

Pollutants in Runoff From Northern and Southern California Neighborhoods

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Delta Pelagic Organism Decline Contaminants Work Team

CVRWQCB

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Runoff From Urban Landscapes

Evaluating BMP effectiveness
to reduce volumes and
improve quality of runoff
from urban environments



Runoff From Urban Landscapes

Evaluating BMP effectiveness

Project outline

- Controlled landscape studies
- Residential runoff characterization
- Load estimation
- Outreach

Collaborations

- UCD, UCR, UC-IPM, USDA-CUFR
- UCCE Sacramento and Orange Counties
- NGOs and consultant



Runoff From Urban Landscapes

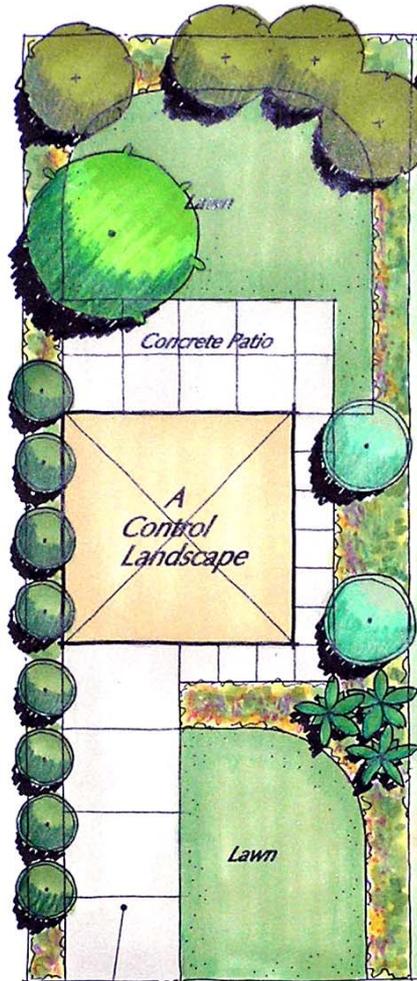
Evaluating BMP effectiveness

Project outline

- Controlled landscape studies
 - Landscape installations at SCREC
- Irrigation Practices
- Pesticides
- Plant Selection
- Vegetative Buffers
- Porous Surfaces
- Sediment Control
- Alternative Pest Control

Landscape Demonstration Sites

South Coast Research & Extension Center

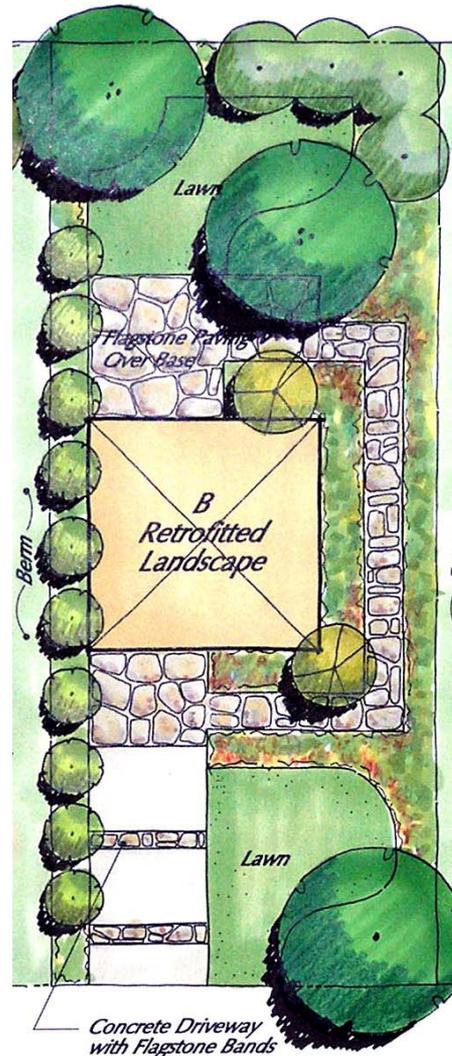


“Conventional” landscape

- Trees in turf, exotic species
- Cool season turfgrass
- Concrete drive, walkways, patio
- Standard solid wall drain line
- Standard spray heads
- Automatic irrigation timer on default setting

Landscape Demonstration Sites

South Coast Research & Extension Center



Low Impact 1 landscape

- More drought tolerant species
- Warm season turfgrass
- UC Verde buffalograss
- Slot drains added to drive
- Flagstone walkways, patio
- Rain barrel collection
- Low flow spray heads
- Soil moisture -based irrigation controllers
- Hydrozones

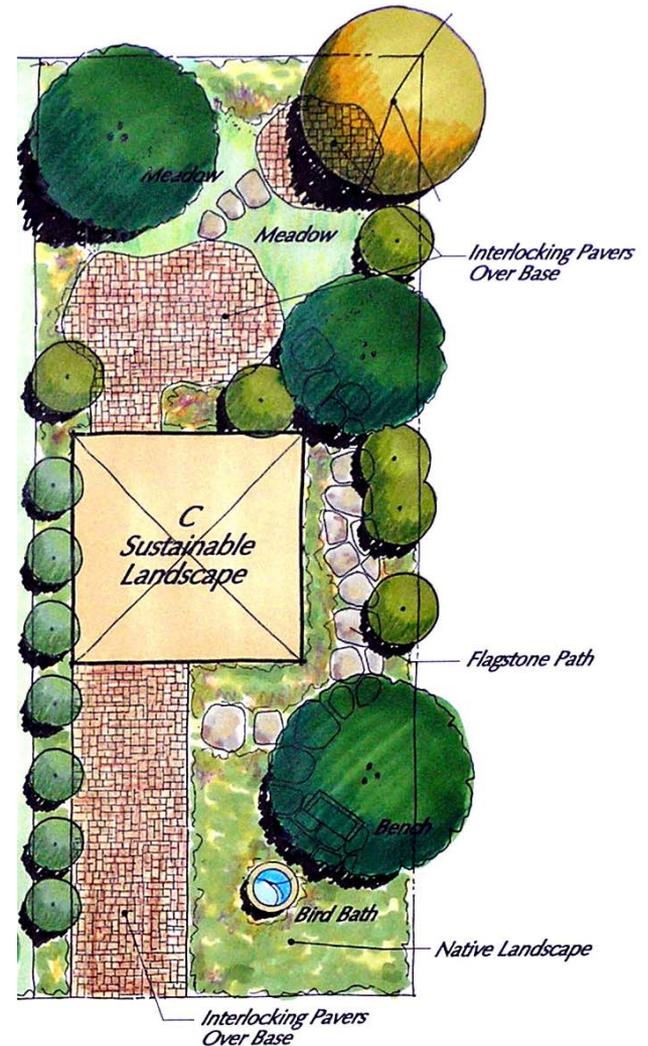
Landscape Demonstration Sites

South Coast Research & Extension Center



Low Impact 2 landscape

- Predominantly native species
- Meadow (*Carex pansa*)
- Interlocking pavers
- Flagstone walkway
- Dry well
- Drip irrigation
- ET based irrigation controller
- Hydrozones



Landscape Demonstration Sites

South Coast Research & Extension Center



Conventional

Low Impact 1

Low Impact 2

Runoff From Urban Landscapes

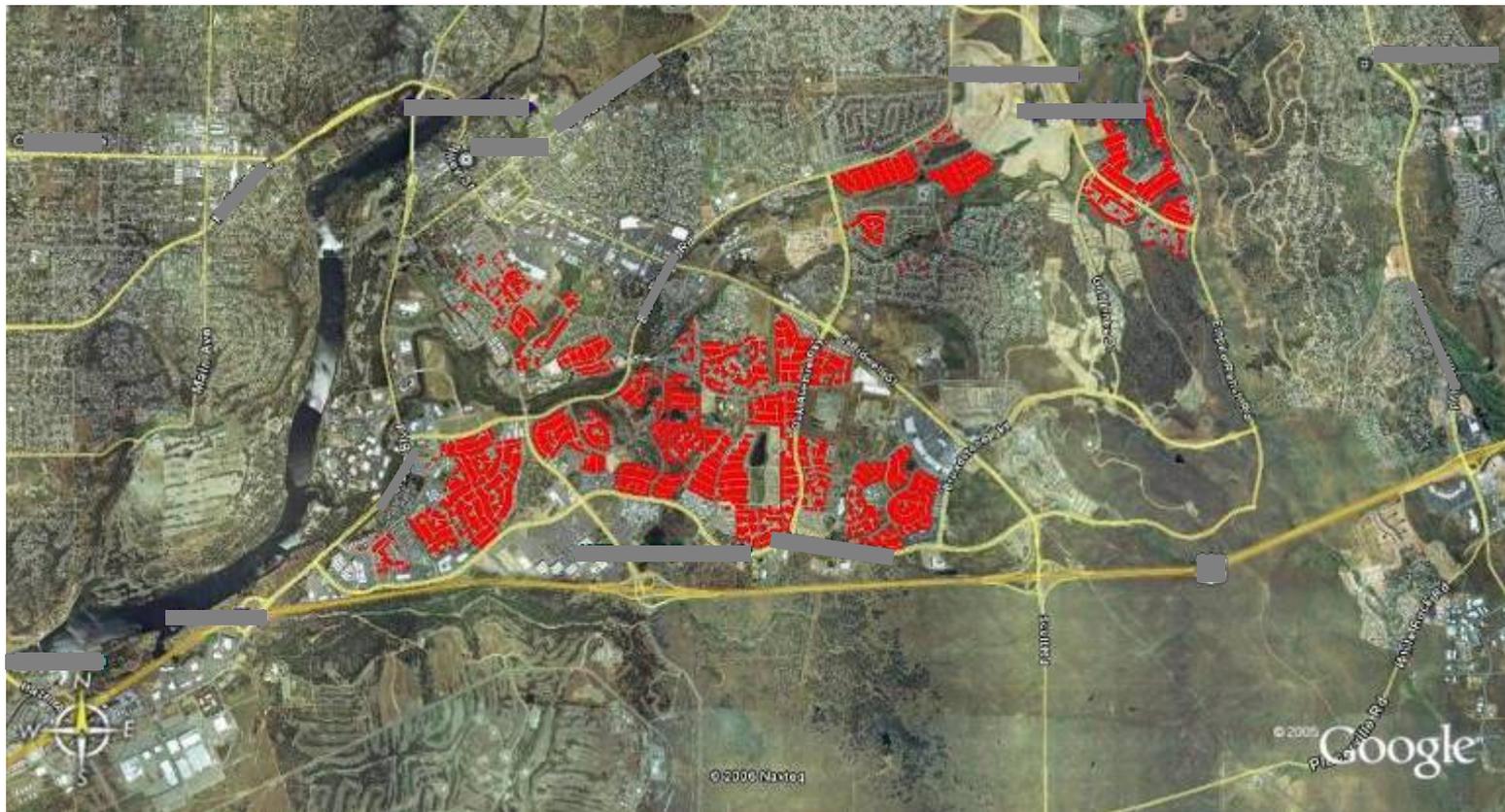
Evaluating BMP effectiveness

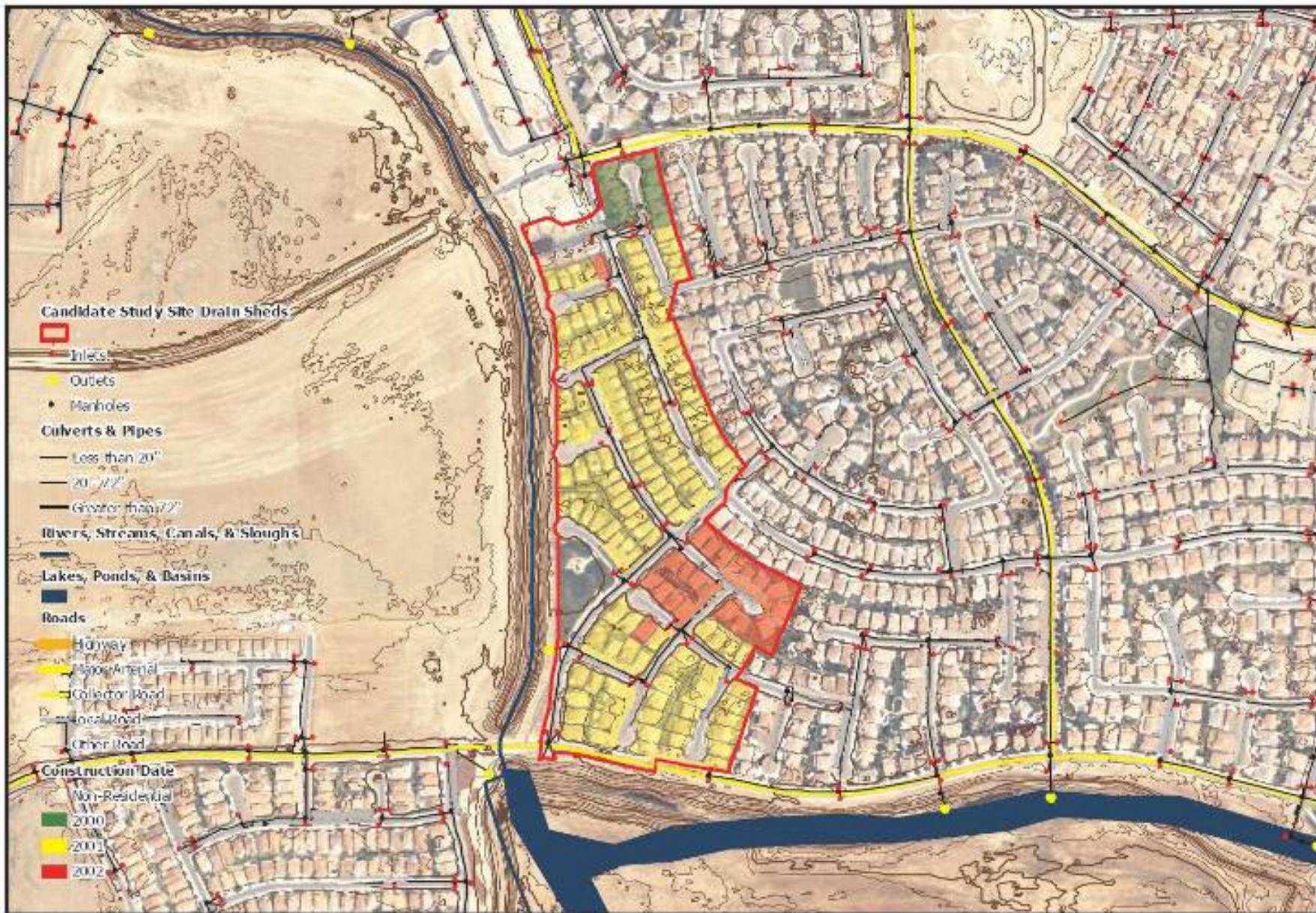
Project outline

- Controlled landscape studies
- Residential runoff characterization
 - 8 sites in Sacramento and Orange Counties
 - Site criteria
 - 150 to 460 homes
 - 4-20 years old
 - Primarily single-family residential
 - Outfall access

Runoff From Urban Landscapes

Evaluating BMP effectiveness



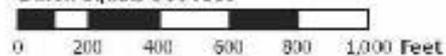


Evaluating Best Management Practices (BMPs)
 Effectiveness to Reduce Volumes of Runoff and
 Improve the Quality of Runoff from Urban Environments

Candidate Study Site #5

May 25, 2006

1 inch equals 500 feet



Runoff From Urban Landscapes

Evaluating BMP effectiveness

- Residential runoff characterization
 - Data collected includes:
 - Nutrients
 - NO_3 , TKN, PO_4 , total P
 - Drinking Water Constituents of Concern (COCs)
 - TOC, DOC, Br^- , Cl^- , TDS, TSS, turbidity
 - Pesticides
 - diazinon, chlorpyrifos, pyrethroids, fipronil

Runoff From Urban Landscapes

Evaluating BMP effectiveness

Residential landscape studies

- Data collected includes:
 - Nutrients
 - Water Constituents of Concern (COCs)
 - Pesticides
 - Pathogens
 - Total coliform
 - *Giardia*
 - *Cryptosporidium*
 - *E. coli*
 - Enterococci
 - Somatic coliphages
 - Male-specific coliphages
 - *Clostridium perfringens*

Runoff From Urban Landscapes

Water Sample Collection

	Q1	Q2	Q3	Q4
2006		Weekly*	Weekly*	Weekly
2007	Biweekly	Weekly	Weekly	Weekly
2008	Biweekly	Biweekly	Biweekly	Weekly
2009	Monthly	Monthly#		

Up to 5 early storms of each season

Runoff From Urban Landscapes

Water Sample Collection



Photo: B.Hollings



Photo: L.Oki



Photo: L.Oki

Runoff From Urban Landscapes

Evaluating BMP effectiveness

Project outline

- Controlled experiments
- Residential landscape studies
 - Data collected includes:
 - Flows (depth, velocity)
 - Temperature
 - pH
 - Electrical Conductivity
 - Rainfall



Runoff From Urban Landscapes

Sensors

Flow velocity and depth
pH, EC, temperature



Runoff From Urban Landscapes

Sensors

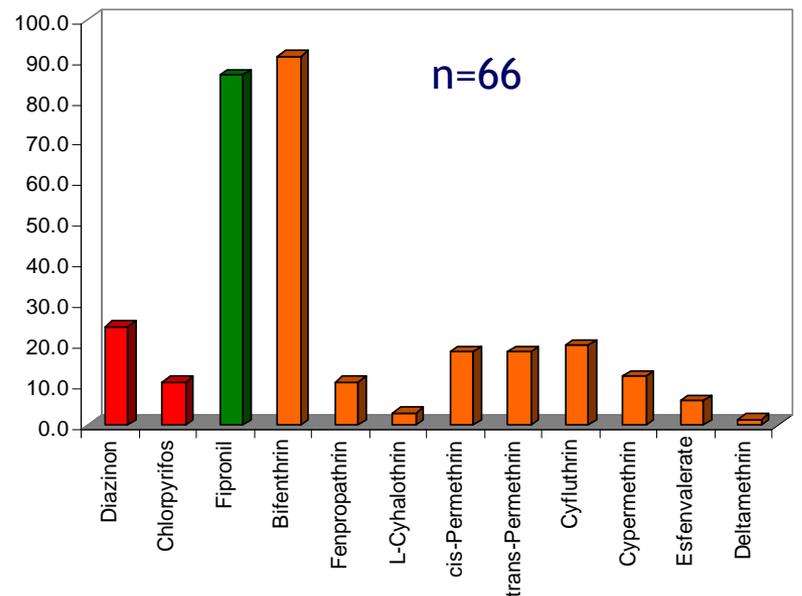
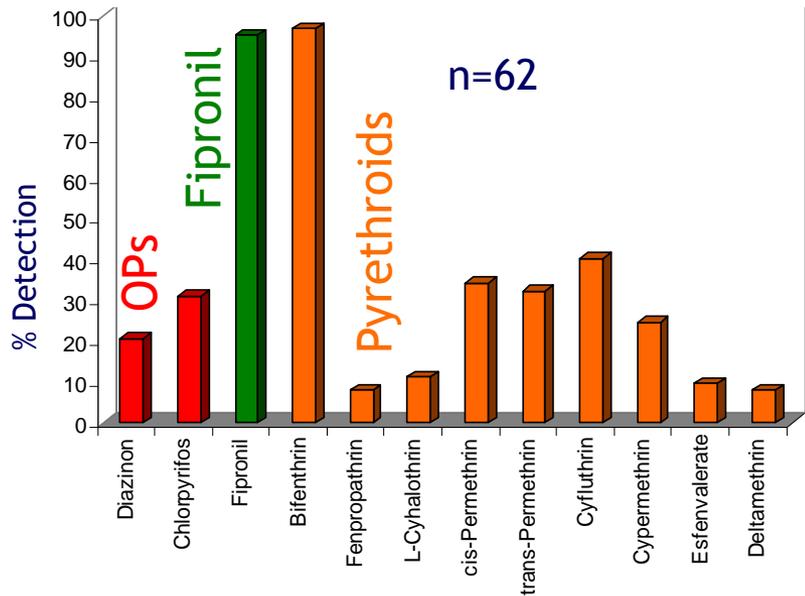
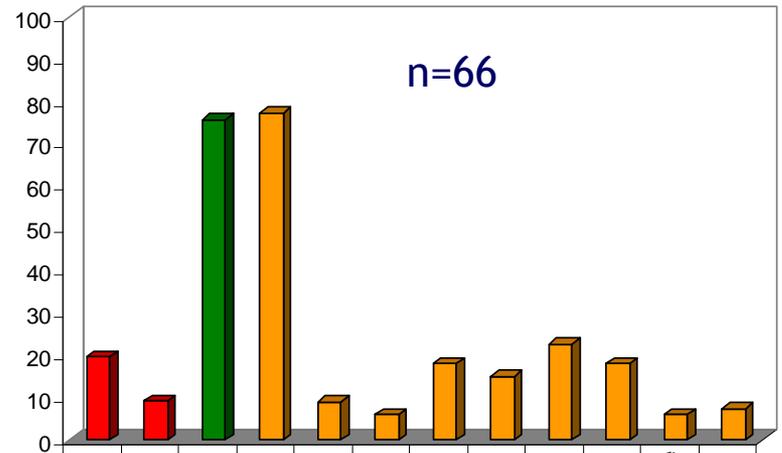
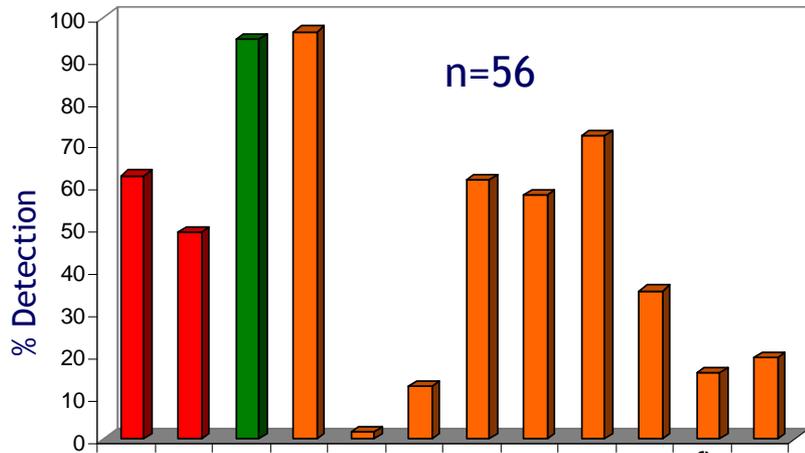
Flow velocity and depth
pH, EC, temperature



Photos: L. Oki

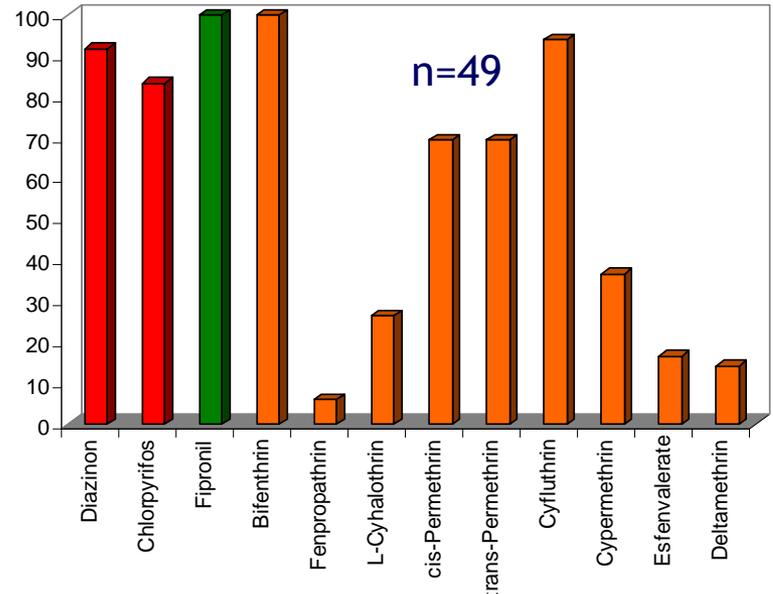
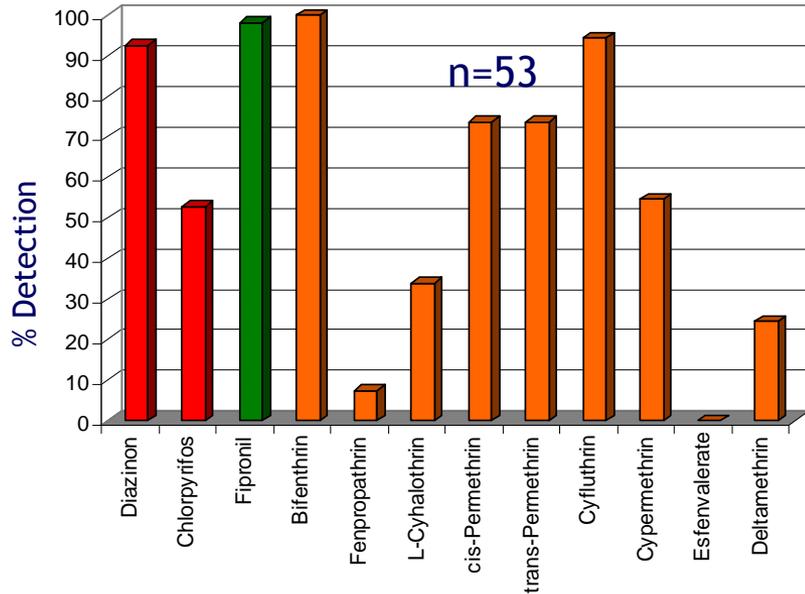
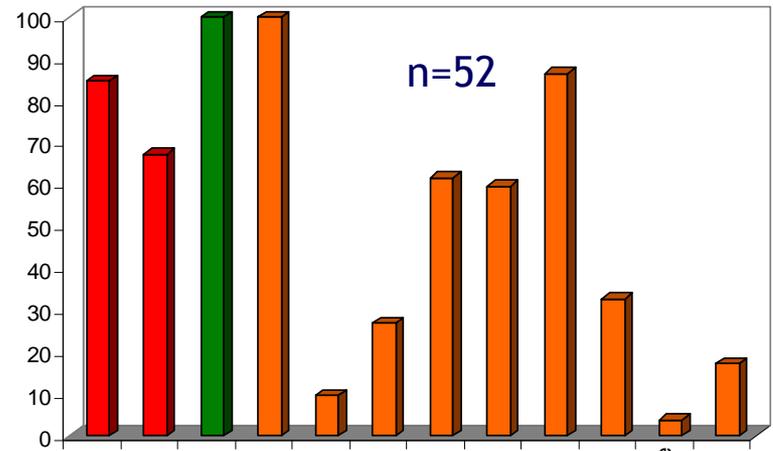
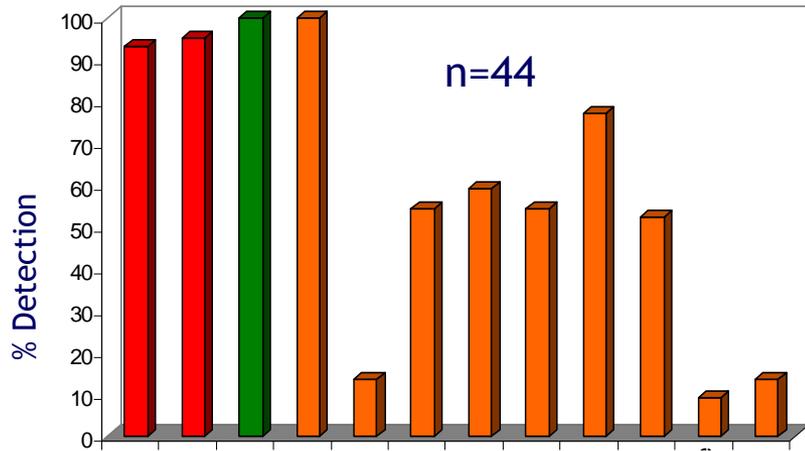
Pesticide Detection Frequency

Sacramento County

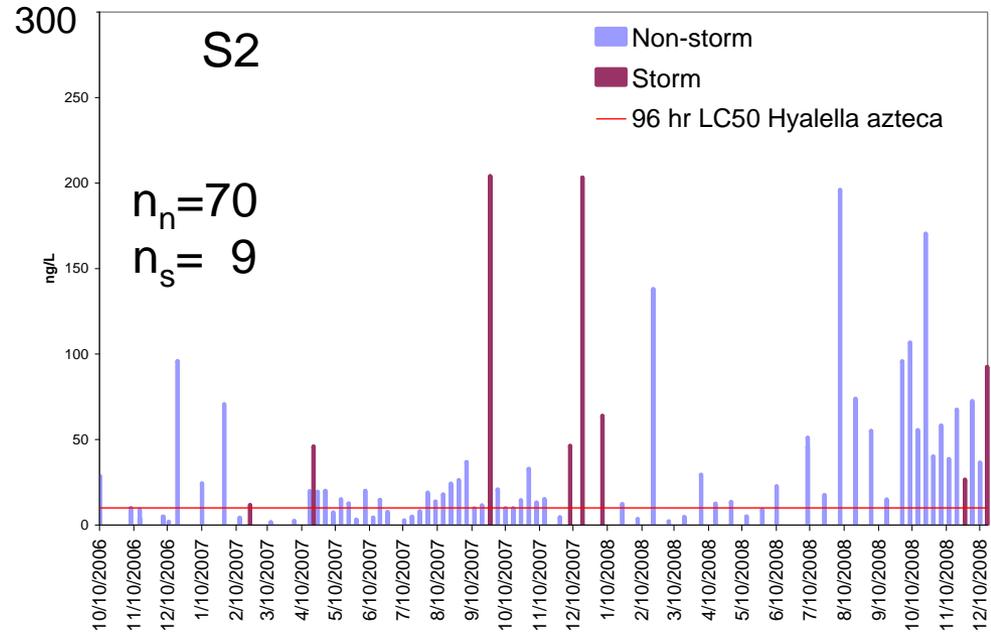


Pesticide Detection Frequency

Orange County

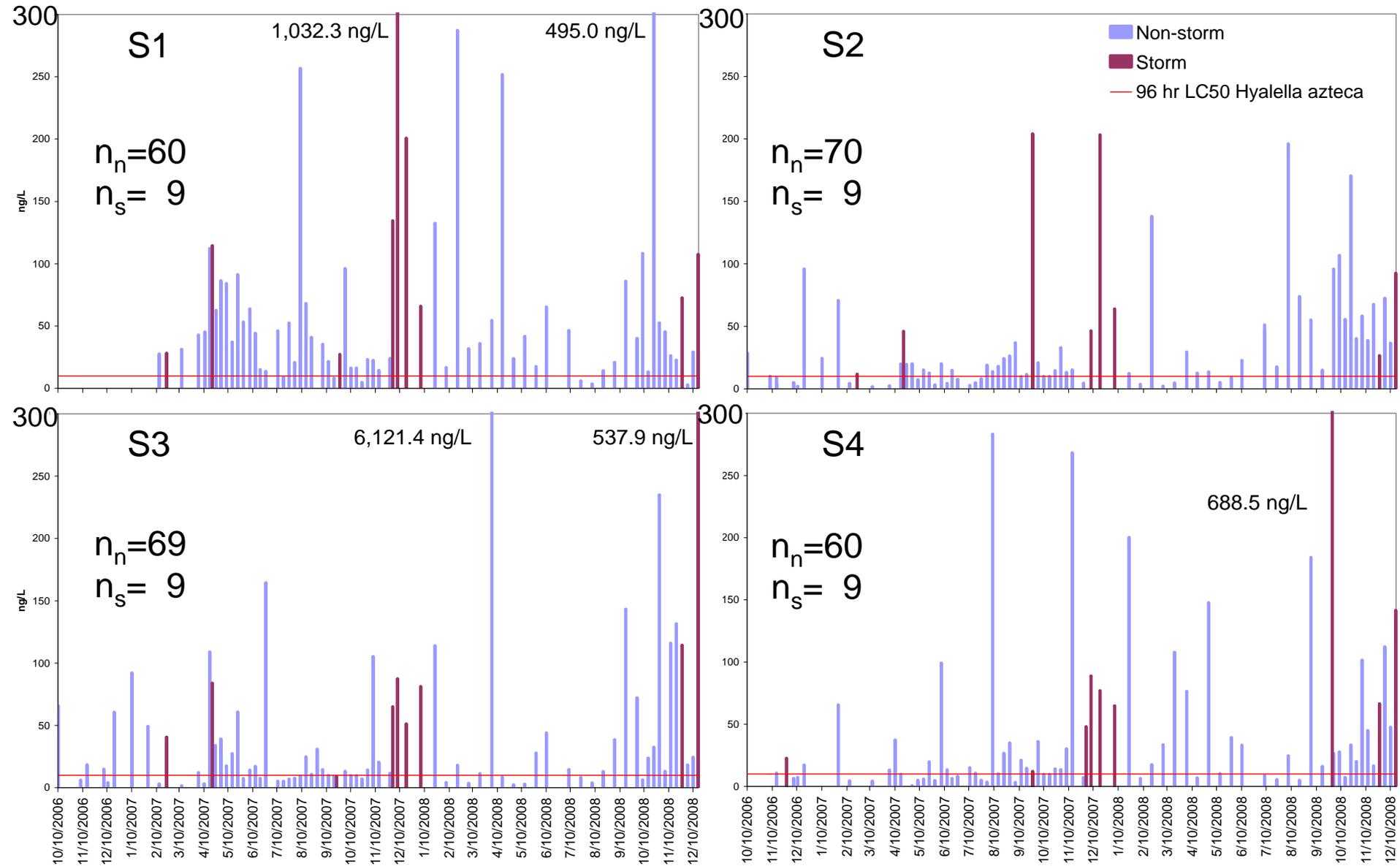


Bifenthrin Concentration- S Cal

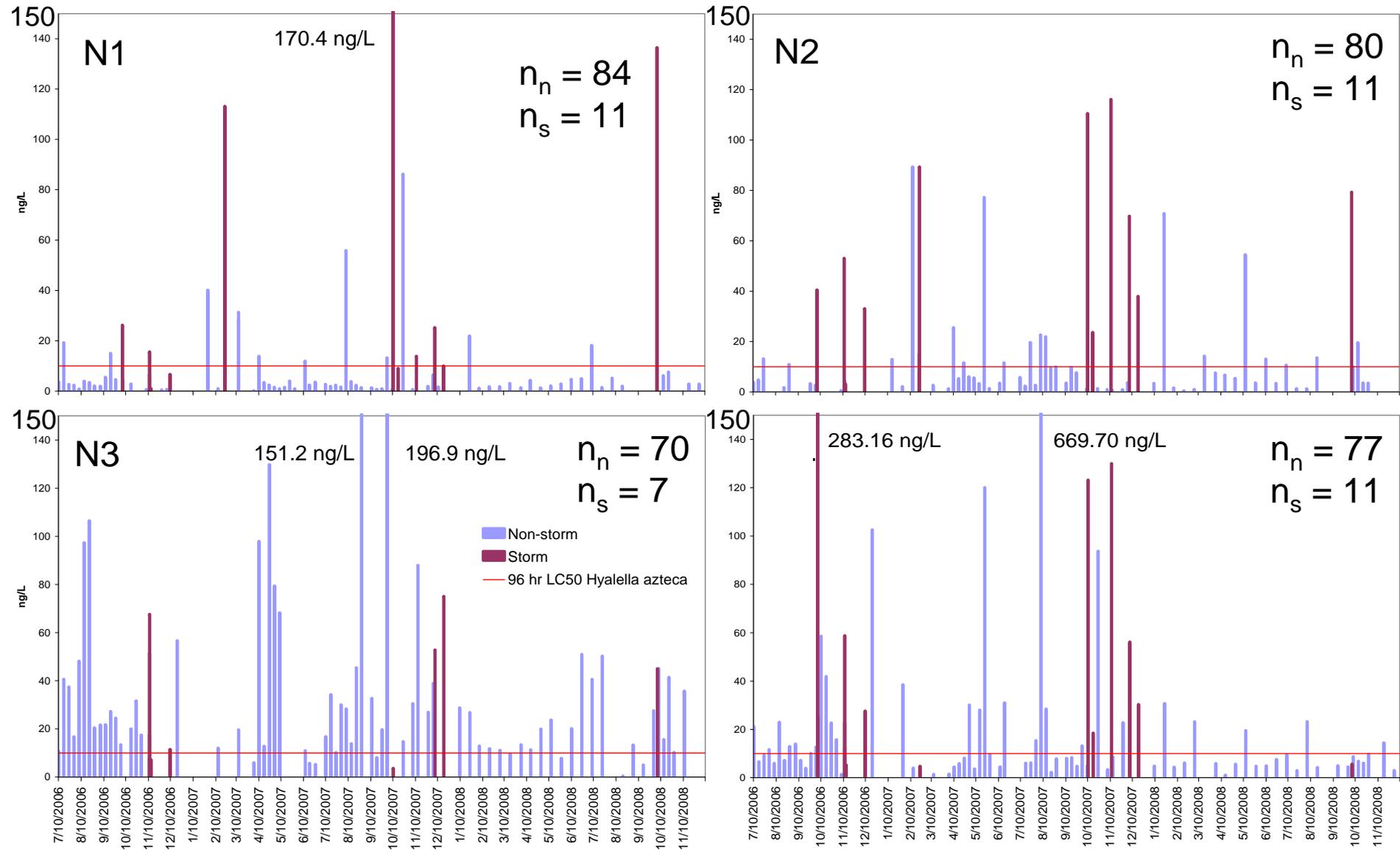




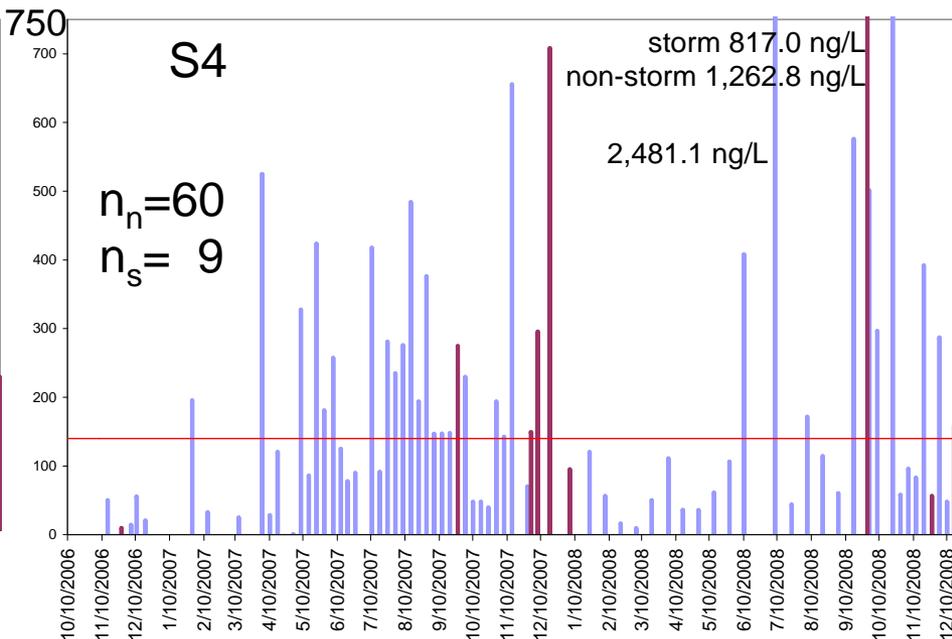
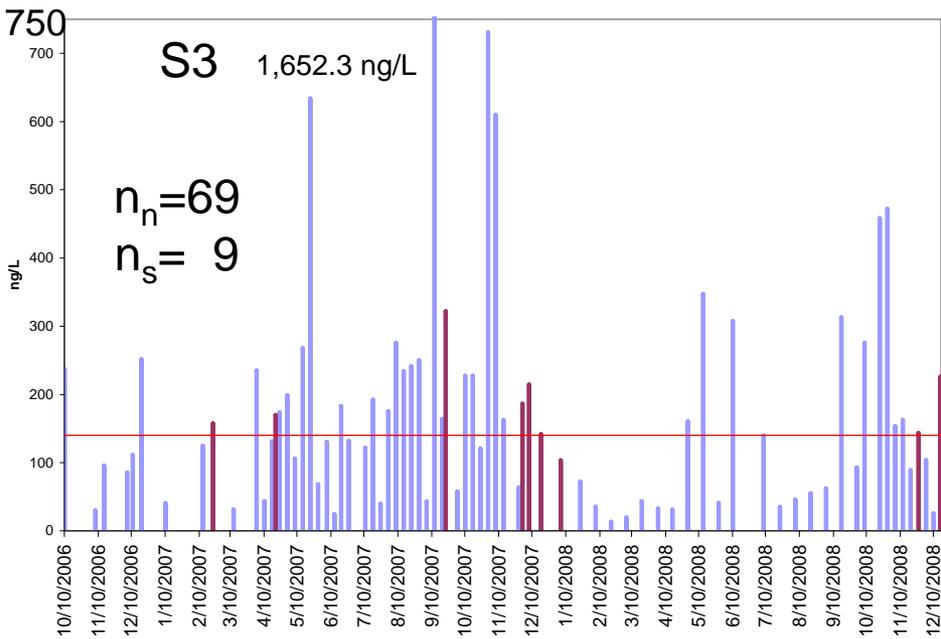
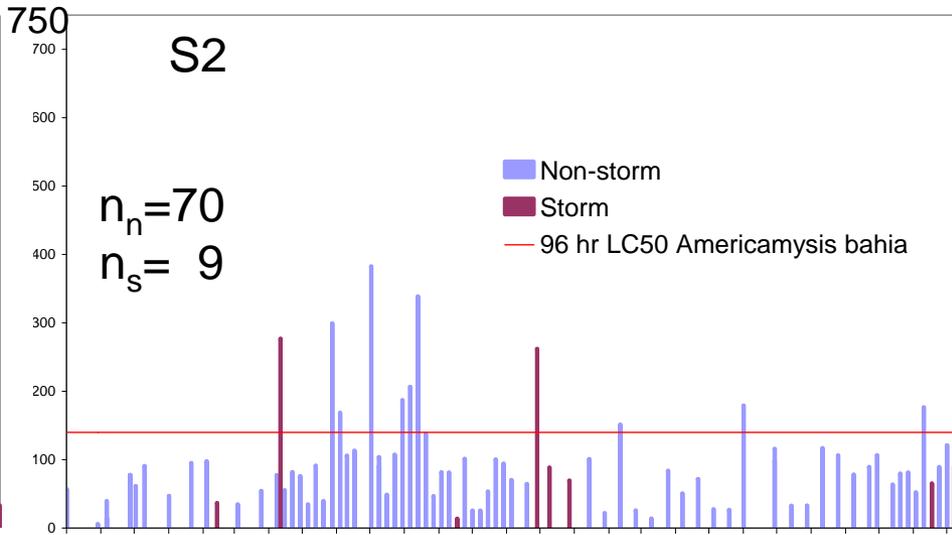
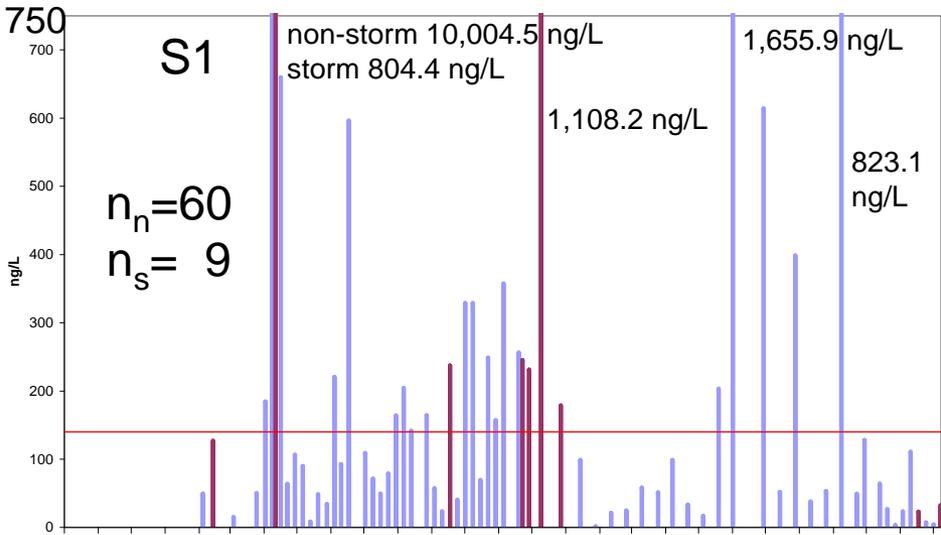
Bifenthrin Concentration- S Cal



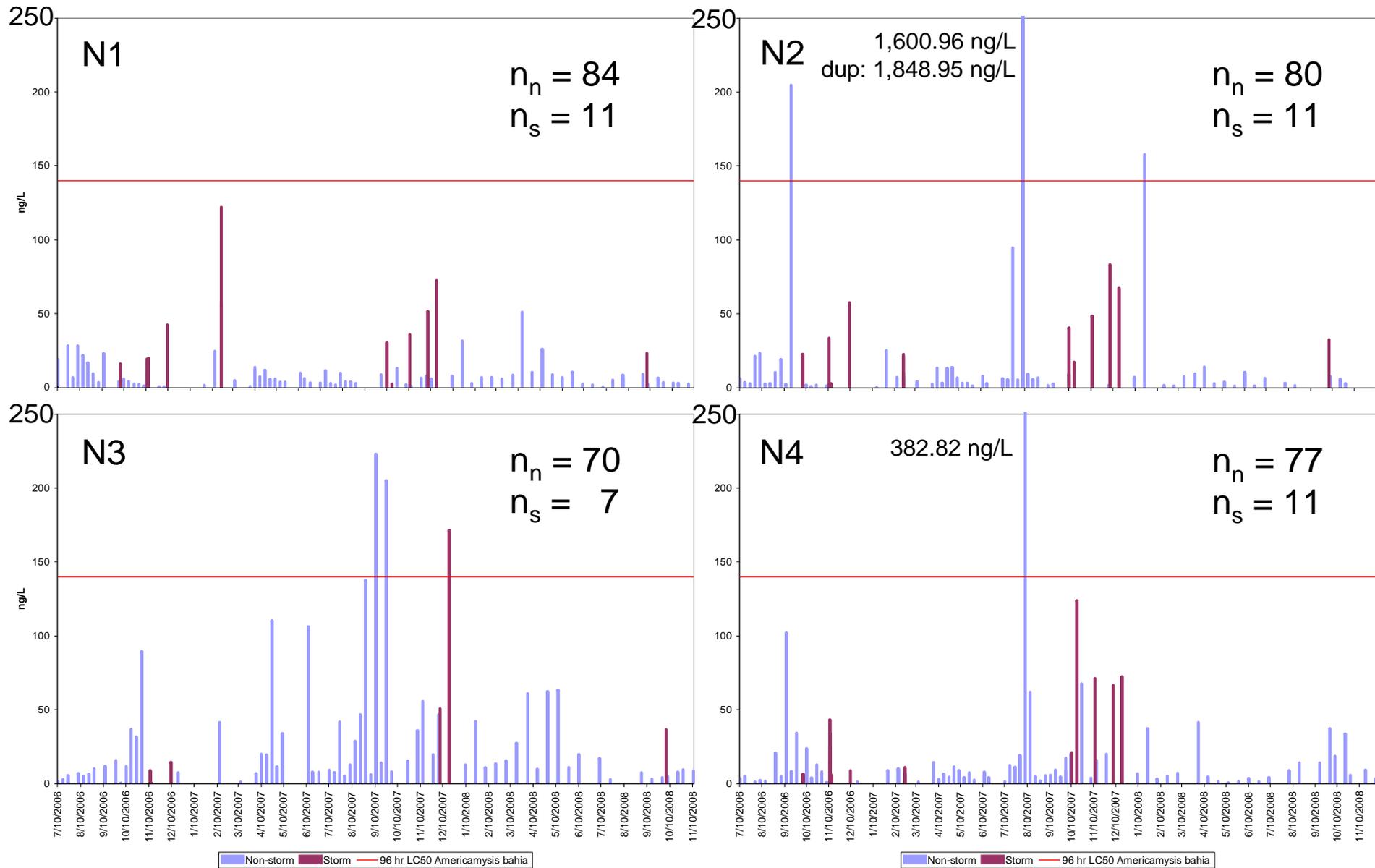
Bifenthrin Concentration- N Cal



Fipronil Concentration- S Cal



Fipronil Concentration- N Cal



Pesticide Concentration

	S1		S2		S3		S4	
	Max	Median	Max	Median	Max	Median	Max	Median
Fipronil	10,004	91.4	383	78.2	1,652	132	2,484	112.2
Bifenthrin	1,032	36.6	204	15.1	6,121	16.0	709	17.3
<i>n</i>	69		79		79		78	

	N1		N2		N3		N4	
	Max	Median	Max	Median	Max	Median	Max	Median
Fipronil	122	5.8	1,849	3.1	222	11.4	323	7.0
Bifenthrin	170	2.3	116	3.5	197	22.8	670	8.4
<i>n</i>	95		91		77		88	

	LC ₅₀	organism
Fipronil	140	<i>Americamysis bahia</i>
Bifenthrin	9.3	<i>Hyalella azteca</i>

Concentrations are ng/L

Intensive Dry Weather Sampling

- Dry weather grab sampling
 - Tuesdays (N. California)
 - Wednesdays (S. California)
- Monitor daily watering habits
 - When do residents water?
 - How much do they water?
- For a 7 day period:
 - Nutrients, pesticides, and microorganism levels
 - Identify weekly flow and pollutant patterns

Intensive Sampling Locations

- Northern California Site
 - consistent high flows
 - fairly reliable flow data
 - July 23-30, 2008
- Southern California Site
 - significant pesticide concentrations
 - fairly reliable flow data
 - June 16- 23, 2008

Sample Collection & Parameters Measured

- Physical parameters
 - TOC, TSS, turbidity
 - Hourly: 300 ml sample via autosampler
 - 3- 300 mL samples were composited
 - resulting in 8- 3hr composites per day
- Pesticides
 - Pyrethroids, Organophosphates, and Fipronil
 - Hourly: 300 mL sample via autosampler
 - 12- 300 mL samples were composited
 - resulting in 2- 12hr composite samples per day

Sacramento County Location



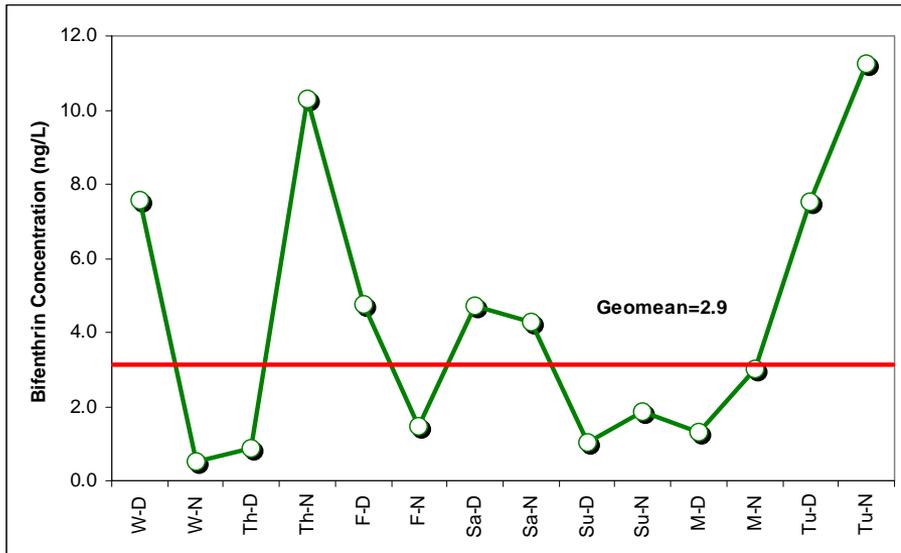
Orange County Location



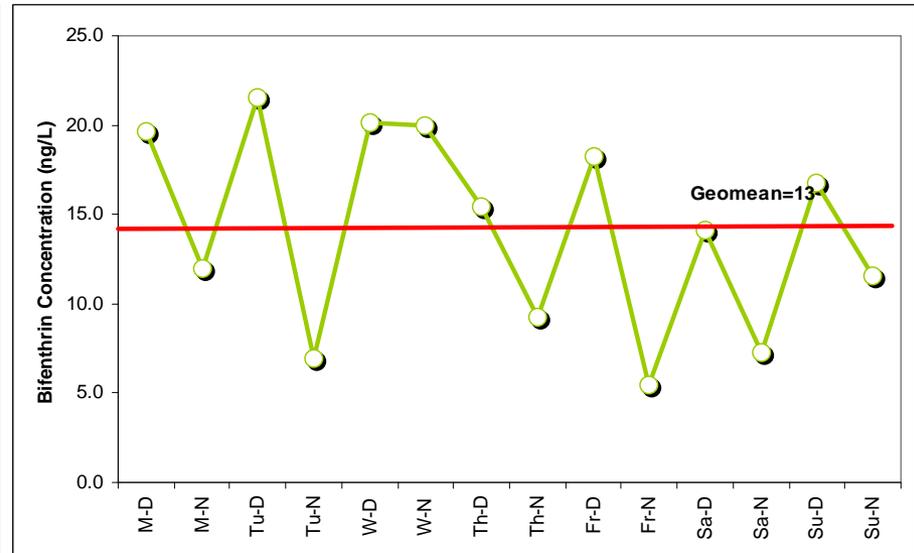
Synthetic Pyrethroids

Bifenthrin

Northern California Neighborhood Site

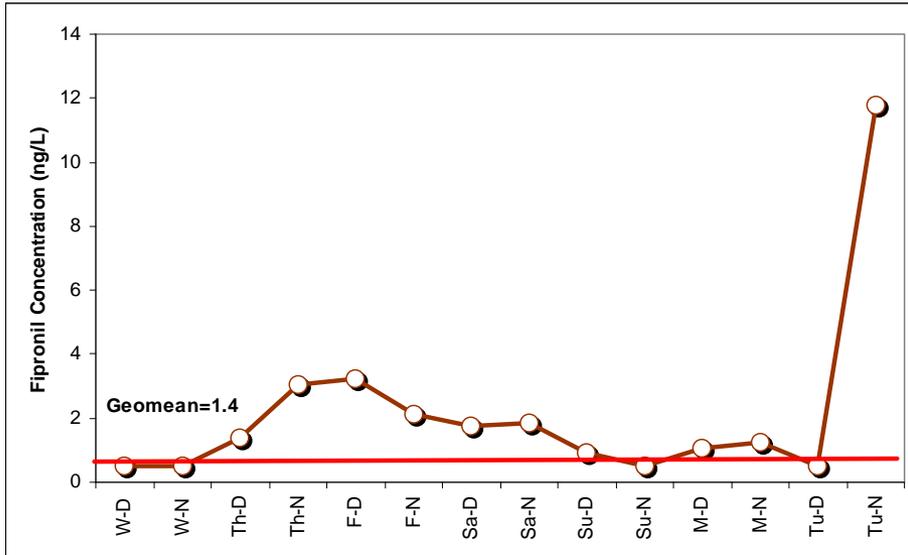


Southern California Neighborhood Site

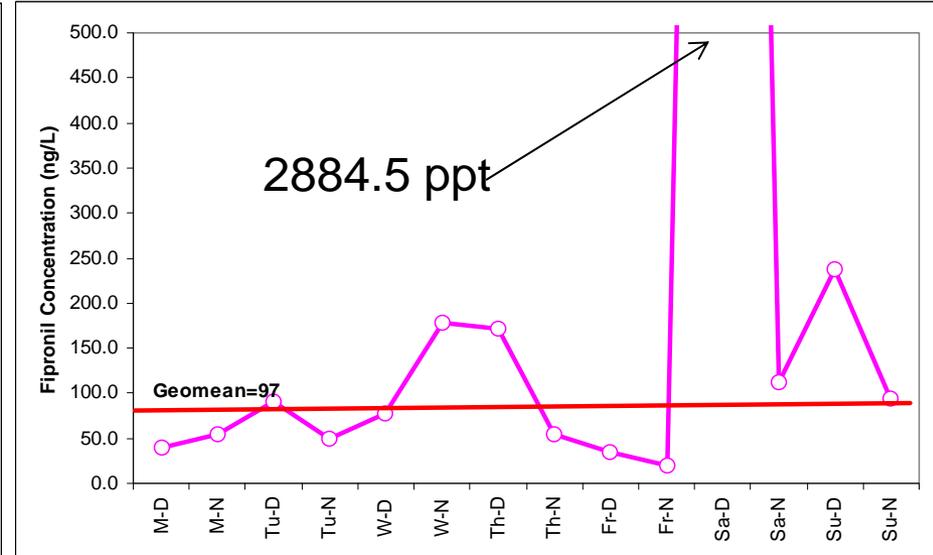


Fipronil

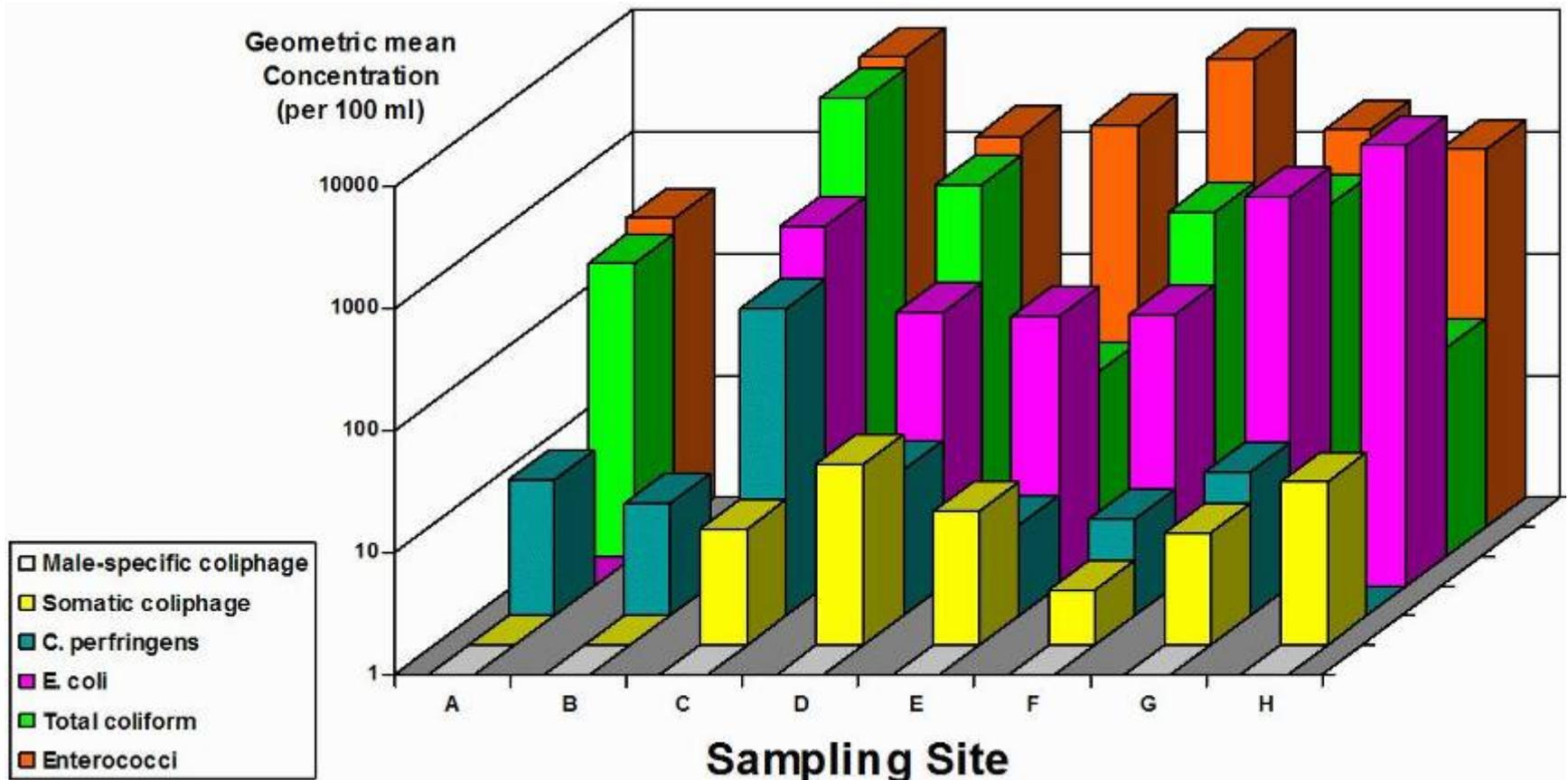
Northern California Neighborhood Site



Southern California Neighborhood Site

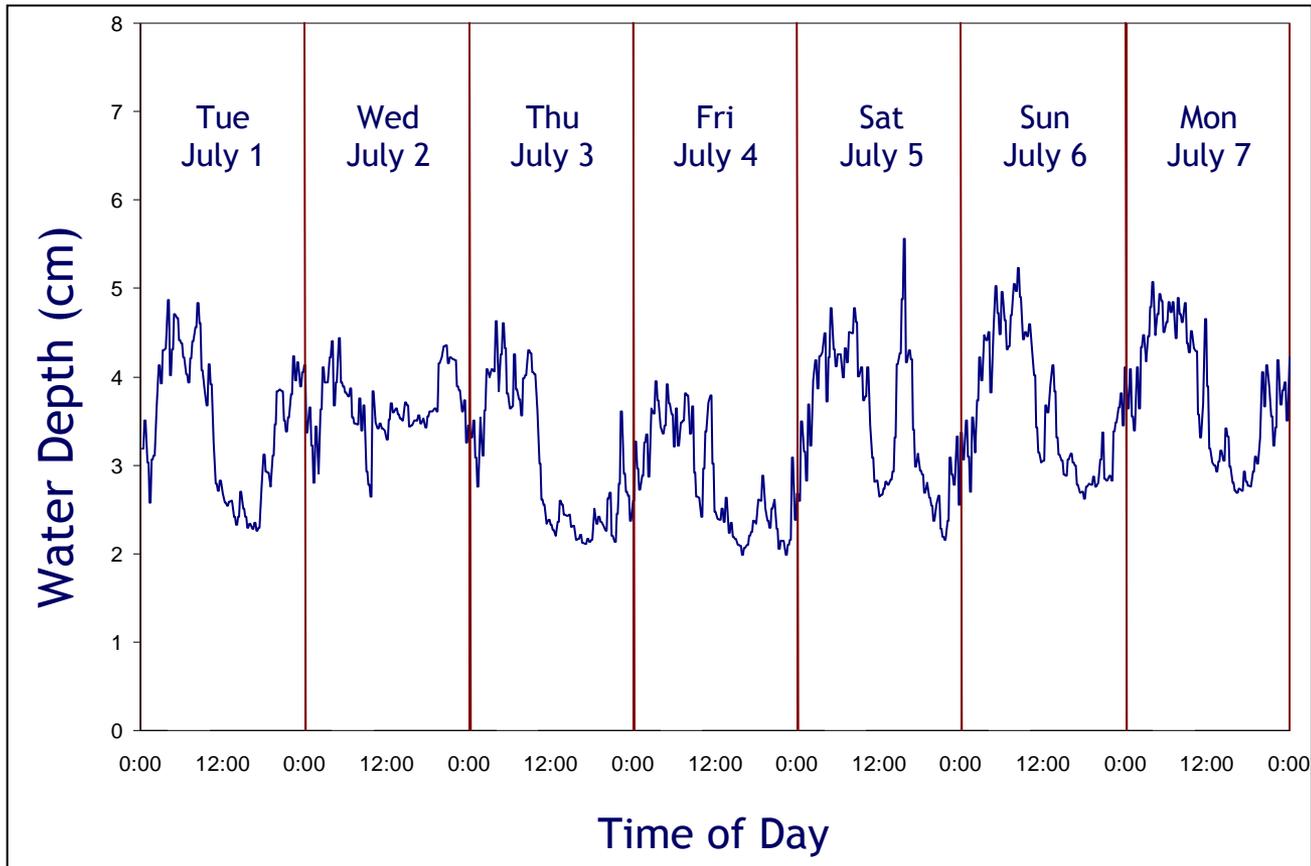


Microorganisms by Site



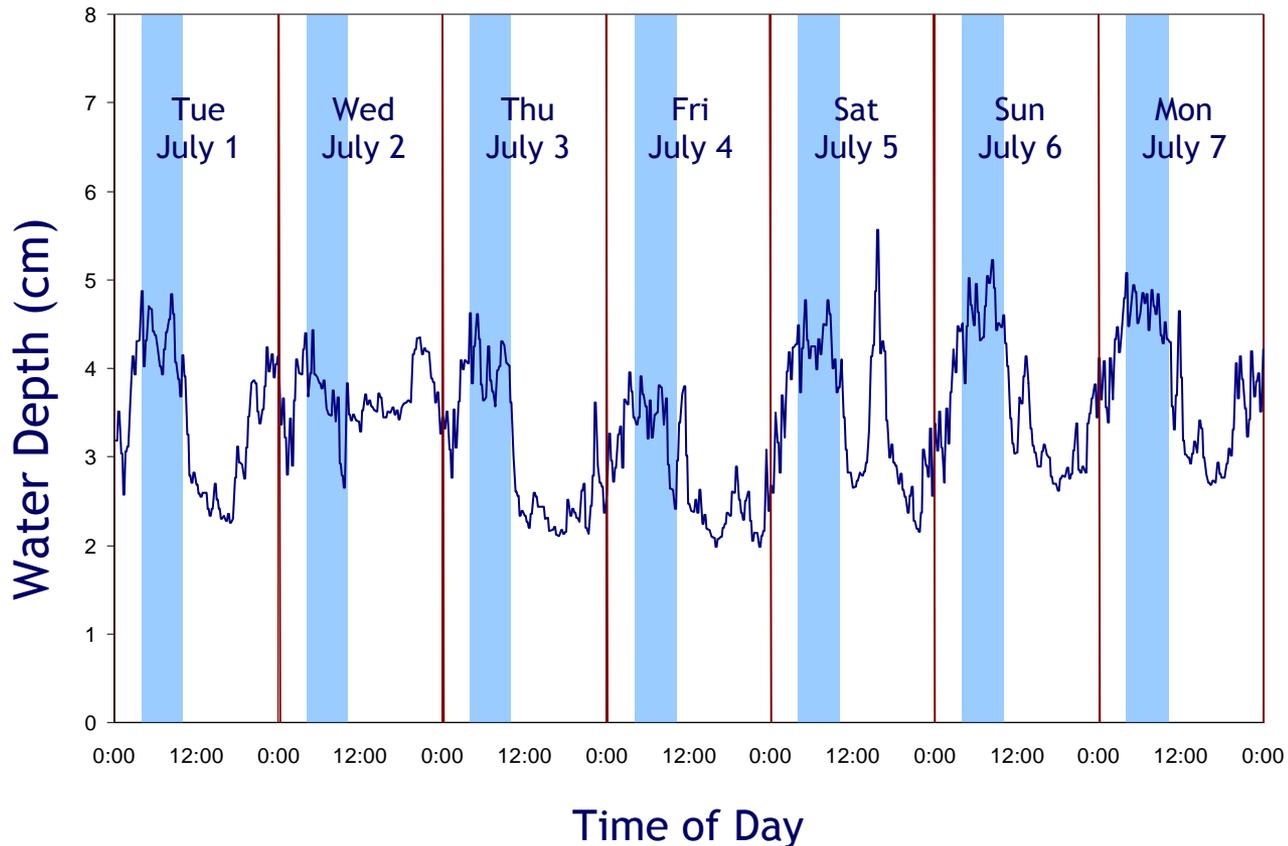
Dry season runoff patterns

Daily Periodicity



Dry season runoff patterns

Daily Periodicity



Runoff From Urban Landscapes

Evaluating BMP effectiveness

Project outline

- Controlled experiments
- Residential landscape studies
- Load estimation
 - Runoff models
 - Pollutant loadings
 - Pollutant load reductions

General Loading
Equation (lbs/acre)

$$L = \frac{VC}{A}$$

Annual Dry
Weather
Loading Rate
(lbs/acre-year)

$$L_i = \frac{F_i}{A_d} \sum_{j=1}^n V_j C_{i,j}$$

PRISM Experimental
Site Annual Dry
Weather Load
(lbs/acre)

$$L_{k,i}^e = \frac{V_k^e C_{k,i}^e}{A^e}$$

Neighborhood Reference Load
(pounds/year)

$$L_i^N A^N = F_i \sum_{j=1}^n V_j C_{i,j}$$

Loading Ratios
from PRISM
Experimental
Sites:

L_0, L_1, L_2
(ratio)

$$L_{k,i}^e = (1 - \alpha_{k,i}) L_{0,i}^e$$

$$\alpha_{1,i} = \left(1 - \frac{L_{1,i}^e}{L_{0,i}^e}\right)$$

$$\alpha_{2,i} = \left(1 - \frac{L_{2,i}^e}{L_{0,i}^e}\right)$$

$$L_i^N A^N = A_0 L_{0,i} + A_1 L_{1,i} + A_2 L_{2,i}$$

$$L_i^N A^N = L_{0,i} (A^N - \alpha_{1,i} A_1 - \alpha_{2,i} A_2)$$

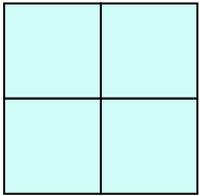
$$L_{0,i} = \frac{F_i \sum_{j=1}^n V_j C_{i,j}}{(A^N - \alpha_{1,i} A_1 - \alpha_{2,i} A_2)}$$

Regional Dry Season Loading (pounds/year)

$$A_d L_a = L_{0,i} (A_d - \alpha_1 A_1 - \alpha_2 A_2)$$

Pollutant Load Modeling

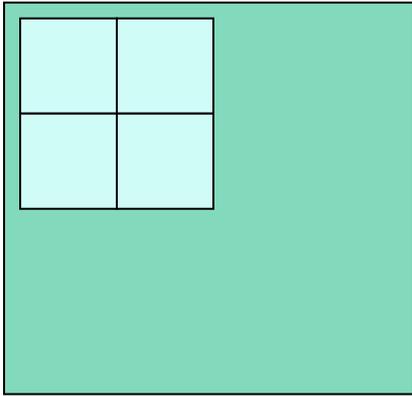
Multi-scale



- 4 Neighborhood drainsheds

Pollutant Load Modeling

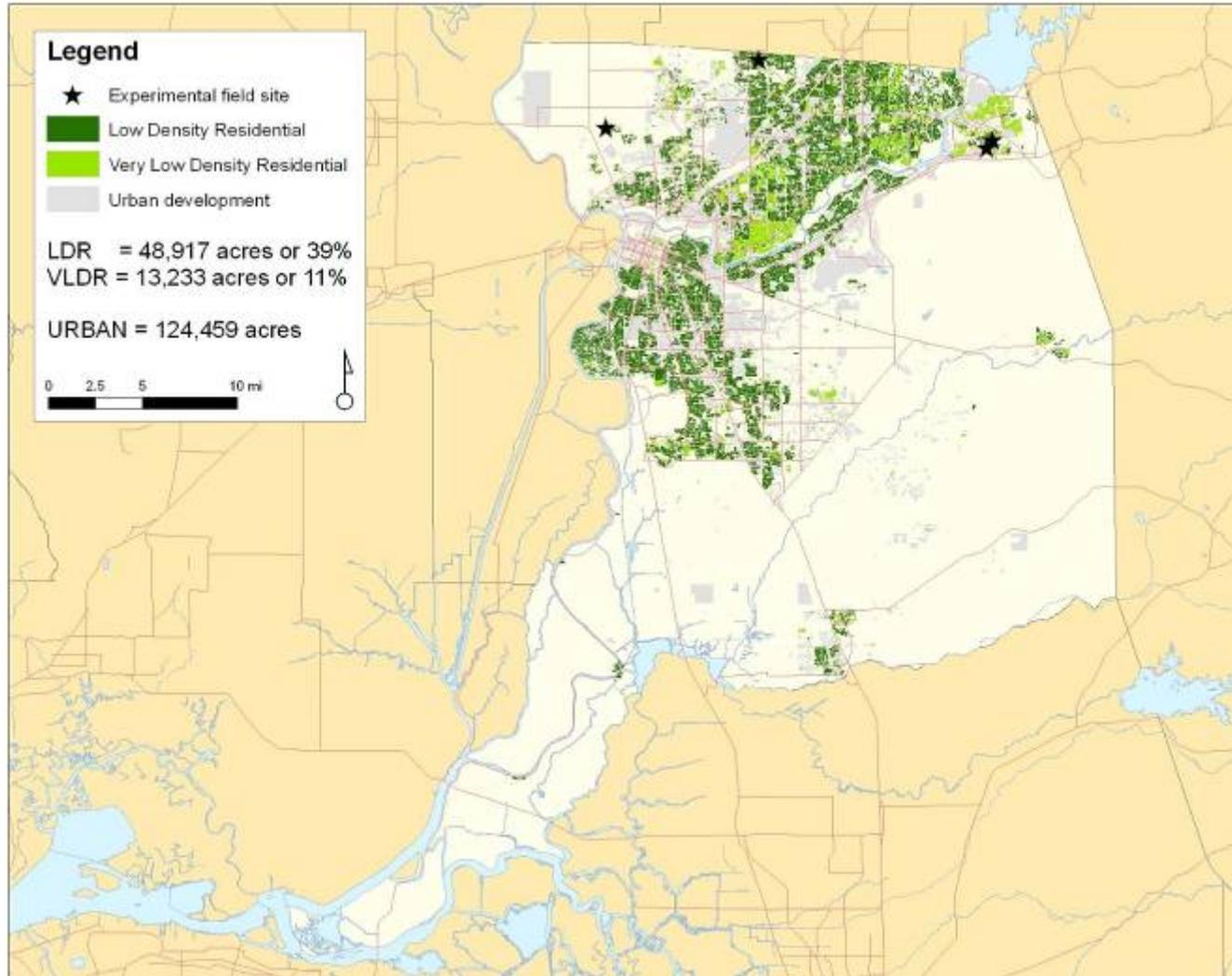
Multi-scale



- 4 Neighborhood drainsheds
- Sacramento County LDR and VLDR

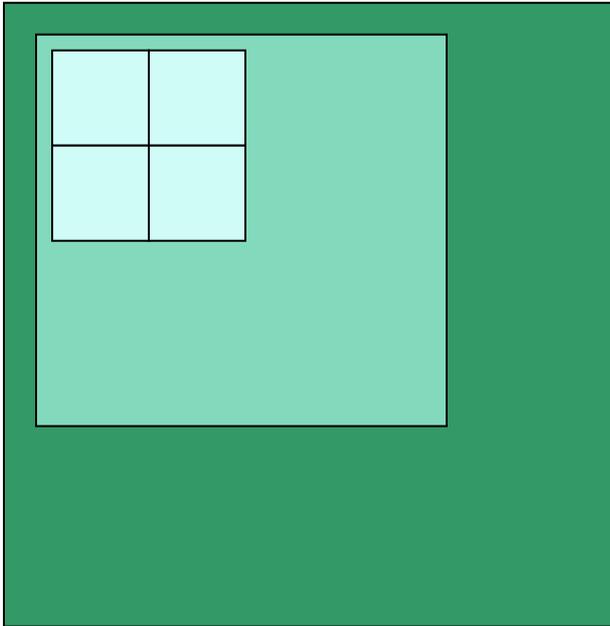
Pollutant Load Modeling

Low & Very Low Density Residential Zones



Pollutant Load Modeling

Multi-scale



- 4 Neighborhood drainsheds
- Sacramento County LDR and VLDR
- 50 year projected growth LDR and VLDR

Runoff From Urban Landscapes

Evaluating BMP effectiveness

Project outline

- Controlled experiments
- Residential landscape studies
- Load estimation
- Outreach of results
 - Promotion of low impact management

Outreach Materials

Top Ten Ways to Keep Our Water Clean

Home and garden pesticides and fertilizers are contaminating California creeks, rivers, and oceans. Garden chemicals cause pollution when people dump them down drains or when they are washed into gutters, drains, and creeks by rain, garden watering, or hosing down sidewalks. Here's what you can do to help.



Be Careful with Garden Chemicals

- 1. Avoid using pesticides.** Be sure you have identified a specific pest problem before applying any pesticide. If treatment is necessary, use non-chemical methods or least toxic pesticides where ever possible. Ask a UC Master Gardener for help.
- 2. Keep fertilizer and pesticides off of hard surfaces** like sidewalks or driveways. Sweep any material that accidentally gets on hard surfaces back onto lawns.
- 3. Don't over use fertilizer.** More is not better. Actively growing turf, flowering shrubs, some annuals and fruit trees require regular fertilization but ornamental trees do not. Use slow-release fertilizers and be sure to measure and apply them according to label directions.
- 4. Avoid using pyrethroid insecticides** to control ants. Manage ants by reducing food sources, excluding them from homes, and using baits in containers.
- 5. Use a mulching mower** to recycle your lawn clippings and reduce your lawn's requirement for fertilizer.
- 6. Dispose of garden chemicals properly.** Never sweep, hose off, or pour leftover pesticides or fertilizers into drains or gutters. Dispose of unused products at your local hazardous waste site.



Keep Water in your Garden and out of the Gutter

- 7. Manage your watering system** so water does not run off your landscape onto hard surfaces and into gutters.
- 8. Reduce runoff** by using mulches in beds and permeable materials for walkways and driveways. Aerate and add organic matter such as compost to heavy or compacted soils. Install terraces or other features on slopes to keep water on site.
- 9. Install equipment** such as drip irrigation, soaker hoses, "smart" irrigation controllers, and rotor heads that improve watering efficiency and distribution.
- 10. Choose water efficient plants and garden designs.** Be creative about reducing your landscape's need for water.



- PROTECT YOUR WATER -

To eliminate runoff to storm drains and protect our creeks, rivers and the ocean, minimize the use of pesticides and follow proper use and disposal practices. Whenever possible, use non-chemical alternatives or less toxic pesticide products.

Learn more by contacting the Sacramento UC Master Gardeners at (916) 375-6913, Monday-Friday, 9 am to noon and 1-4 pm, for other pest information, visit the UC IPM web site at www.ipm.ucdavis.edu.



University of California Cooperative Extension

- Landscape design & water quality
- Fertilizing & watering
- Lawn fertilizing
- Lawn Watering
- Ant control
- Lawn insects
- Garden chemicals: Safe use & disposal

Runoff From Urban Landscapes

UC Master Gardener Advanced Training



Runoff From Urban Landscapes

Outreach Events



Runoff From Urban Landscapes

Outreach Events



Runoff From Urban Landscapes

Evaluating BMP effectiveness

Project outline

- Controlled landscape studies
- Residential runoff characterization
- Load estimation
- Outreach



Thank you

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