Stormwater Runoff Effects on Santa Monica Bay

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https://www.sccwrp.org/

The Backdrop

- This project was conducted over 20 years ago!
- Municipal stormwater (MS4) regulatory discharge (NPDES) permits were first being issued
- Nobody knew much about stormwater effects at the time
- Citation: Bay, Jones, Schiff, Washburn. 2003. *Marine Environmental Research* 56:205-223

Study Questions

- Are stormwater discharges from Ballona Creek toxic to marine organisms?
- What is the extent and magnitude of marine organism toxicity offshore Ballona Creek during storm events?
- What are the contaminants responsible for the toxicity to marine organisms?

Sea Urchin Fertilization Test

- Endemic species to California
- Short-term test (20 min exposures) amenable to stormwater inputs
- Measures success of embryo fertilization
- EPA and California approved method

Study Answers

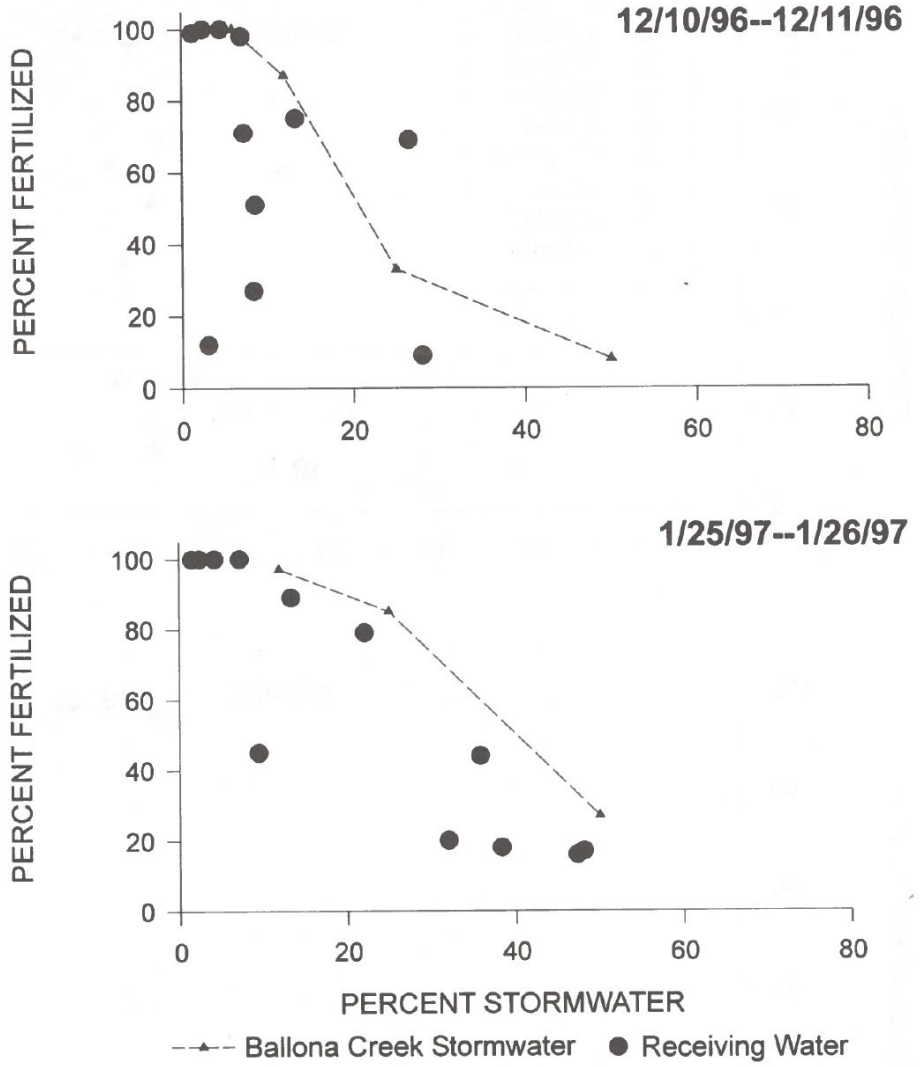
- Stormwater discharges from Ballona Creek are toxic to marine organisms
  - Even after adjusting for salinity

- Toxicity extended up to 1.5 kilometers offshore Ballona Creek, and as much as 4 kilometers alongshore during storm events

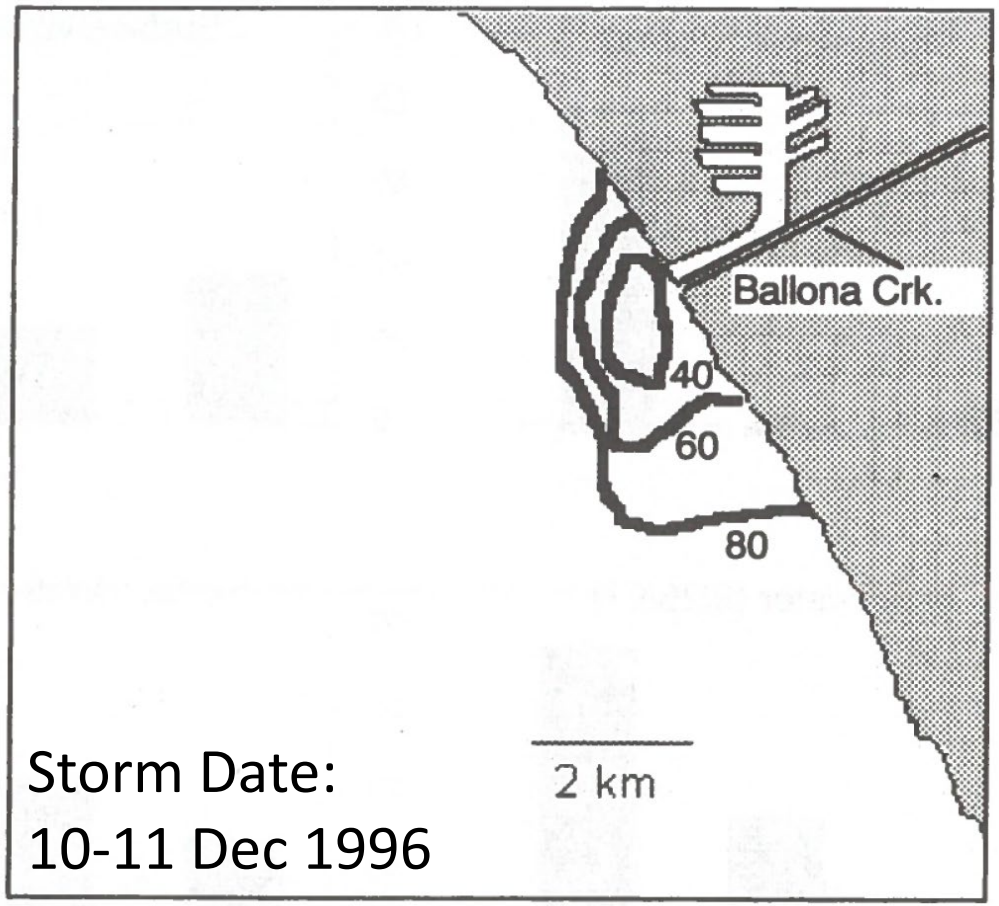
- Trace metals, particularly zinc, accounted for the toxicity observed from stormwater discharges
  - Utilizing a Toxicity Identification Evaluation (TIE)

Discharges from Ballona Creek Were Toxic to Marine Organisms

- Two different storms, similar conclusions
- Both samples of Ballona Creek runoff were highly toxic (dashed line), even after adjusting for salinity
- Samples collected offshore (black circles) were toxic in roughly similar proportions to diluted stormwater



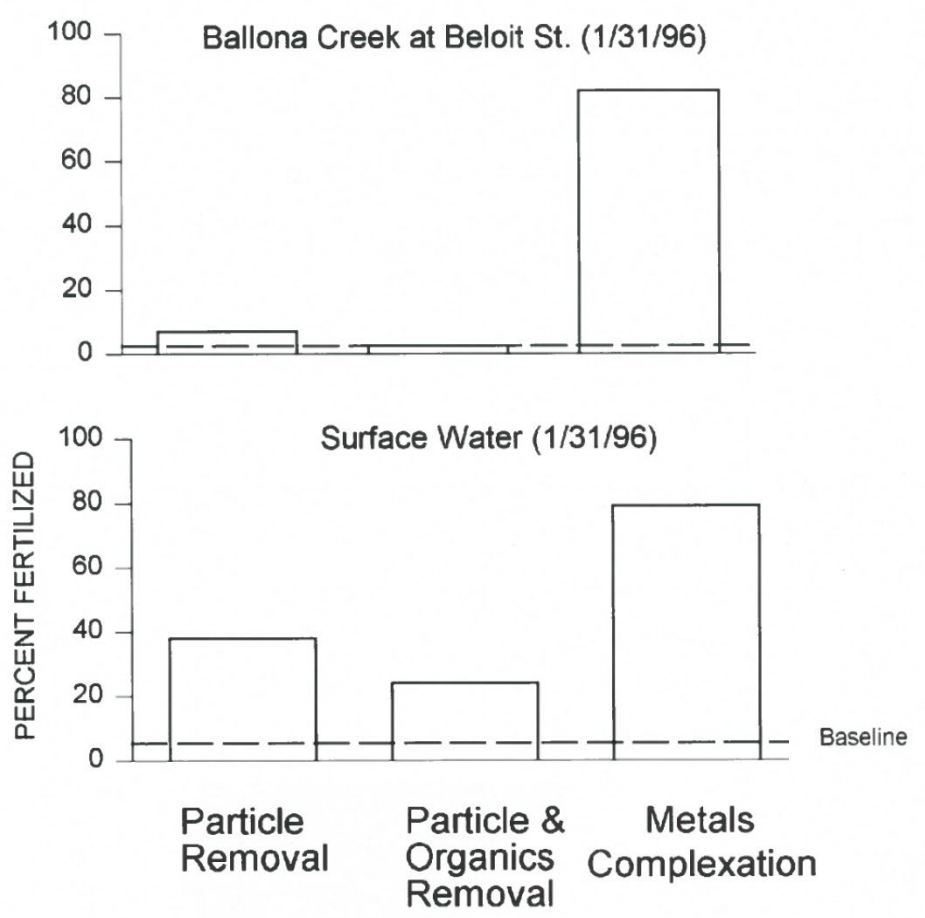
Measurable Extent and Magnitude of Toxicity Offshore During Storm Events



- Ships were deployed during multiple storm events to map the stormwater plume and collect samples for toxicity testing
- Using logistic regression between salinity and toxicity, mapped gradients of % sea urchin fertilization relative to controls
- 80% fertilization relative to controls (default toxic level) extended kilometers offshore and alongshore during storm events
- Offshore grab sample results coincided with estimated levels of mapped toxicity to sea urchins

Trace Metals Were the Primary Toxicant

- TIEs are a forensic tool for identifying contaminants in toxic samples
  - Selectively remove or “de-toxify” certain compound classes
- Trace metals accounted for the majority of toxicity in both Ballona Creek runoff and Offshore samples
- Concentration data pointed towards zinc as the likely culprit



Comparison of dissolved trace metal concentrations in Ballona Creek stormwater and toxicity levels in sea urchin fertilization tests

Metal	Toxicity Levels[a]		Stormwater Concentrations[b]	
	No Effect Concentration (NOEC)	Effects Concentration at 50% (EC50)	Mean	Standard Deviation
Barium	>1,000	>1,000	39	25
Cadmium	3,700	11,500	<1	
Chromium	>100,000	>100,000	<5	
Copper	17	30	13	14
Lead	>4,000	>4,000	<5	
Nickel			6	4
Zinc	8	29	66	88

[a] From SCCWRP tests with individual metals spiked in seawater

[b] From 35 composite storm samples analyzed during 1996-2000 (LACDPW 2000)

Epilogue

- SCCWRP repeated this wet weather study with sea urchin fertilization toxicity tests a few years later in San Diego Bay offshore of Chollas Creek
- Wet weather toxicity conclusions were very comparable to Santa Monica Bay, including extent and magnitude
- Toxicity was once again largely attributed to zinc using TIEs
- Schiff, Bay, Stransky. 2001. *Environmental Monitoring and Assessment* 81:119-132