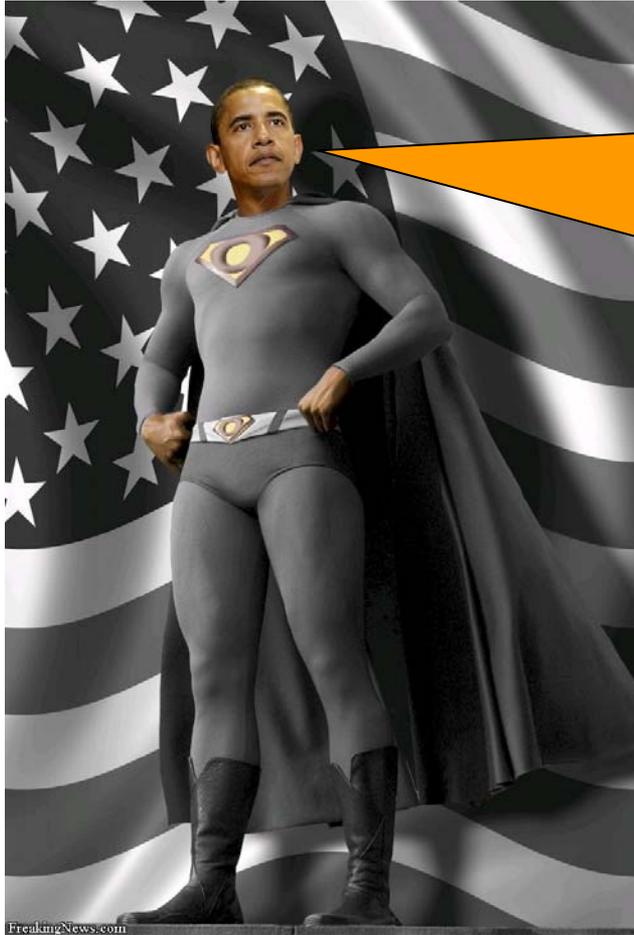
- Pollutant concentrations are highly variable both during and between storm events
- Better characterization of range, variability and average concentrations during storm events requires \$\$\$\$ (limited number of sites)
- Is this timeframe important from an biological exposure and pollutant dose perspective?



Conceptual (sediment associated) Pollutant Dose and BMI Exposure Relationship



Super-Obama Says....



I think it's time for a **CHANGE...maybe you should look in the bedded sediments.**

The need for “CHANGE”

■ What we know:

- Most pollutants of concern (POCs) are associated with sediment (fine fraction)
- Sediment transport from watersheds occurs during storm/runoff events
- Sampling during storms is expensive and may not represent what we care about – *To what degree are POCs impacting aquatic life?*

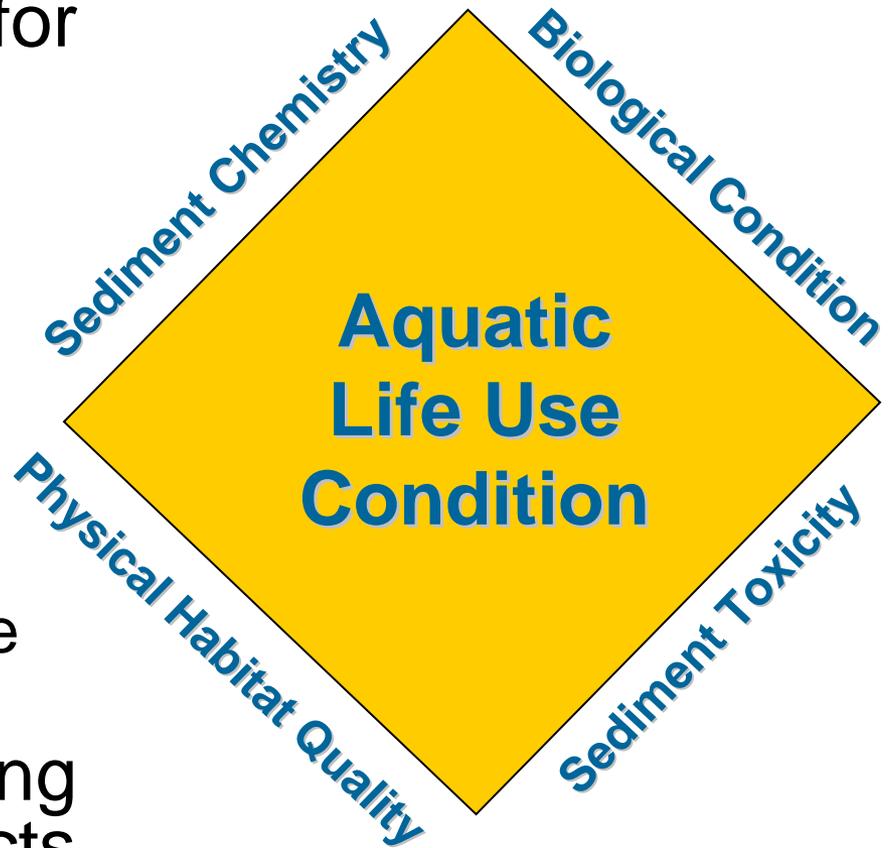


■ What we need:

- A holistic, robust and cost-effective framework for assessing aquatic life use condition in creeks

Sediment Quality Triad

- Developed in 1980's for Lakes and Estuaries
- Ecological Risk Assessment Method
- Weight of Evidence Approach
 - Uses multiple lines of evidence
 - Stressor and response variables
- Can assist in identifying likely causes of impacts

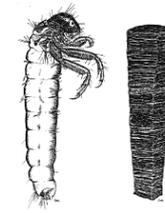


SQT Lines of Evidence

Category	Line of Evidence	Evaluation Tool
Biological	Benthic Macroinvertebrate (BMI) Bioassessments	Draft Preliminary B-IBI for Santa Clara Basin Creeks
Sediment Toxicity	10-day Bioassays of Bedded Sediment (<i>Hyalella azteca</i>)	% Survival (compared to control)
Chemistry	Chemical Analyses of Bedded Sediment for Metals, PCBs and Pyrethroids	Mean Sediment Quality Guideline Quotient
Physical Habitat	Qualitative Physical Habitat Assessments	Total PHAB Score

Biological Indicator and Assessment Tool

- Benthic Macroinvertebrates (BMIs)
 - Reach-wide benthos method
- Provisional B-IBI for Santa Clara Basin Creeks
 - Placeholder for SF Bay Area B-IBI
 - Reference conditions based on PHAB scores and BPJ
 - Southern and Northern California B-IBI metrics screened for range and discriminatory power



Caddisfly
Larva
(Trichoptera)



Fishfly Larva
(Megaloptera)



Black Fly
Larva
(Simuliidae)



Backswimmer
(Corixidae)



Stonefly
Nymph
(Plecoptera)



Mayfly Nymph
(Ephemeroptera)

Metric Comparison

B-IBI Metric	Southern California	Northern California	Contra Costa County	Santa Clara County
Coleoptera Richness	X	X		
EPT Richness	X	X	X	X
Predator Richness	X			X
Diptera Richness		X	X	X
% Collector individuals	X		X	X
% Noninsect Taxa		X	X	X
% Tolerant	X	X		
% Intolerant Taxa	X	X		
% Non-Gastropoda Scraper Individuals		X		
% Predator Taxa	X		X	
% Shredder Taxa		X		

Bioassessment Evaluation

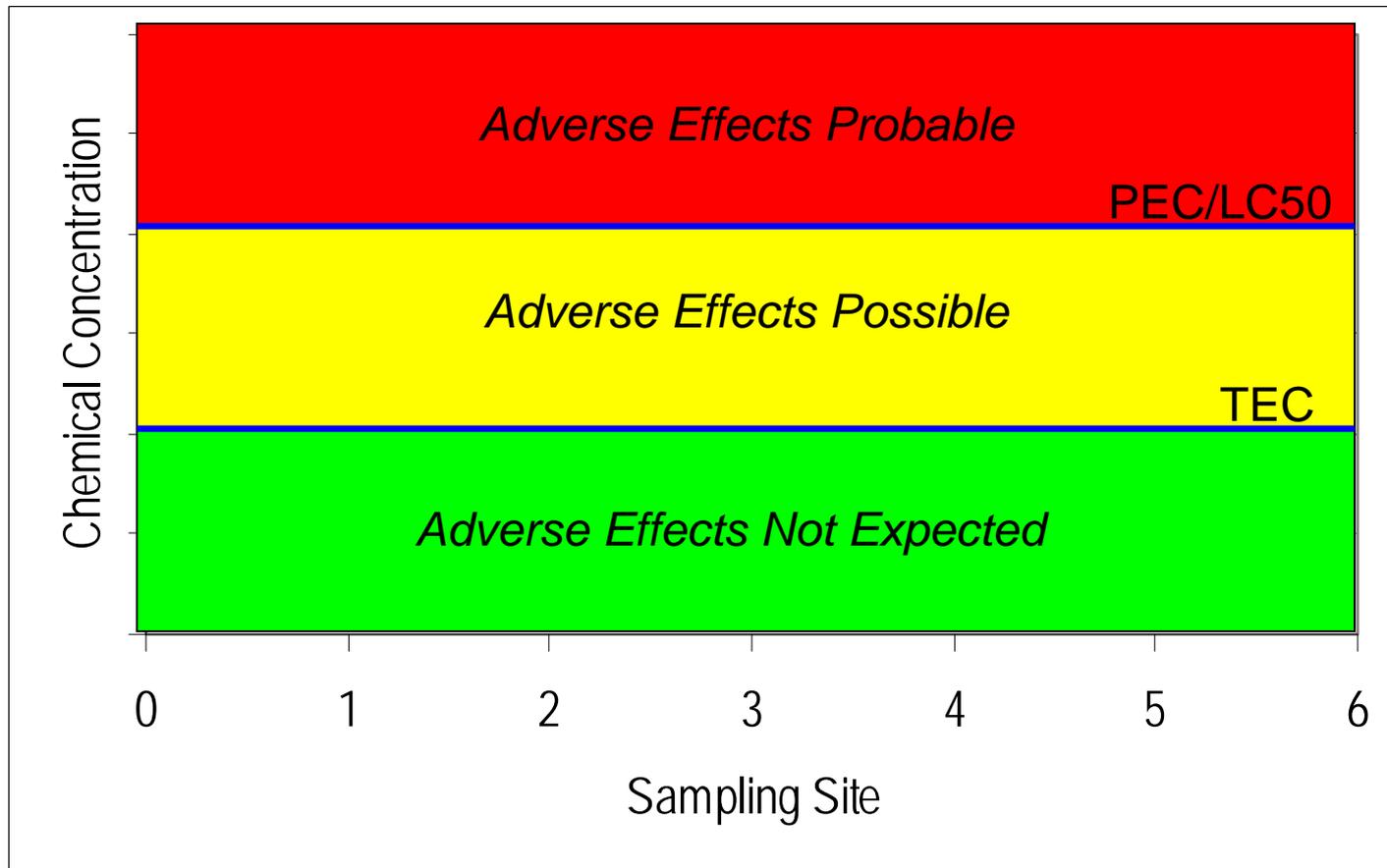
IBI Score	# EPT Taxa	% Non-Insect Taxa	# Diptera Taxa	# Predator Taxa	% Collectors
10	≥21	0 - 11	>10	≥12	0 - 48
9	19-20	12 - 19	10	11	49 - 54
8	17-18	20 - 26	9	10	55 - 60
7	15-16	27 - 32	8	9	61 - 66
6	13-14	33 - 39	7	8	67 - 72
5	11-12	40 - 46	6	7	73 - 78
4	9-10	47 - 53	5	6	79 - 84
3	7-8	54 - 60	4	5	85 - 90
2	5-6	61 - 67	3	4	91 - 96
1	3-4	68 - 74	2	3	97 - 99
0	≤2	75 -100	<2	≤2	100
Poor	Marginal		Fair	Good	Optimal
0-12	13-25		26-39	40-45	46-60

Sediment Quality Evaluation

- **Metals, PCBs and OC Pesticides**
 - **Probable Effects Concentration (PEC)**: concentrations above which one would expect to observe some degree of toxic response
 - **Threshold Effects Concentration (TEC)**: concentrations below which one would not expect to observe toxic responses

- **Pyrethroid Pesticides**
 - **Lethal Concentration 50 (LC50)**: concentrations that are on average lethal to 50% of organisms exposed.

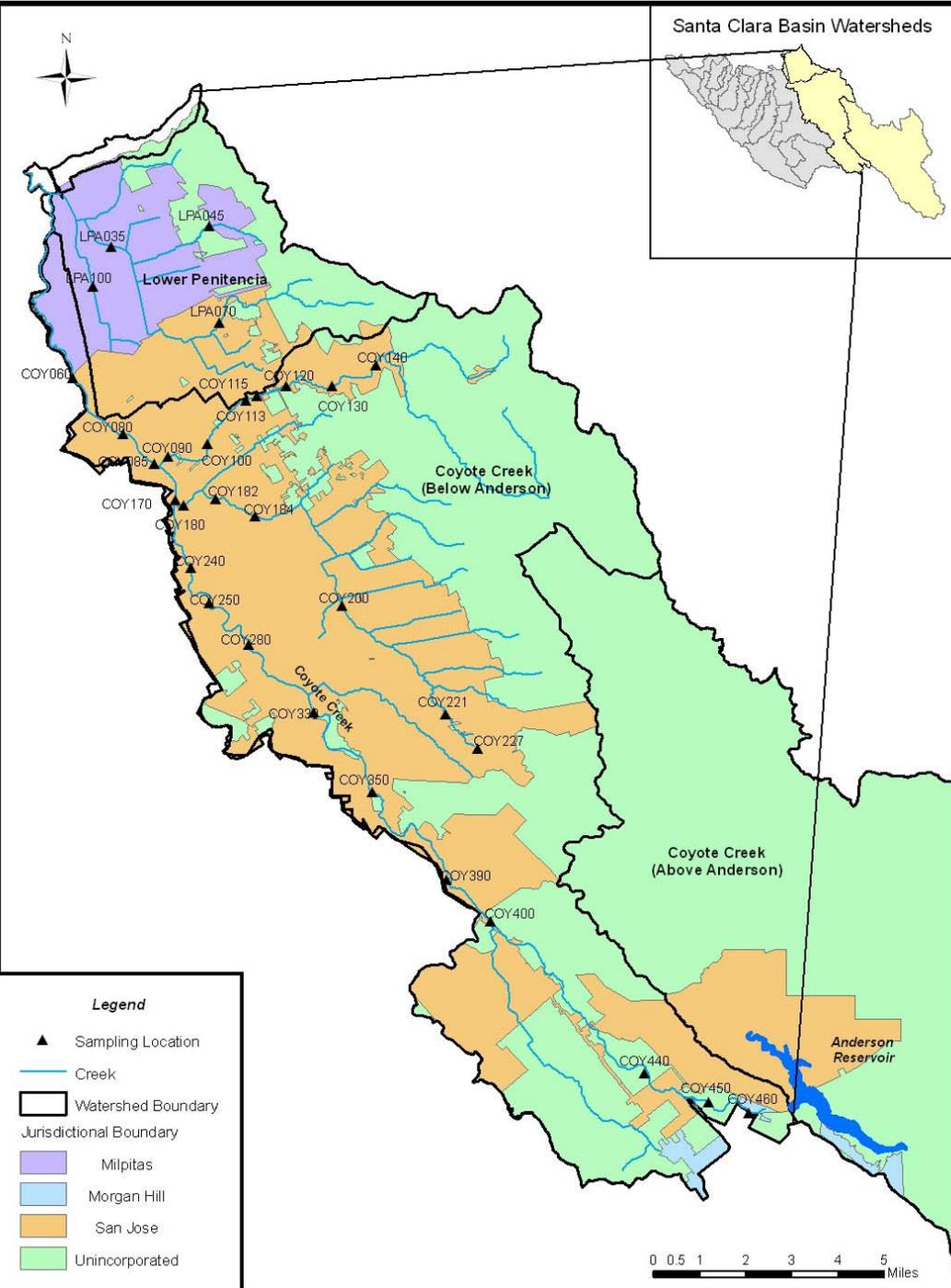
Sediment Quality Evaluation



Summary of Condition Categories

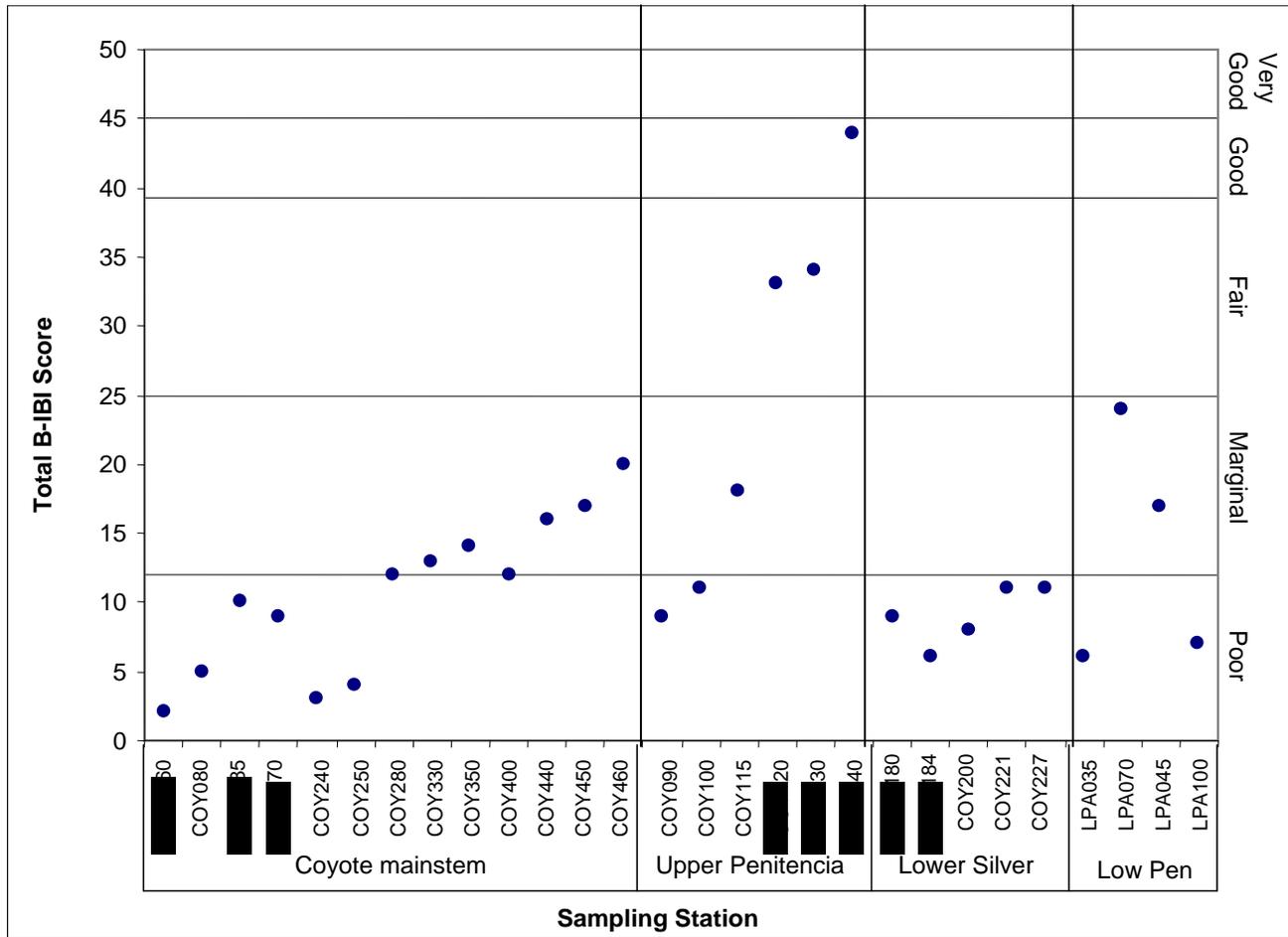
Condition Category	Sediment Chemistry (mean SQGQ)	Sediment Toxicity (% Survival Relative to Control)	BMI Bioassessment (B-IBI)	Physical Habitat Quality (PHAB)
Optimal	< 0.1	≤ 90	60-46	60-49
Good	0.1 - <0.5	89-80	45-40	48-37
Fair	0.5 - <1.0	79-54	39-26	36-25
Marginal	1.0- <5.0	53-27	25-13	24-13
Poor	> 5.0	26-0	12-0	12-0

Pilot SQT Watersheds FY 2007-08

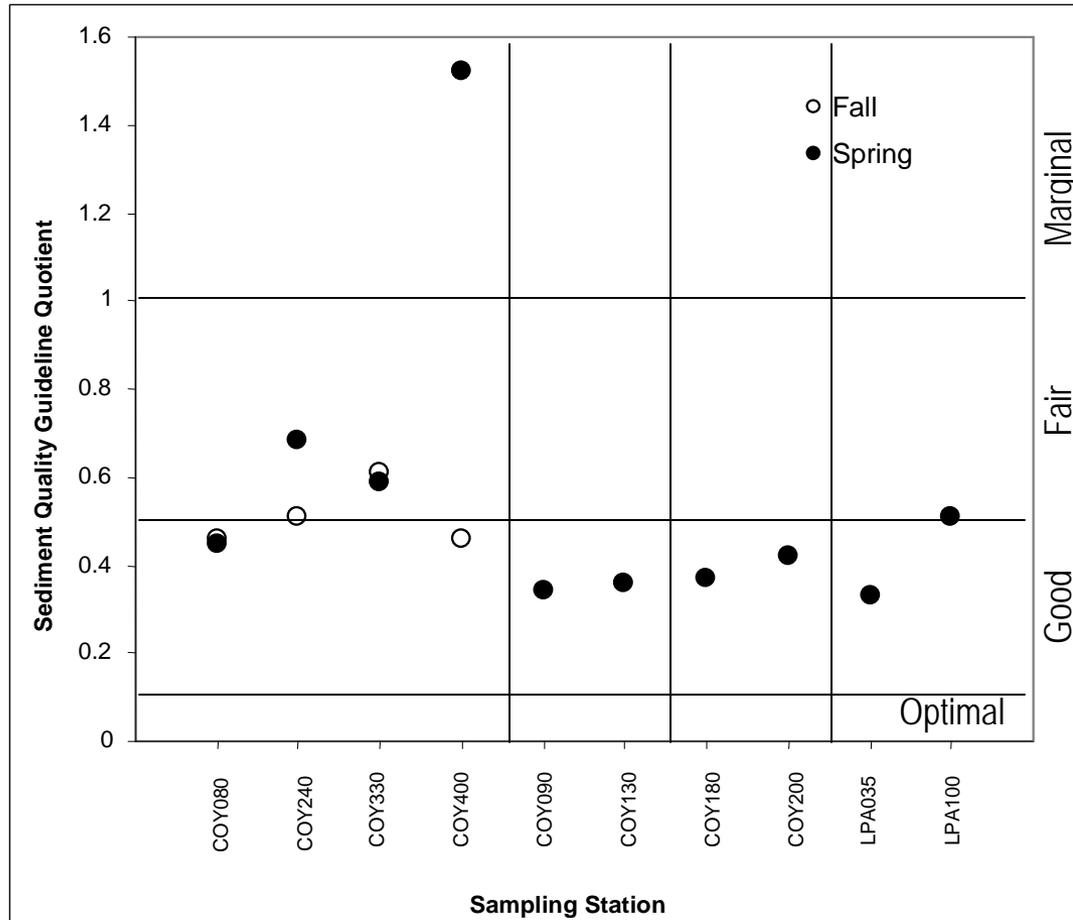


- **Coyote Creek**
 - Largest tributary to South San Francisco Bay (~ 320 mi²)
 - 3000 ft at headwaters
 - Perennial flow
 - Large open space in upper watershed, heavily urban mid/lower watershed
 - Tributaries - Upper Penitencia and Lower Silver
- **Lower Penitencia Creek**
 - Heavily urbanized throughout

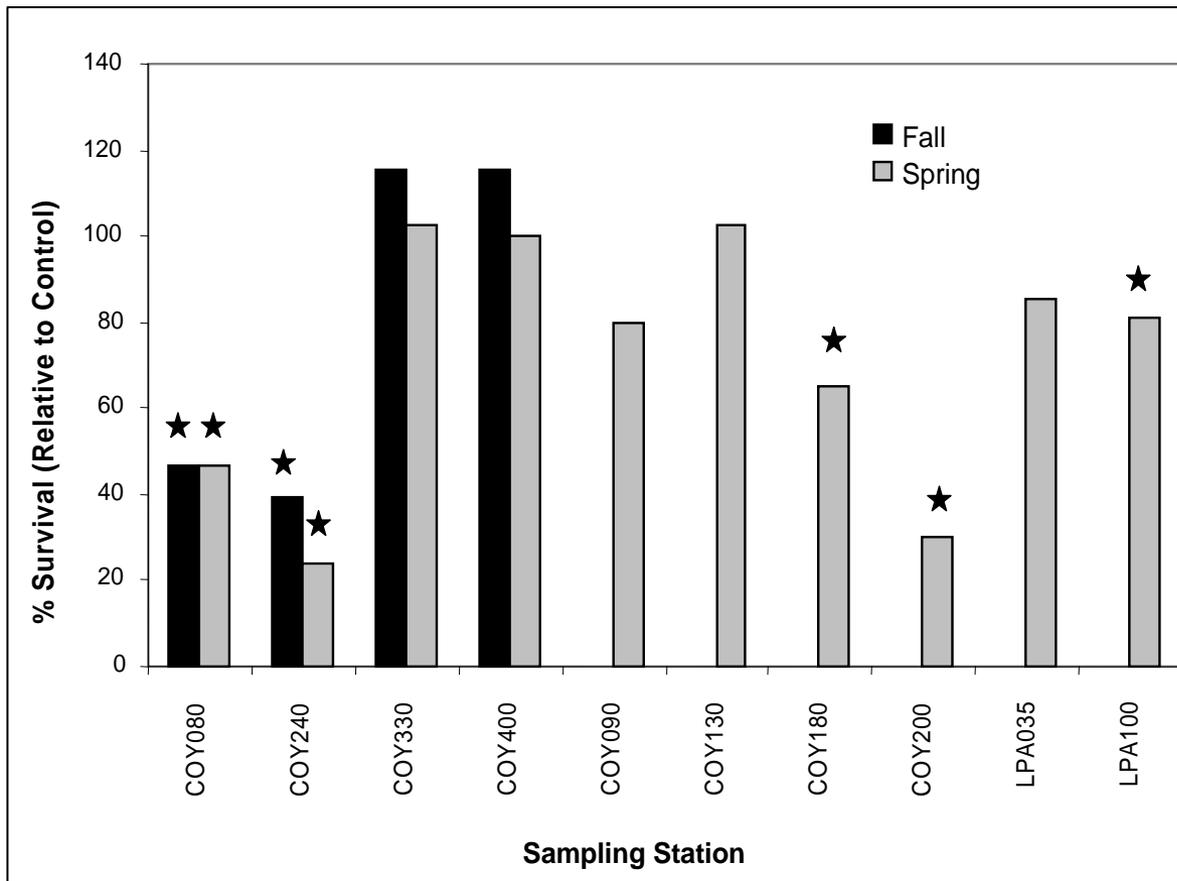
Bioassessment Results

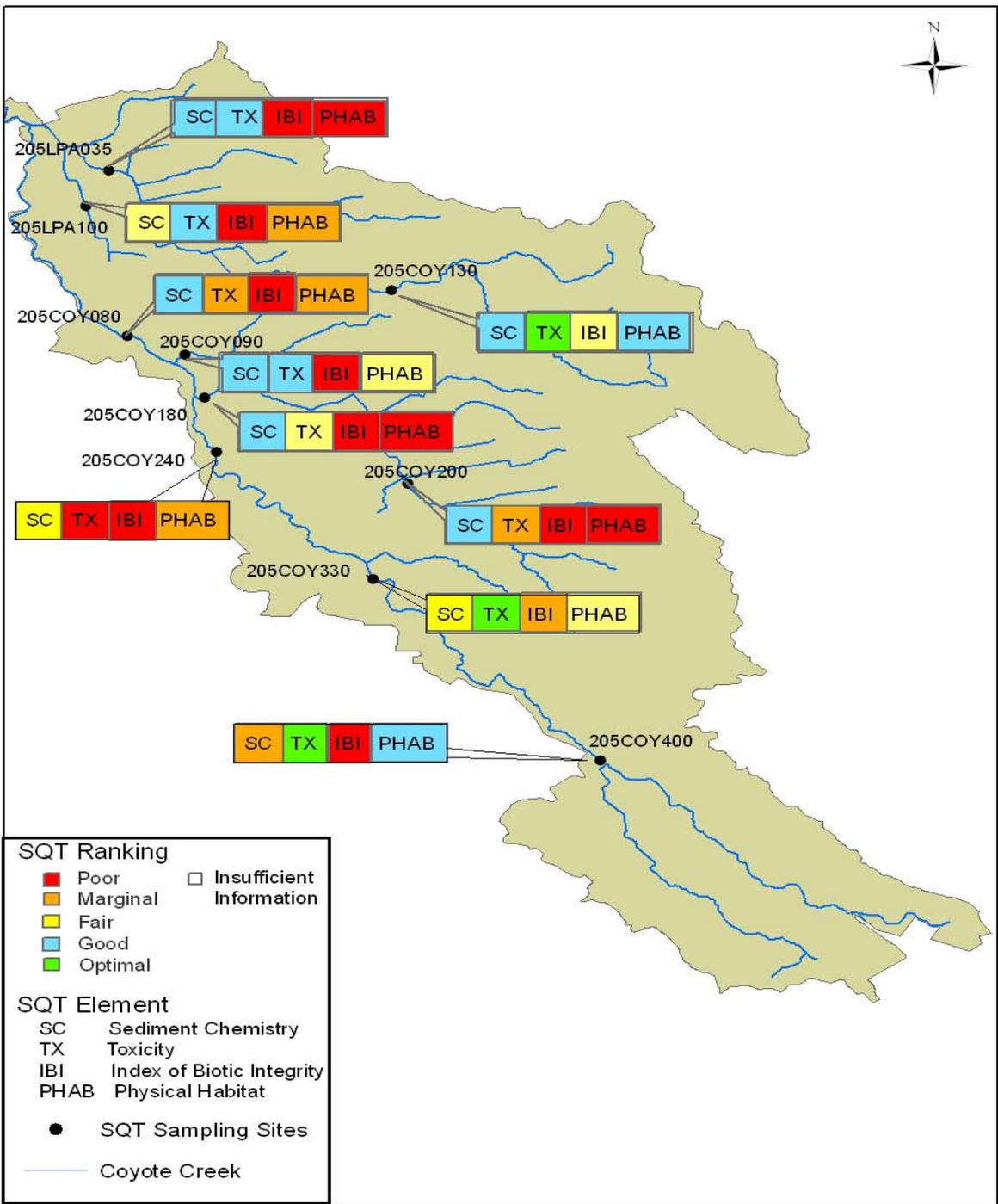


Sediment Quality



Sediment Toxicity

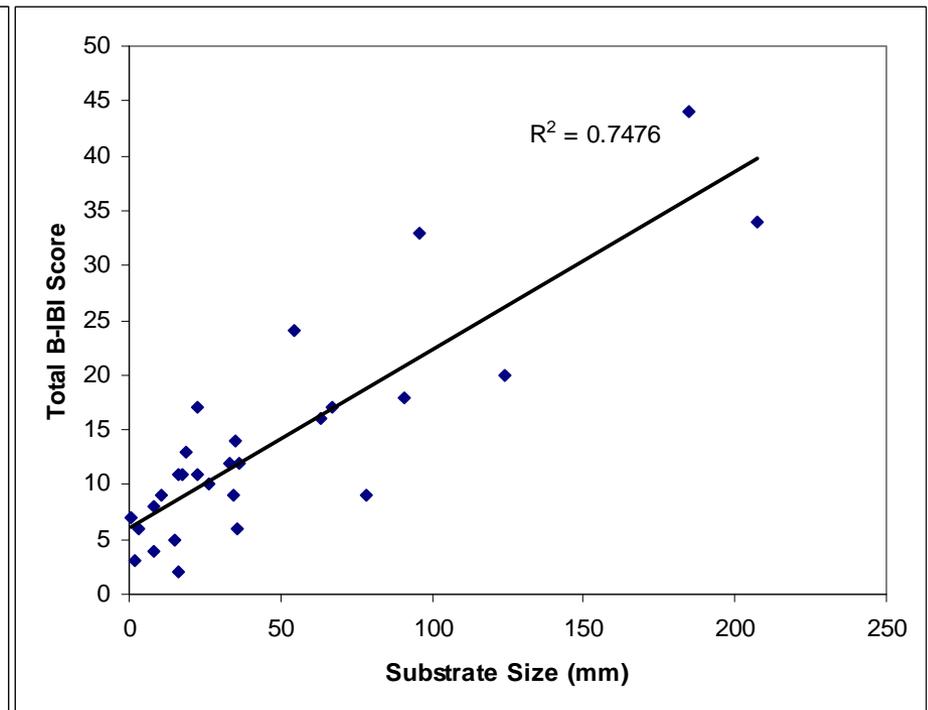
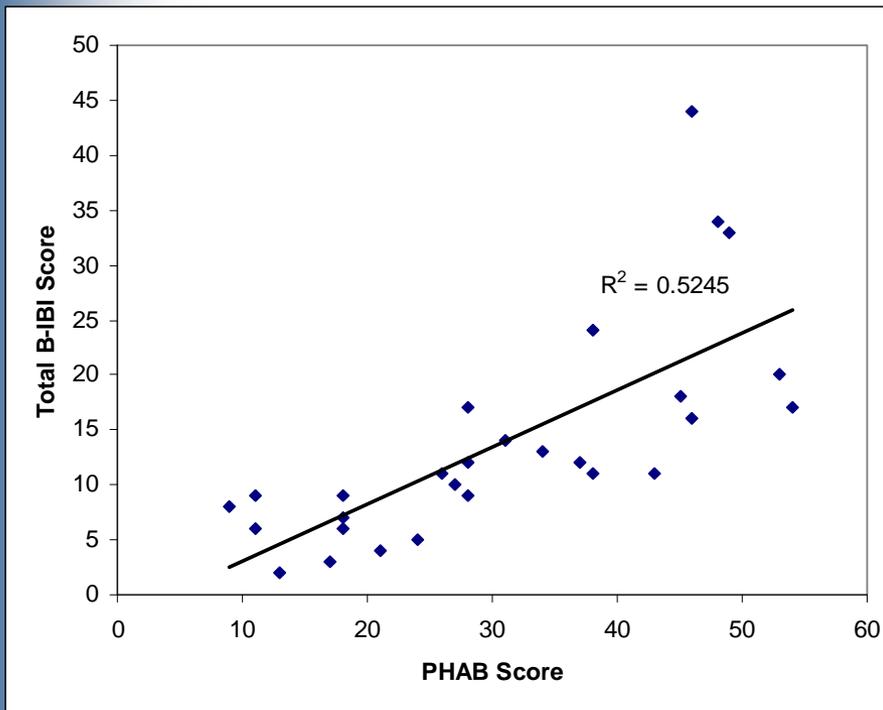




Sediment Quality Triad Results

Variables Explaining Biological Integrity

Reach-scale Physical Habitat



Potential Causes of Toxicity

Sampling Site	Sediment Toxicity (% Survival Relative to Control)	Pyrethroid Concentration Greater than PEC(SQGQ) ¹			
		Bifenthrin	Cyfluthrin	Cypermethrin	L-Cyhalothrin
Coyote Creek					
COY080	Yes (47%)	Yes (1.22)	-	-	-
COY240	Yes (24%)	Yes (1.25)	No (0.29)	Yes (1.21)	No (0.03)
COY330	No	-	-	-	-
COY400	No	-	-	-	-
Coyote Creek Tributaries					
COY090	Yes (80%)	No (0.61)	-	-	-
COY130	No	-	-	-	-
COY180	Yes (65%)	-	-	Yes (1.25)	-
COY200	Yes (30%)	No (0.96)	-	No (0.33)	-
Lower Penitencia Creek					
LPA035	No	-	-	-	-
LPA100	Yes (81%)	Yes (1.32)	-	-	-

Conclusions

- **Biological Condition**
 - Coyote Creek mainstem - Poor to Marginal
 - Upper Penitencia – Good to Very Good
 - Lower Silver - poor condition
 - B-IBI scores appear to be correlated with average substrate size and reach-scale physical habitat quality

- **Physical Habitat Quality**
 - Poor to marginal at most downstream sites
 - Upstream sites (drain open space) good

Conclusions

- Sediment Chemistry
 - Metals do not appear to be at problematic levels
 - Pyrethroid concentrations are above known toxic concentrations at some sites

- Sediment Toxicity
 - Toxicity was observed in 6 of 10 sites
 - Co-occurrence of pyrethroid concentrations above adverse effects levels at these sites suggests that pyrethroids may be the cause of toxicity.

Lessons Learned

Sediment Quality Triad (SQT)

- Provides a robust and holistic method to assessing the magnitude and extent of impacts on aquatic life uses.
- Can assist managers in determining what creek sites/reaches have the greatest impacts, and which stressors may be causing the observed biological responses.

Challenges

- Where's all the fine sediment????
- Sediment effects thresholds
 - Naturally occurring metals
 - Lack of consistent adverse effects threshold for organic chemicals
 - Where to set the condition categories
- Need to include more quantitative PHAB measurements at multiple scales
- Robustness of Countywide B-IBI

Next Steps

- Further Evaluations of Causes of Toxicity in Santa Clara Basin Creeks
- Reissuance of Stormwater NPDES Permit
 - Monitoring requirements for all SQT lines of evidence (limited # of sites)
 - Possible regional sampling design
- Continued Development of B-IBI for SF Bay Area Creeks

SF Bay Area B-IBI Development

- Began in 2004 through the Bay Area Macroinvertebrate Bioassessment Information (BAMBI) network
 - Collaboration with Water Board Region 2, stormwater programs, non-profit organizations, and volunteer monitoring groups
 - Annual meetings/presentations
- B-IBI Work plan development



SF Bay Area Creeks

B-IBI Work Plan

1. Acquire and Compile Existing Data
2. Standardize and Import into Centralized Database
3. Screen Metrics Used in Southern and/or Northern Cal B-IBIs
4. Establish Preliminary Reference Conditions for Bay Area Creeks
5. Test and Select Metrics
6. Score Metrics
7. Confirm Metrics Using Validation Dataset

B-IBI Data Summary

- Temporal Extent
 - Spring 2000-2006
- Spatial Extent
 - 8 county region
 - 722 events at 477 Sites
- Data Quality
 - Target-riffle method
 - Professional Identification
 - Standardize to 500 organisms/sample



Collaborating Programs/Organizations

Program/Organization	# of Events
Alameda Stormwater (ACCWP)	78
Contra Costa Citizens (CCCBMI)	88
Contra Costa Stormwater (CCCWP)	164
Napa River (ICARE)	66
Marin Stormwater (MCSTOPPP)	86
San Francisco Water Board	167
Santa Clara Stormwater (SCVURPPP)	72
Sonoma County (SEC)	27
San Mateo Stormwater (STOPPP)	24
Total	722

Reference Condition Development

- **GIS based approach consistent with Northern and Southern Cal B-IBIs**
 - Disturbance variables at 2 geographical scales (watershed and 500m-local)
 - % Urban Land Use, % Ag Land Use, % Natural Land Use, Road Density
 - Currently at this stage = ~150 sites
 - Good spatial distribution
 - Possible Coastal/Inland Differences
 - Kevin Lunde – UC Berkeley
- **Next Step – Further screen pool through local stakeholder input and PHAB information**

Anticipated Schedule

- End of Calendar Year - Complete Reference Site Selection
- January 2009 - Test, Select, Score and Confirm Metrics
- Spring 2009 - Peer Review
- Fall/Winter 2009 - Submit to Journal



A blue-tinted landscape of rolling hills and mountains covered in dense evergreen forests. The word "Questions?" is overlaid in white, italicized font in the center of the image.

Questions?