# Monitoring Pesticides in Runoff from Northern and Southern California Neighborhoods

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# Presentation Roadmap

- Project Objectives
- Project Design and Implementation
  - Site Selection
  - Monitoring Stations
  - Water Sample Collection
- Project Results
  - Pesticide Detections in Dry and Wet Weather
  - Intensive Dry Weather Sampling
  - Pollutant Loading Estimates
- Future Research and Data Collection

# Project Background

Evaluating Best Management Practices (BMPs) effectiveness to reduce volumes and improve quality of runoff from urban environments

$2,900,350 Provided by:
California State Water Resources Control Board
CALFED Bay-Delta Program

# Project Objectives

- Characterize runoff
  - Single family residences
  - Pesticides, nutrients, drinking water COCs, pathogens
- Develop pollutant loading models
  - Dry and wet season
- Measure outreach effects
  - Develop materials
  - Deliver information

# Collaborations

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

# Site Selection

- Criteria
  - Single family homes
  - 4-20 years old
  - Access to outfalls
  - Lot size
  - Demographics

# Site Selection

- Storm drain maps
  - Locate outfalls
  - Delineate drainshed
  - Identify lots
  - Verify land use

# Site Selection

- Sacramento County
  - Folsom 1
  - Folsom 2
  - Antelope
  - Natomas
- Orange County
  - San Juan Capistrano
  - Laguna Niguel 1
  - Laguna Niguel 2
  - Aliso Viejo

# Water Sample Collection

## Sampling Schedule

| | 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

# Water Sample Collection

UC Cooperative Extension
Master Gardeners

Photos: L.Oki

# Analyses of Water Samples

## UC Riverside

### Gan Lab

**Nutrients**

Nitrate, TKN,
Phosphate, Total P

**Pesticides**

diazinon, chlorpyrifos,
pyrethroids (9), fipronil

**Drinking Water COCs**

TOC, DOC, $Br^-$, $Cl^-$, TDS,
TSS, turbidity

### Yates Lab

**Indicator Organisms**

*E. coli*
Total coliforms
Somatic coliphages
Male-specific coliphages
Enterococci
*Clostridium perfringens*

**Pathogens**

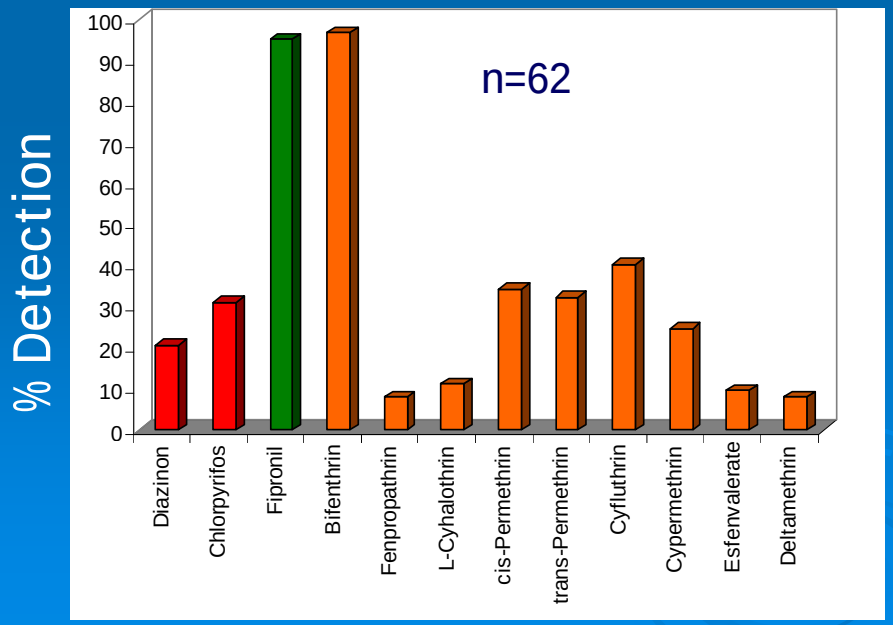
*Giardia*
*Cryptosporidium*

# Monitoring

- Continuous Data Collection
  - Flows (depth & velocity)
  - Temperature
  - pH
  - Electrical conductivity
  - Rainfall
- Automated Stormwater Sampling
- Remote Communication

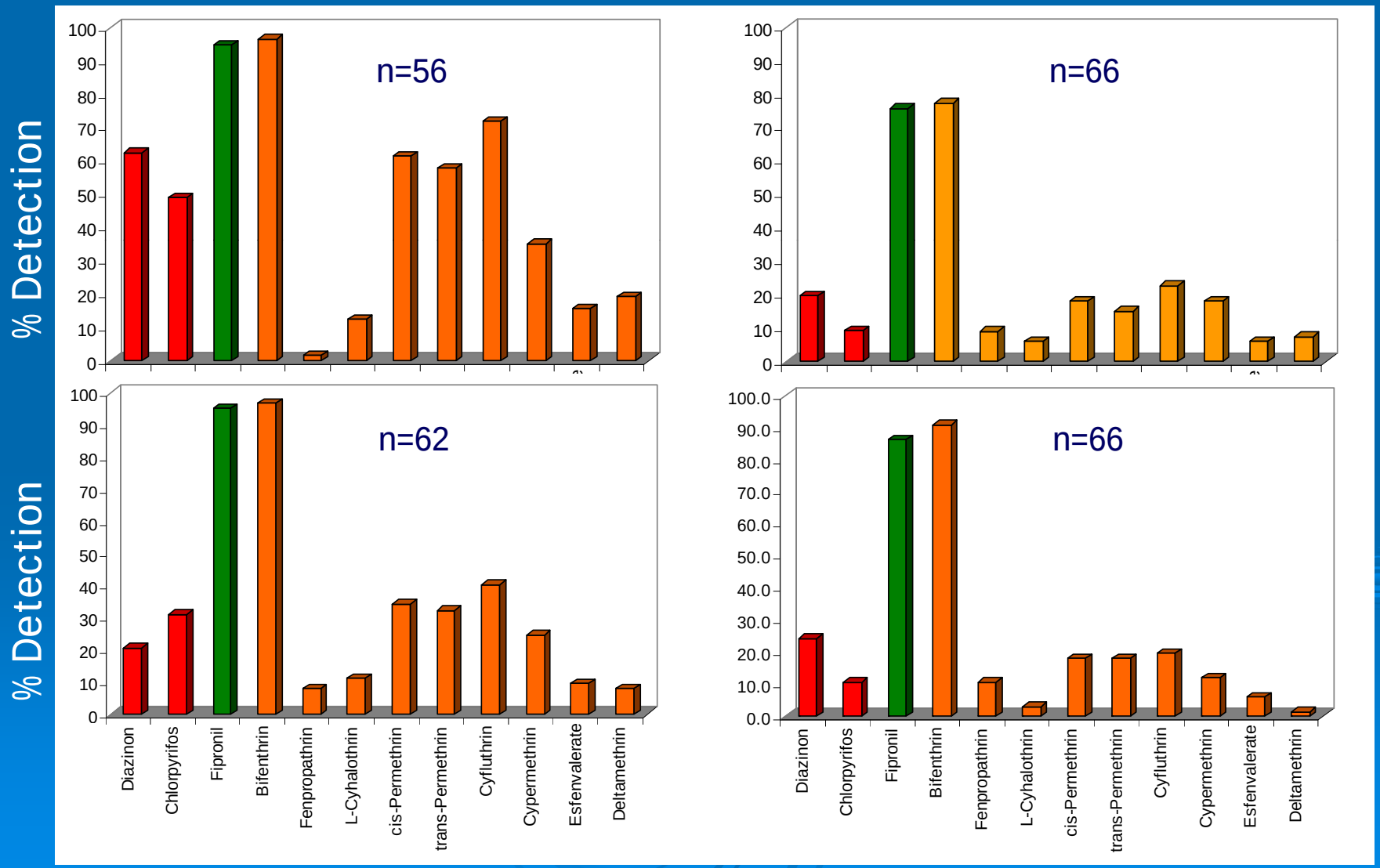
# Pesticide Detection Frequency

As reported Sep 18, 2008



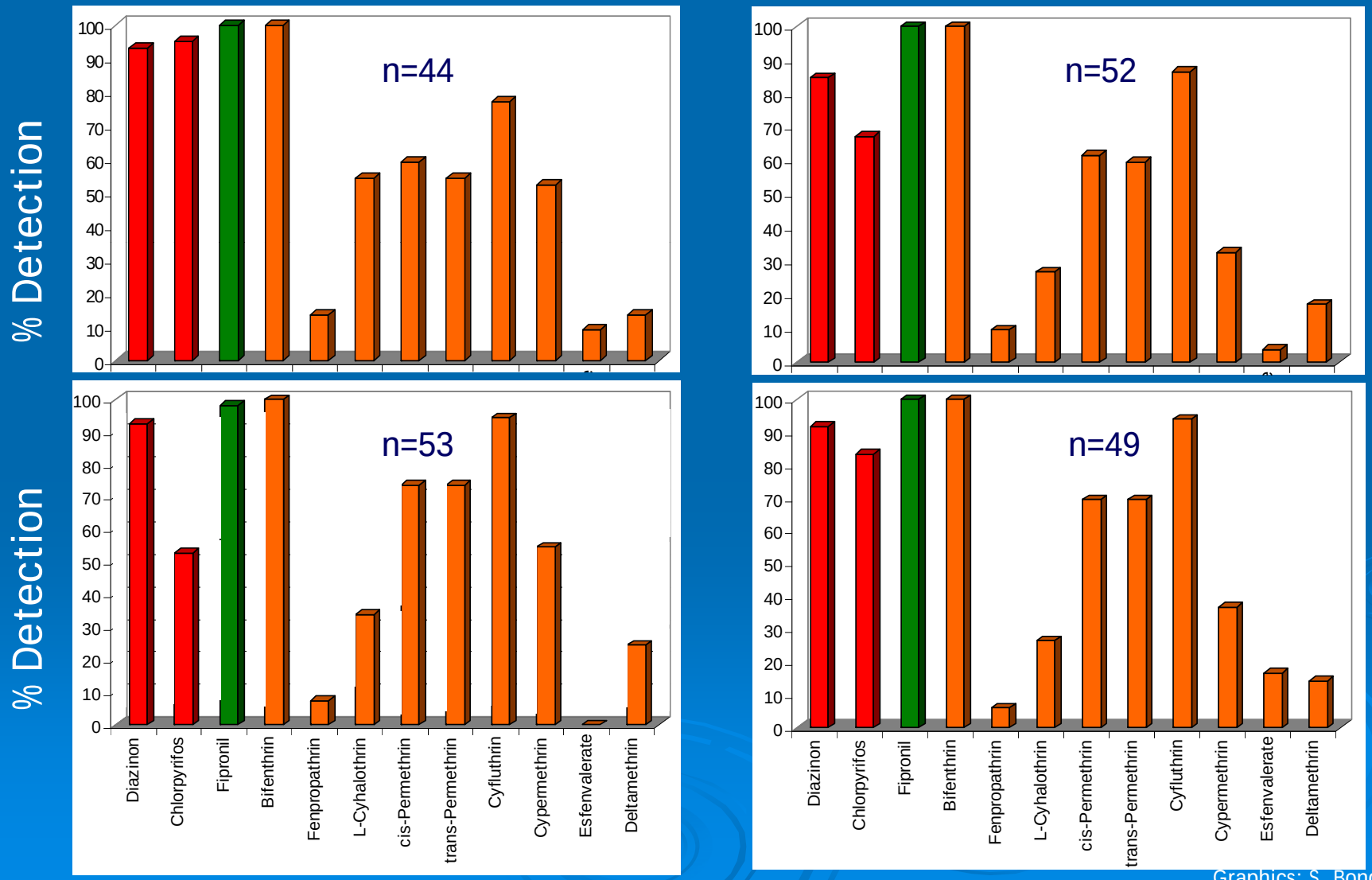
# Pesticide Detection Frequency

## Sacramento County



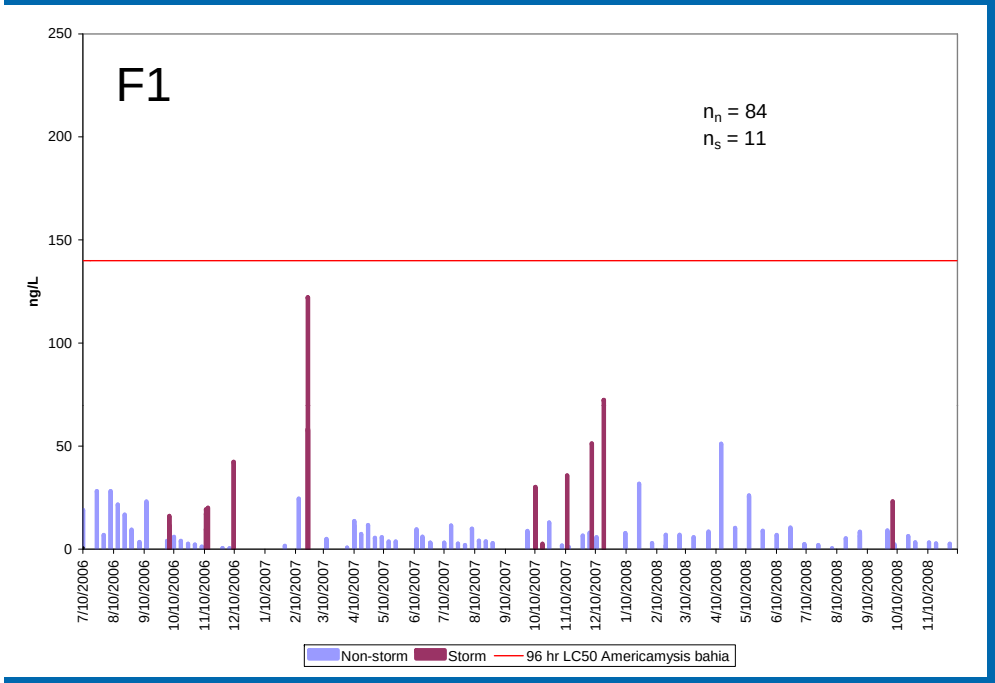
# Pesticide Detection Frequency

## Orange County

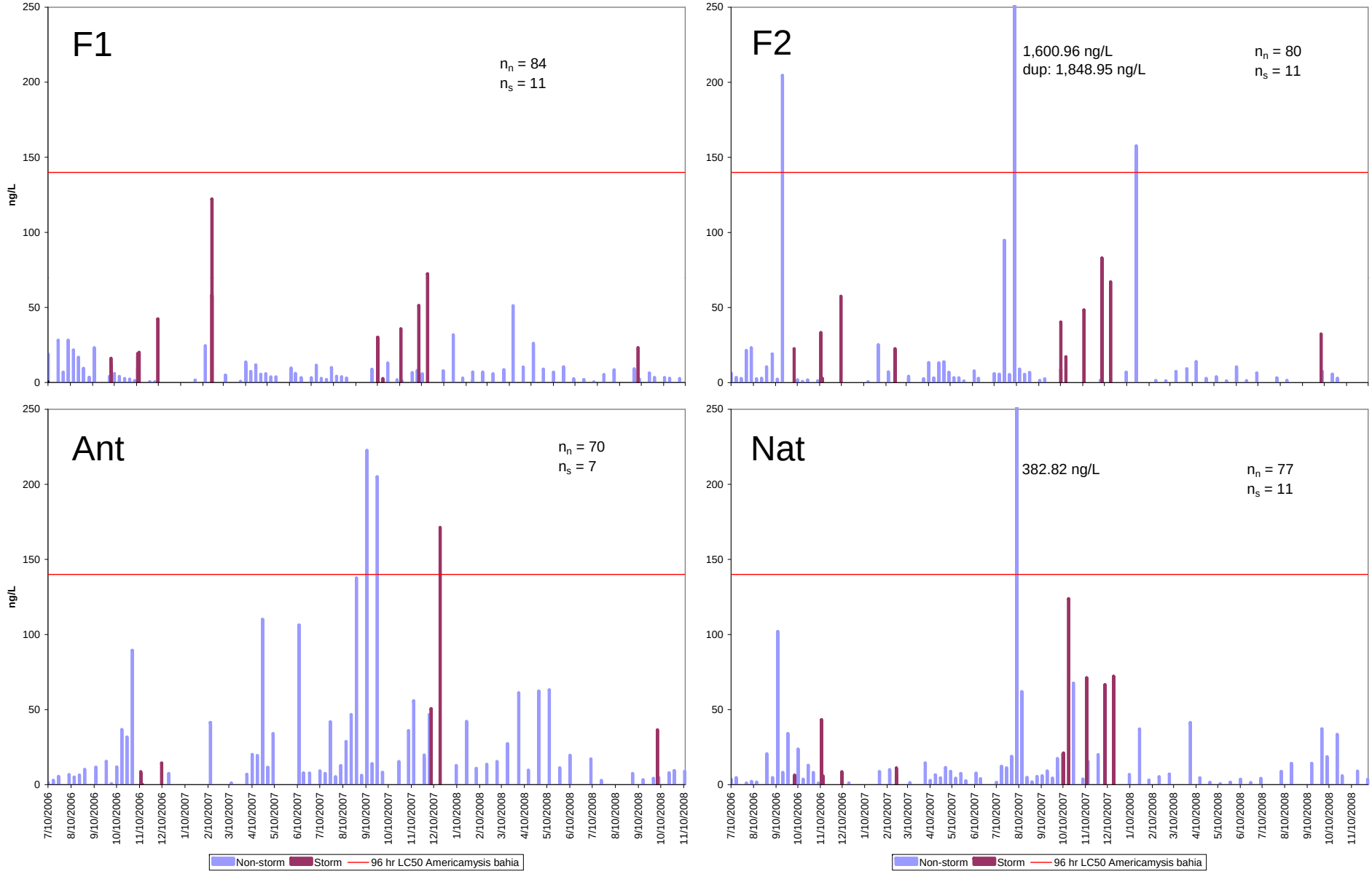



Graphics: S. Bondarenko

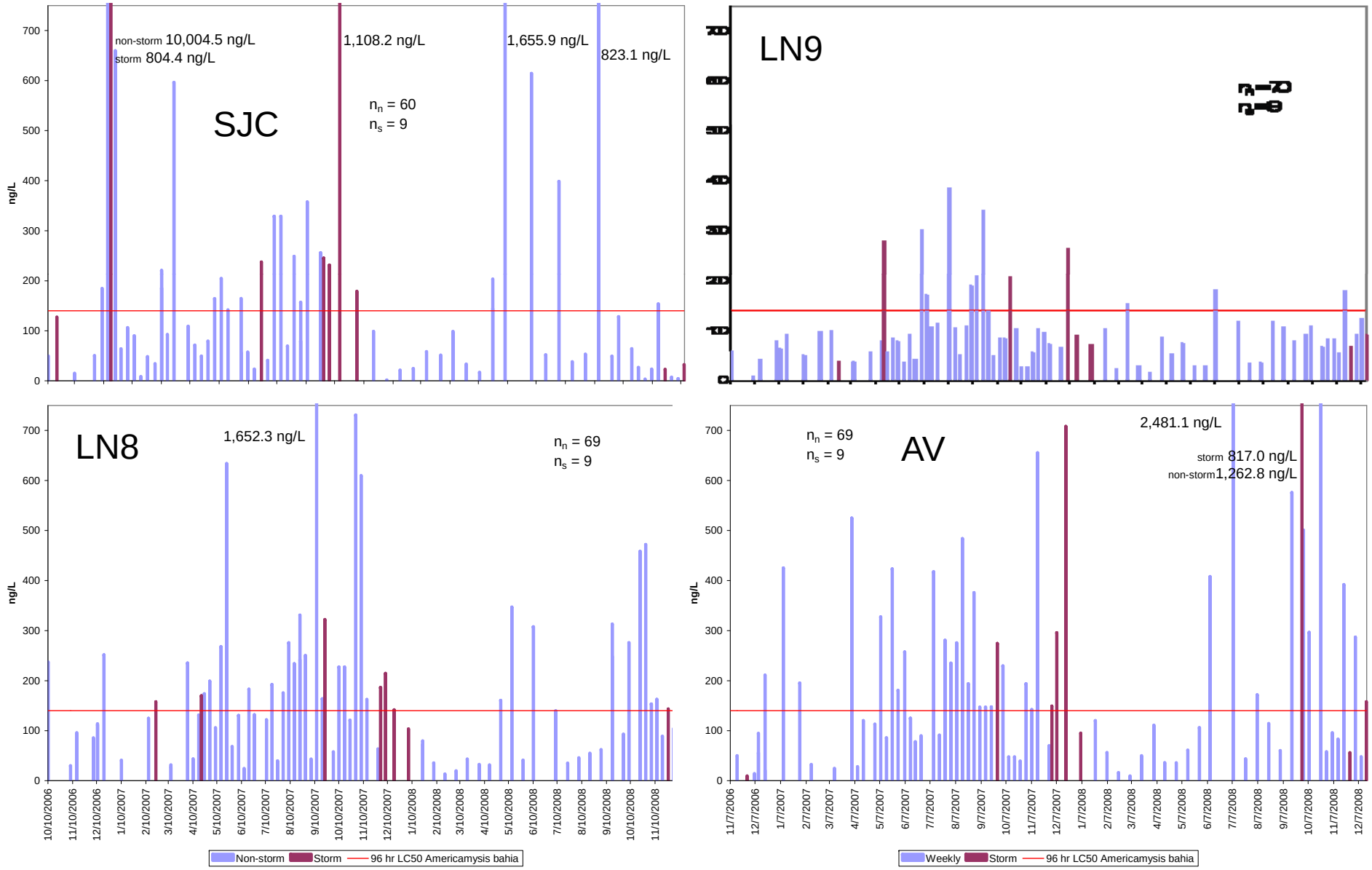
# Fipronil Concentration



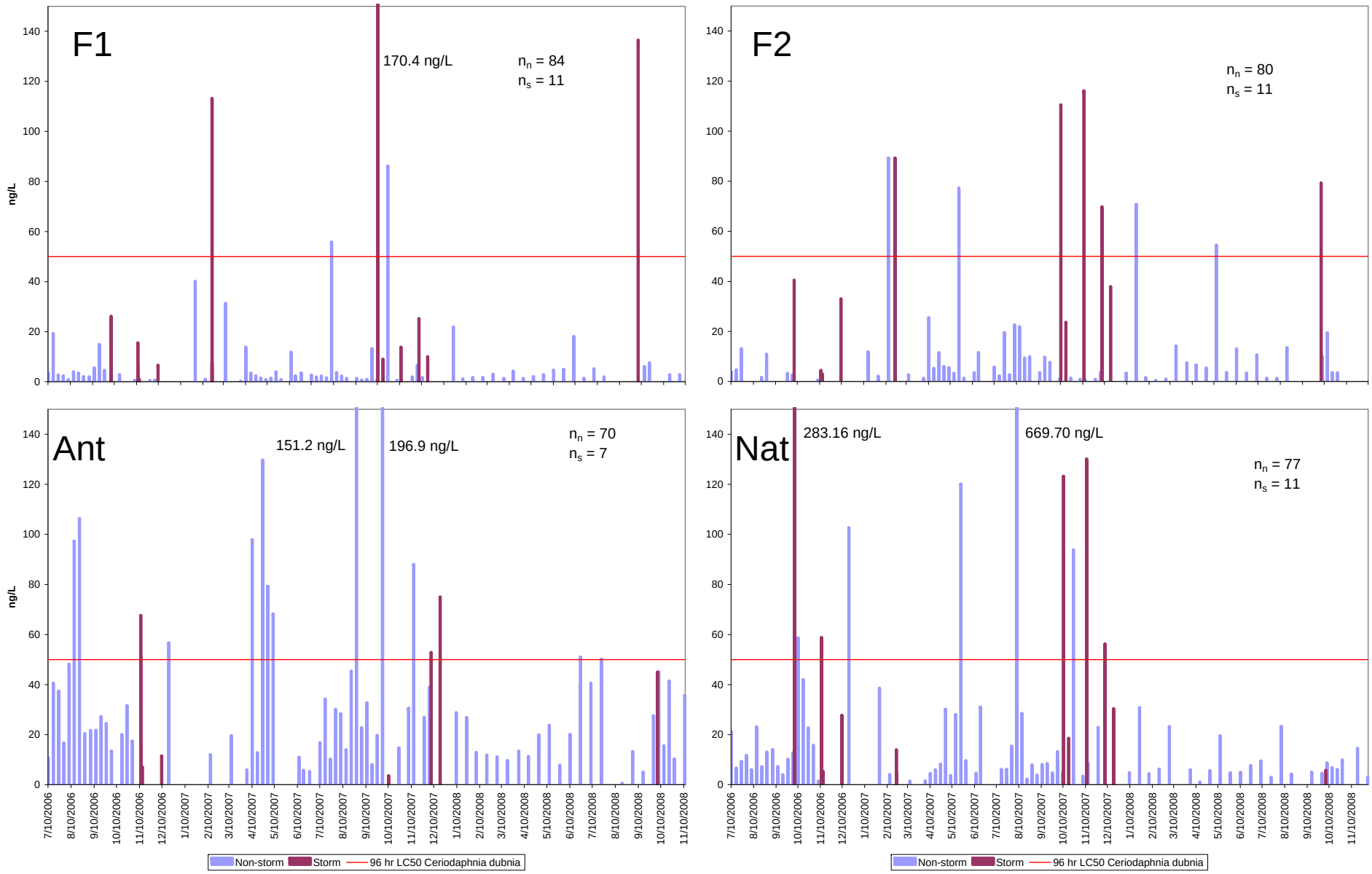
# Fipronil Concentration- N Cal



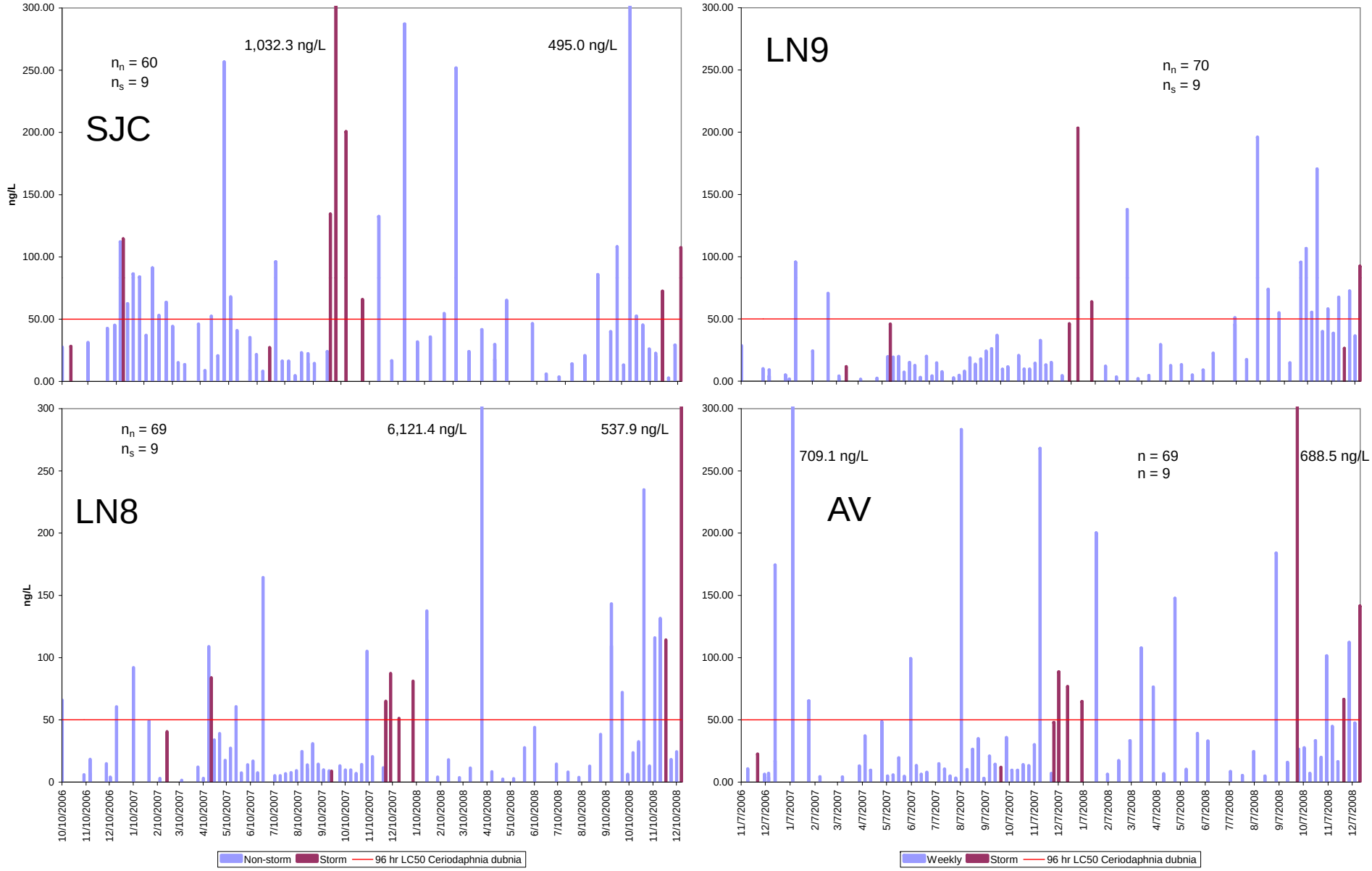
# Fipronil Concentration- S Cal



# Bifenthrin Concentration- N Cal



# Bifenthrin Concentration- S Cal



# Pesticide Concentration

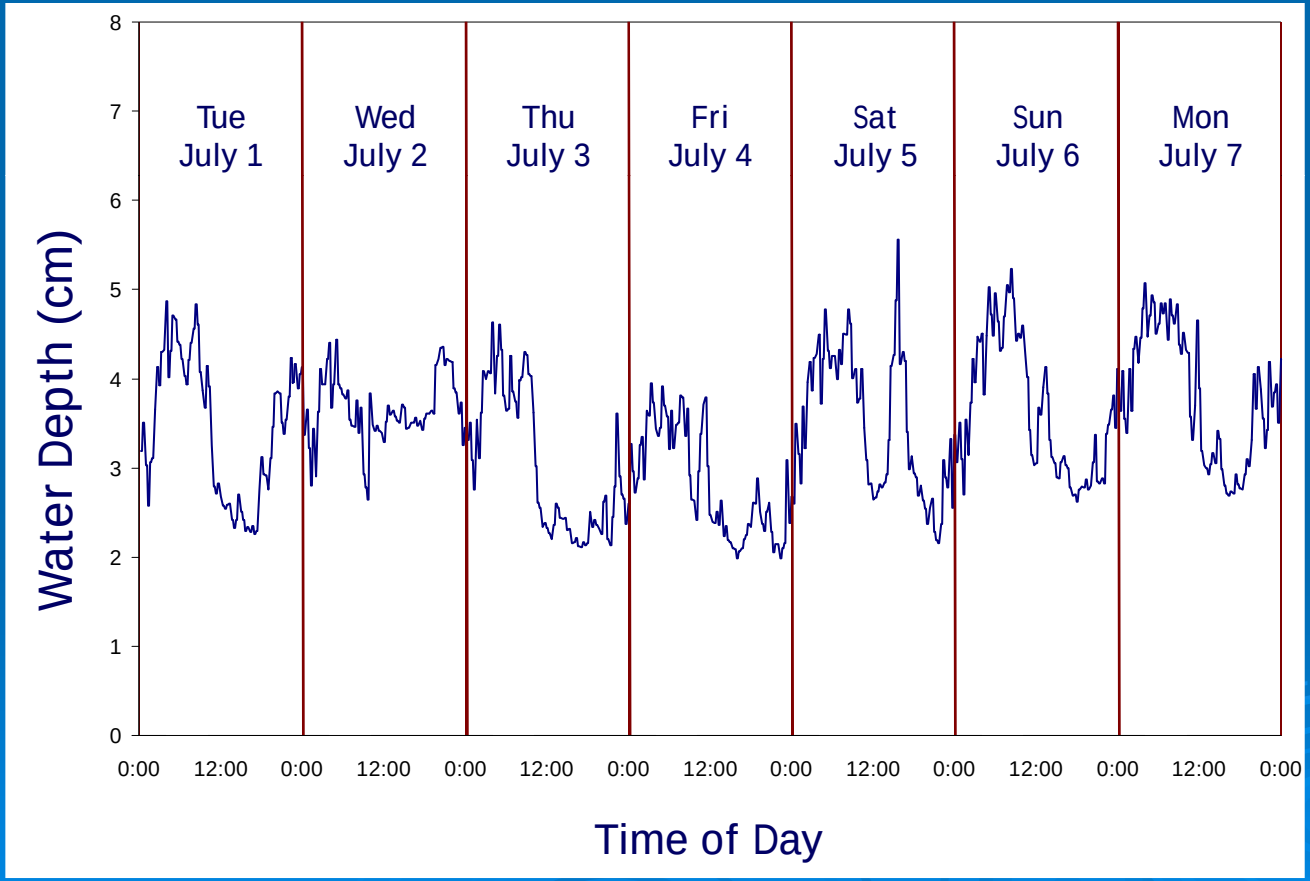
## Orange County

| | Site A | | Site B | | Site C | | Site D | |
|---|---|---|---|---|---|---|---|---|
| | Max | Median | Max | Median | Max | Median | Max | Median |
| Diazinon | 2,086 | 2.8 | 63.9 | 1.2 | 344 | 4.3 | 253 | 2.6 |
| Fipronil | 10,004 | 75.4 | 382 | 76.6 | 1,652 | 129 | 656 | 119 |
| Bifenthrin | 287 | 36.5 | 138 | 12.6 | 6,121 | 12.9 | 709 | 13.9 |
| no. samples | 49 | | 52 | | 53 | | 44 | |

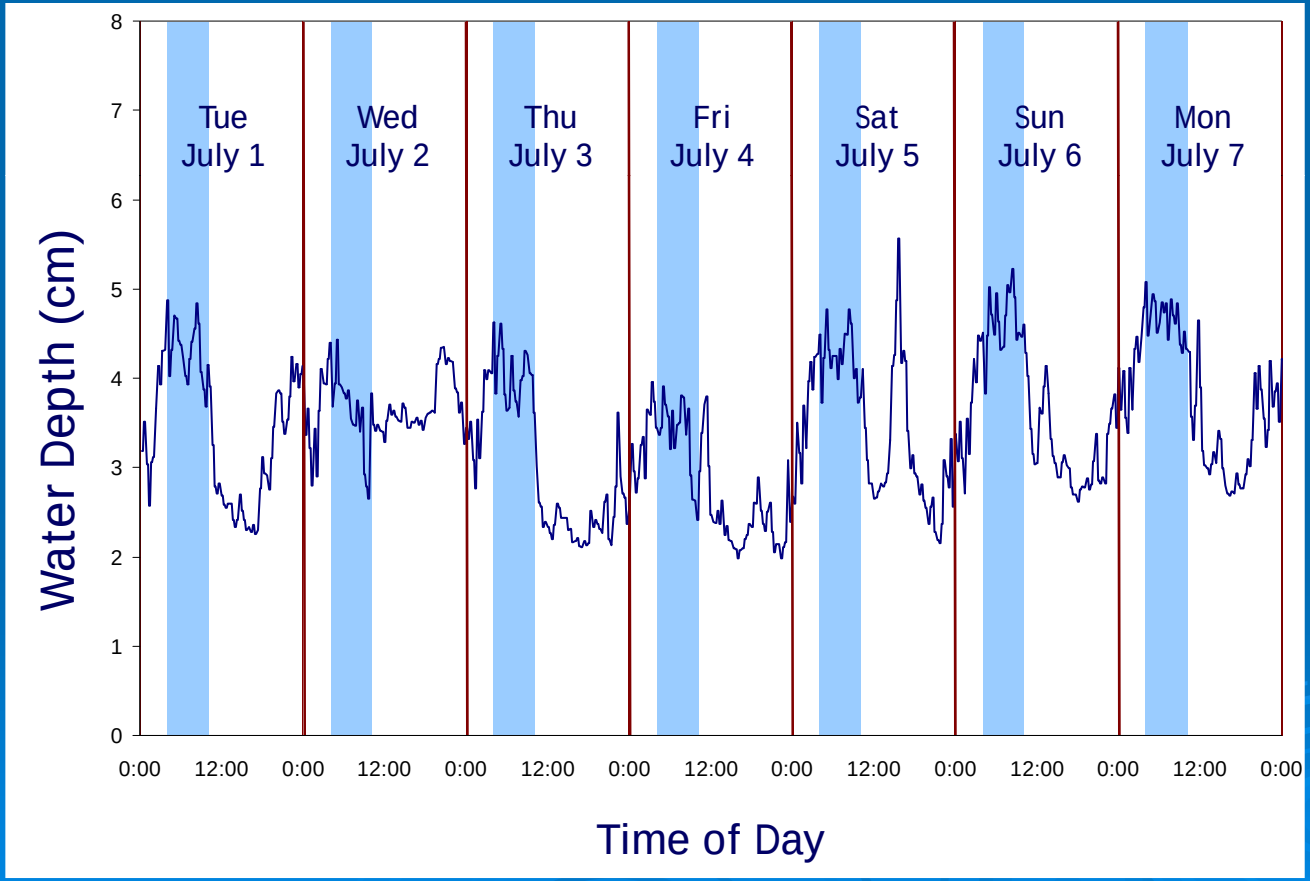
Values are concentrations in ng/L

| | 96 hr $LC_{50}$ | organism |
|---|---|---|
| diazinon | 436 | *Ceriodaphnia dubnia* |
| fipronil | 140 | *Americamysis bahia* |
| bifenthrin | 50 | *Ceriodaphnia dubnia* |

# Dry season runoff patterns



# Dry season runoff patterns



# Intensive Dry Weather Sampling

- Weekly samples on Tuesdays (N. California) and Wednesdays (S. California)
  - What about the other days?
- Monitor daily watering habits
  - When do residents water?
  - How much do residents water?
- Examine differences in nutrients, pesticides, and microorganism levels.
- Identify any weekly pollutant patterns.

# Intensive Sampling Methods

- 7 days, 8 composite samples per day
  - hourly samples
  - three samples per composite
- Two 12 hour composite samples for pesticide test
- In Northern CA, Folsom (2) site
  - consistently high flows
  - reliable auto-sampler data
- In Southern CA, Aliso Viejo (4A) site
  - significant pesticide concentrations
  - non-treatment site

# Laboratory Analysis

- Nutrient and physical parameter analysis on 3 hour composite samples
  - Hach sampling kits
- Seven nutrient and physical parameters tested
  - total nitrogen
  - nitrate
  - total phosphorus
  - orthophosphate
  - total organic carbon
  - turbidity
  - total suspended solids
- Pesticide analysis on 12 hour composite samples

# Results can be presented by:

- Parameter

  - track each parameter throughout the 7-day period.

  - observe how parameter levels change throughout the day.

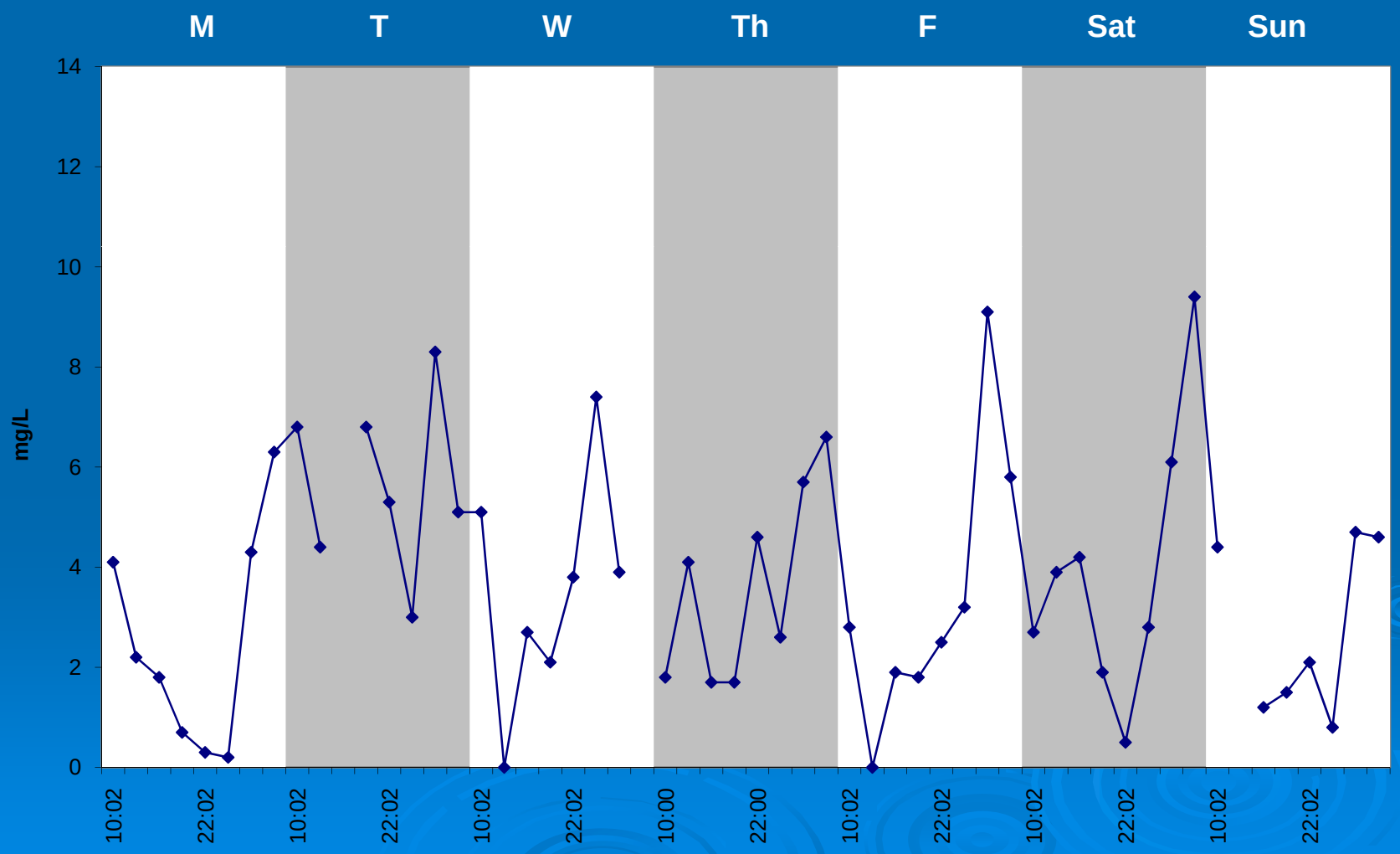
- Composite sample bottle

  - allows for comparing parameter at the same three hours of each day.

  - allows for comparing changes between days of the week.

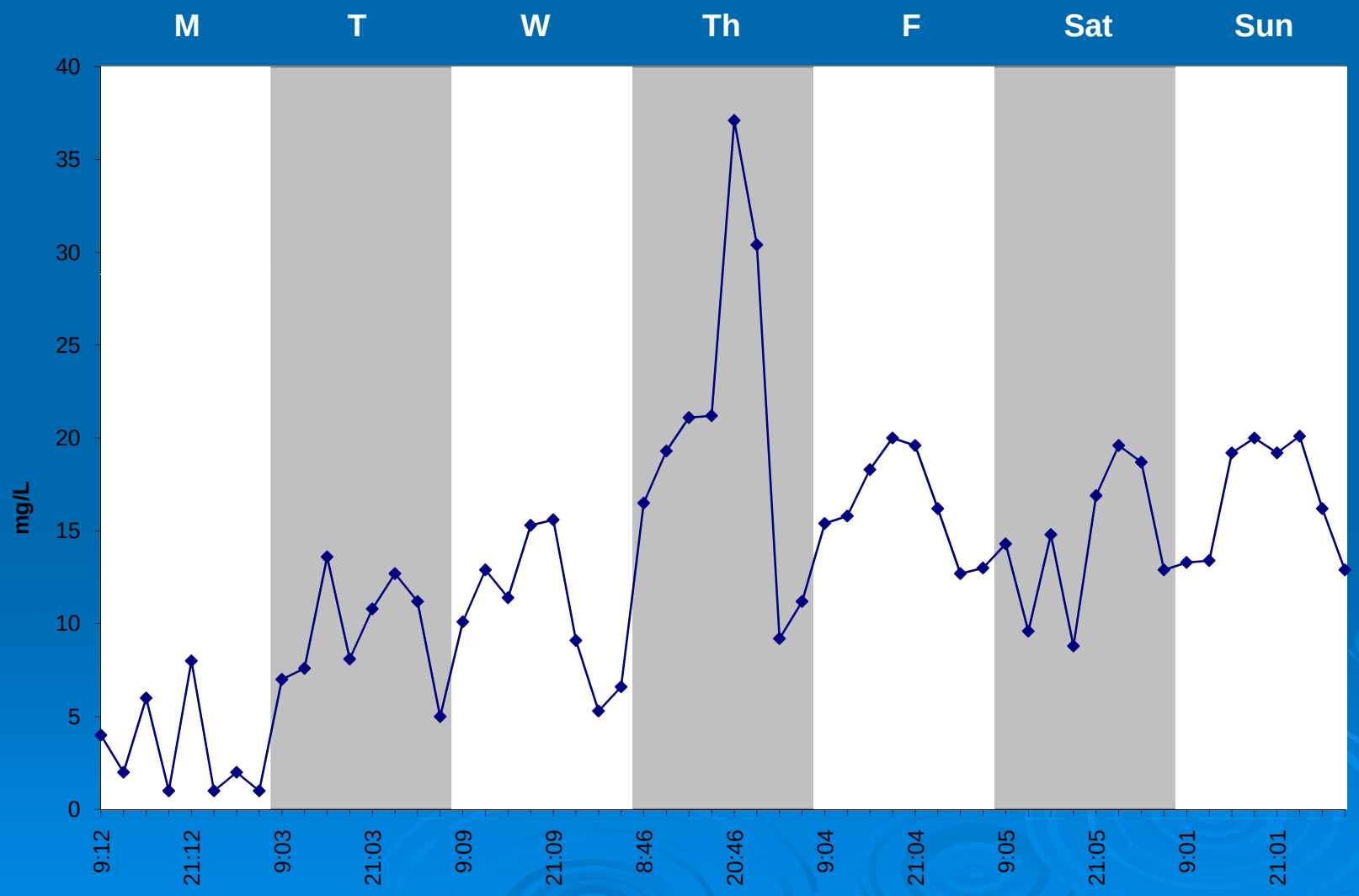
Northern CA

# Total organic carbon



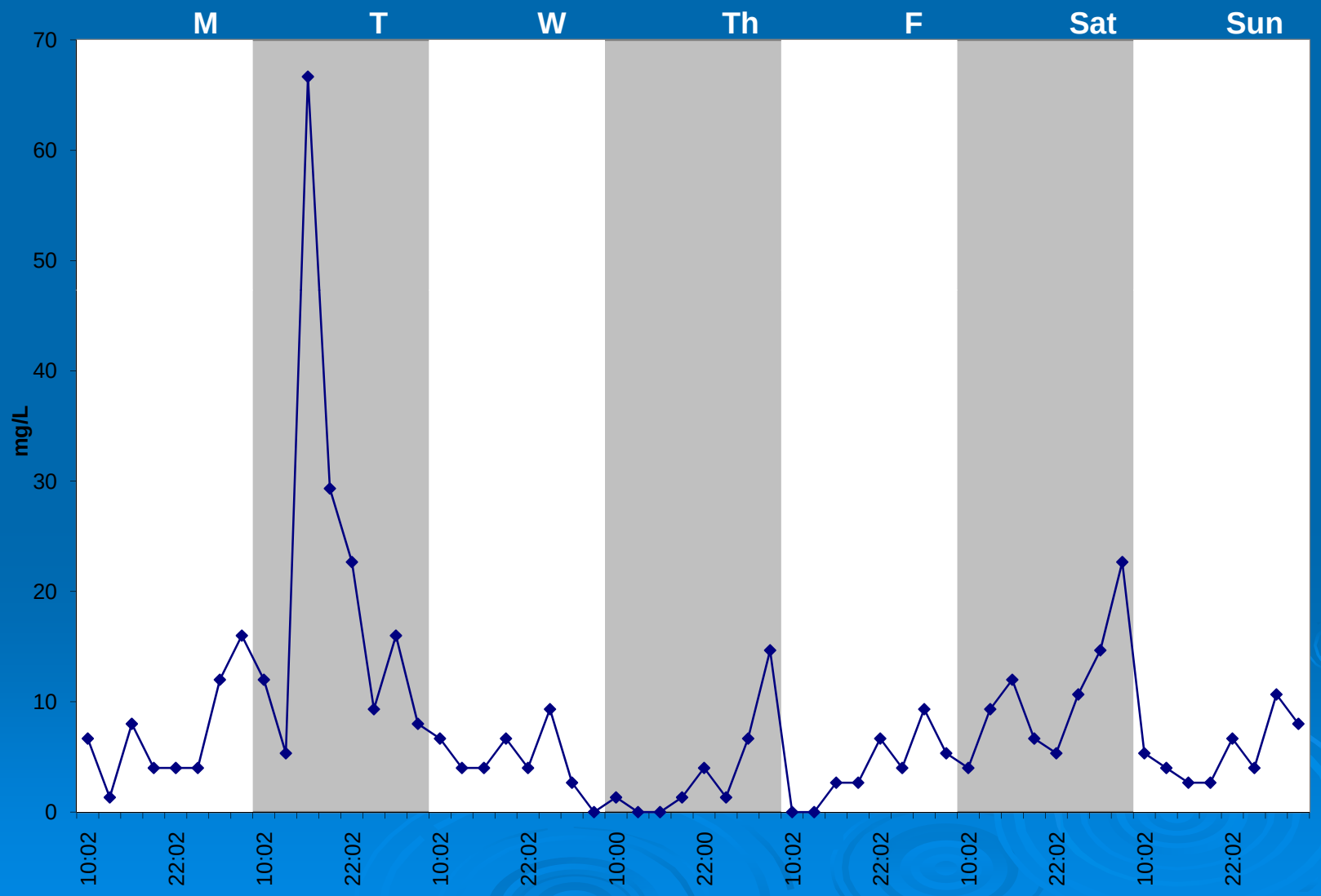
Southern CA

# Total organic carbon



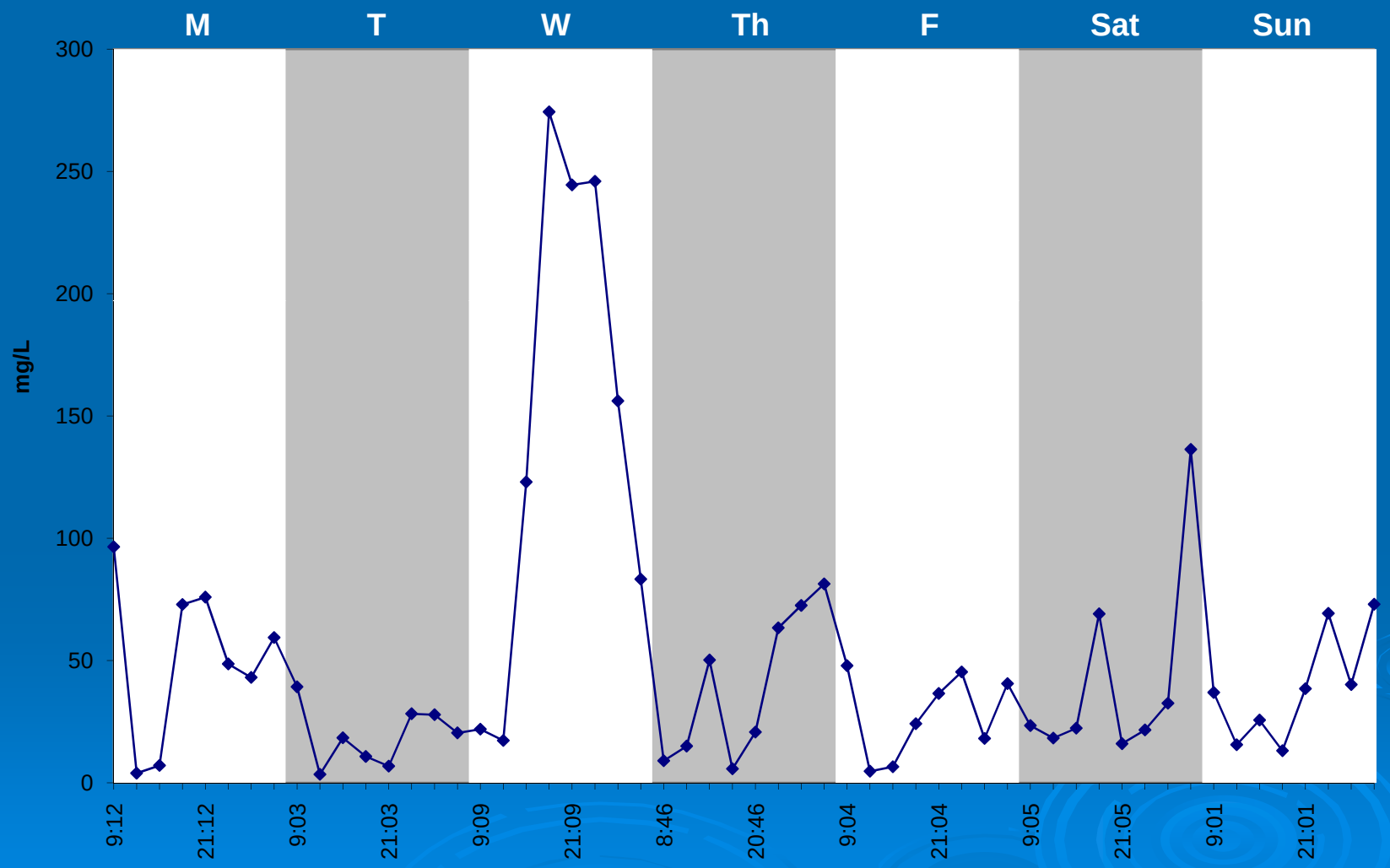
Northern CA

# Total suspended solids

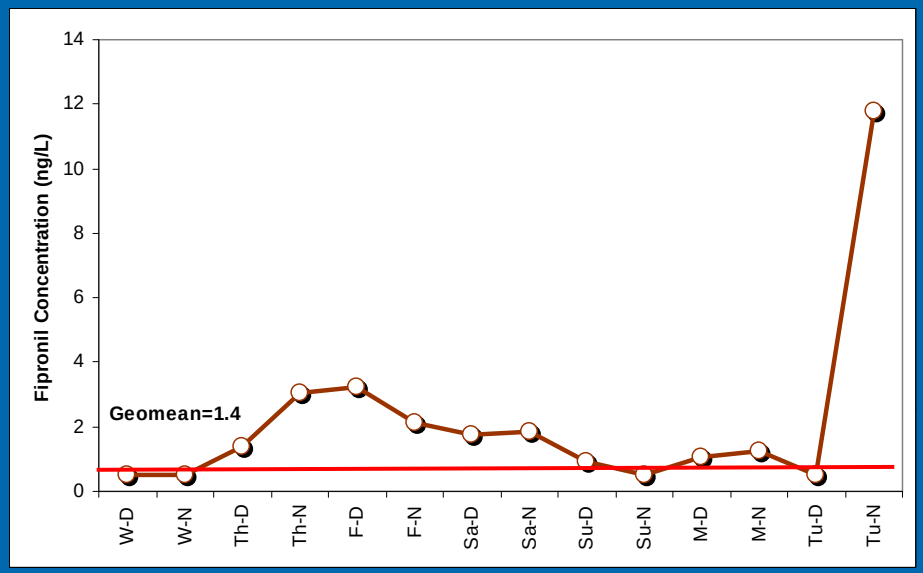


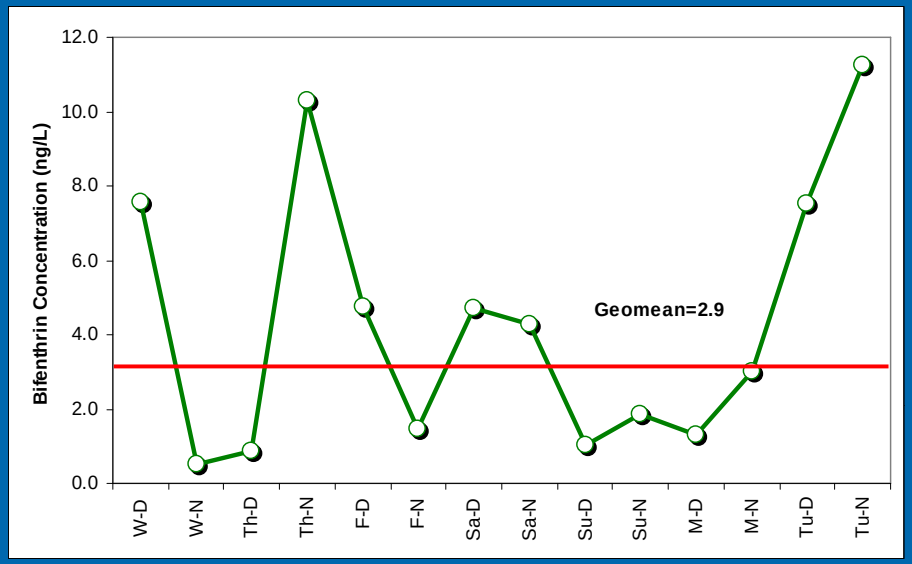
Southern CA

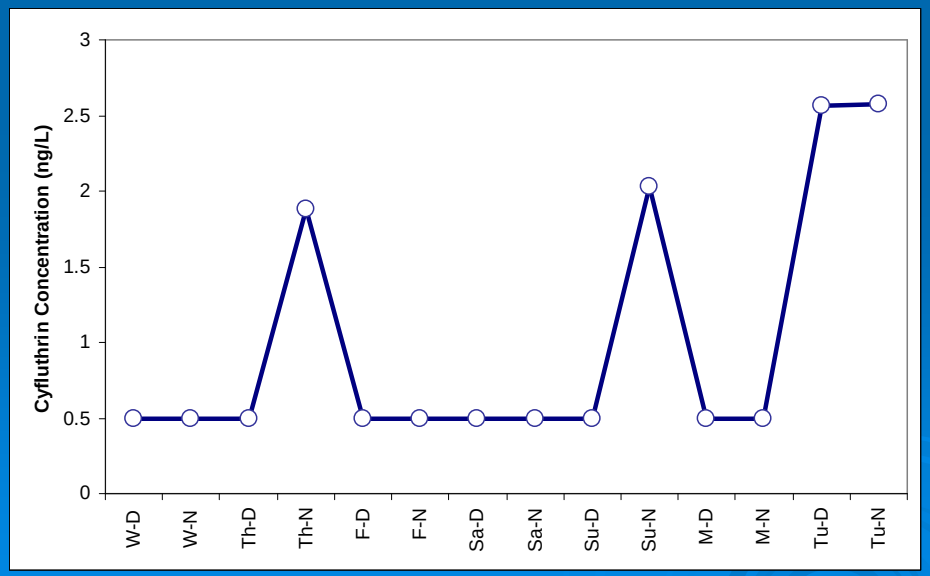
# Total suspended solids

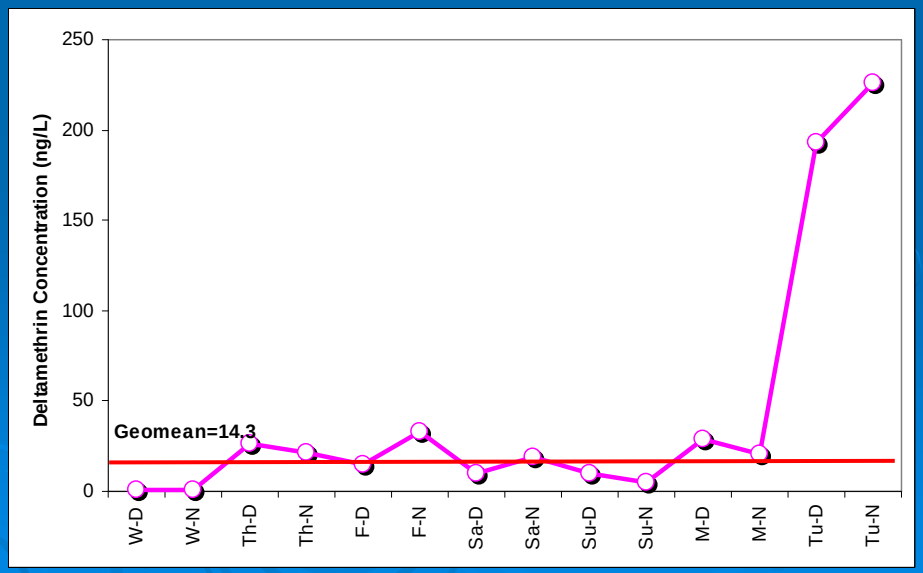


# Northern California Intensive Sampling
# July 23-29, 2008



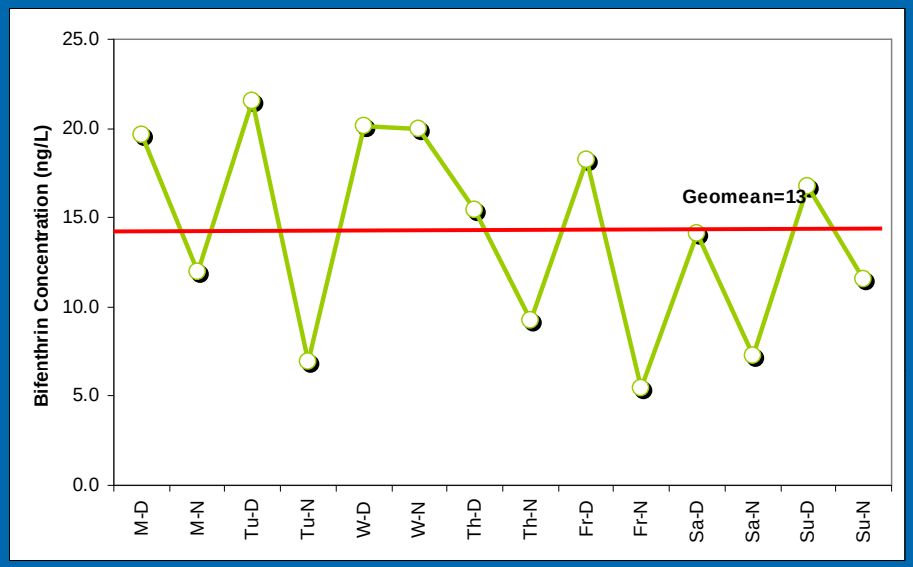



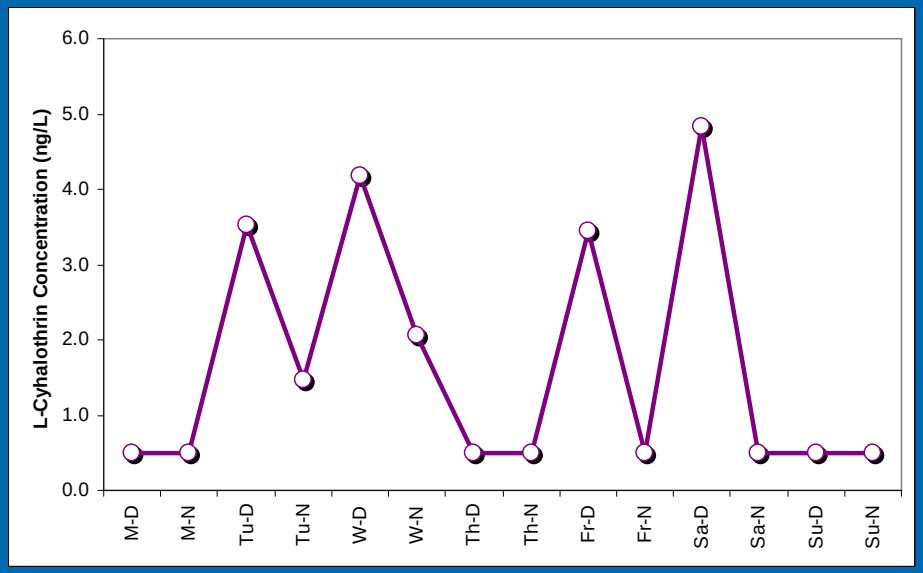



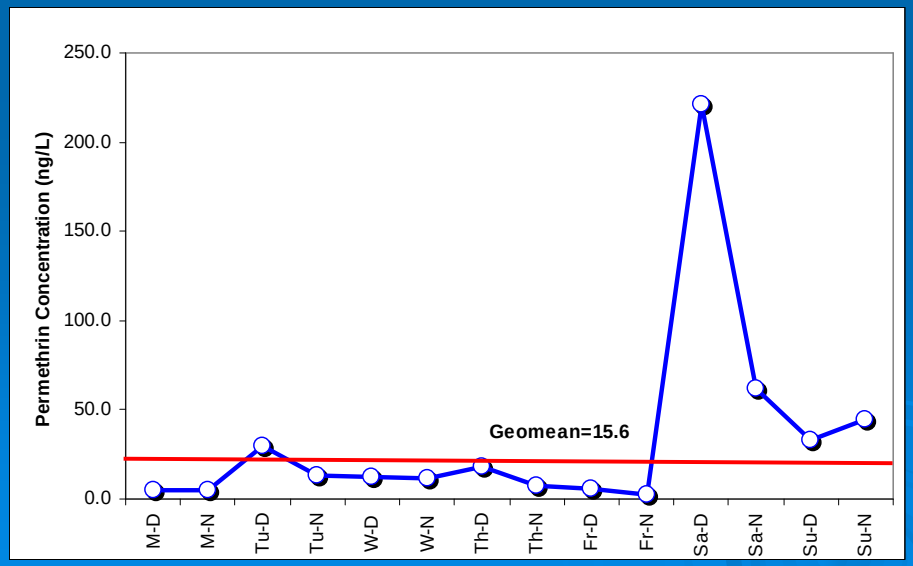
# Northern California Intensive Sampling Summary
# July 23-29, 2008

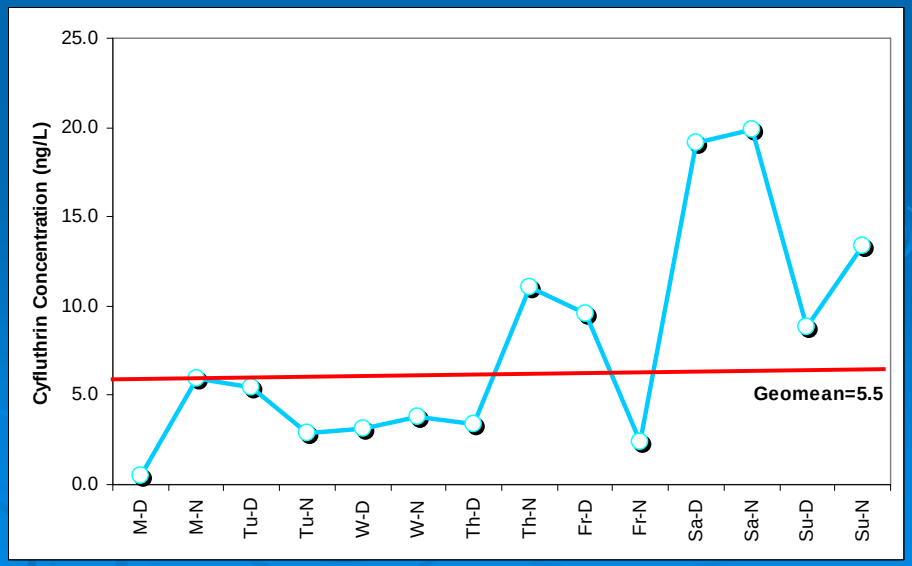
| Compound | Min (ng/L) | Max (ng/L) | Geomean (ng/L) | % Detect. |
|---|---|---|---|---|
| Bifenthrin | 0.5* | 11.2 | 2.9 | 93 |
| Fenpropathrin | 0.5* | 0.5* | * | 0 |
| L-Cyhalothrin | 0.5* | 0.5* | * | 0 |
| Permethrin | 0.5* | 0.5* | * | 0 |
| Cyfluthrin | 0.5* | 2.6 | * | 29 |
| Cypermethrin | 0.5* | 0.5* | * | 0 |
| Esfenvalerate | 0.5* | 0.5* | * | 0 |
| Deltamethrin | 0.5* | 226.3 | 14.3 | 86 |
| Diazinon | 0.5* | 0.5* | * | 0 |
| Chlorpyrifos | 0.5* | 0.5* | * | 0 |
| Fipronil | 0.5* | 11.8 | 1.4 | 71 |

# Southern California Intensive Sampling
# June 16-23, 2008

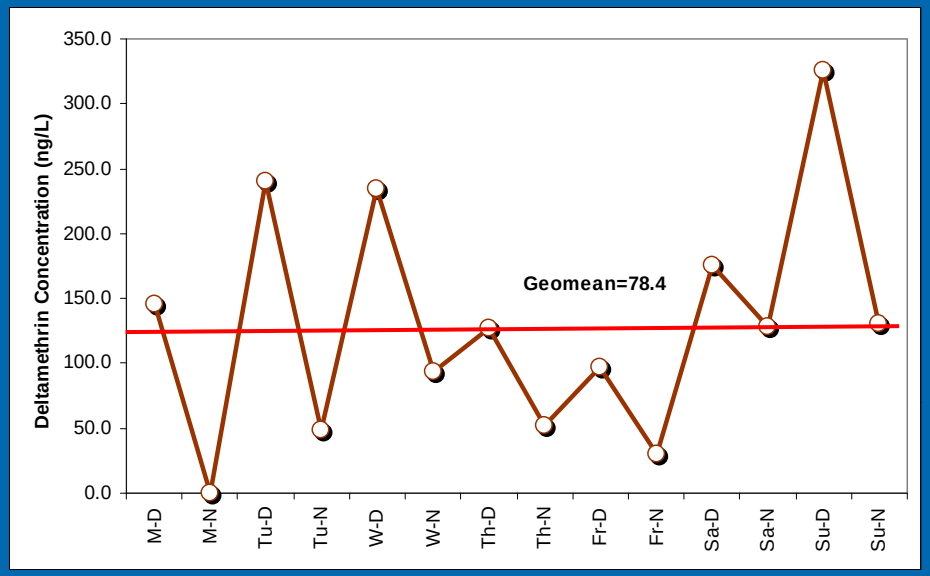


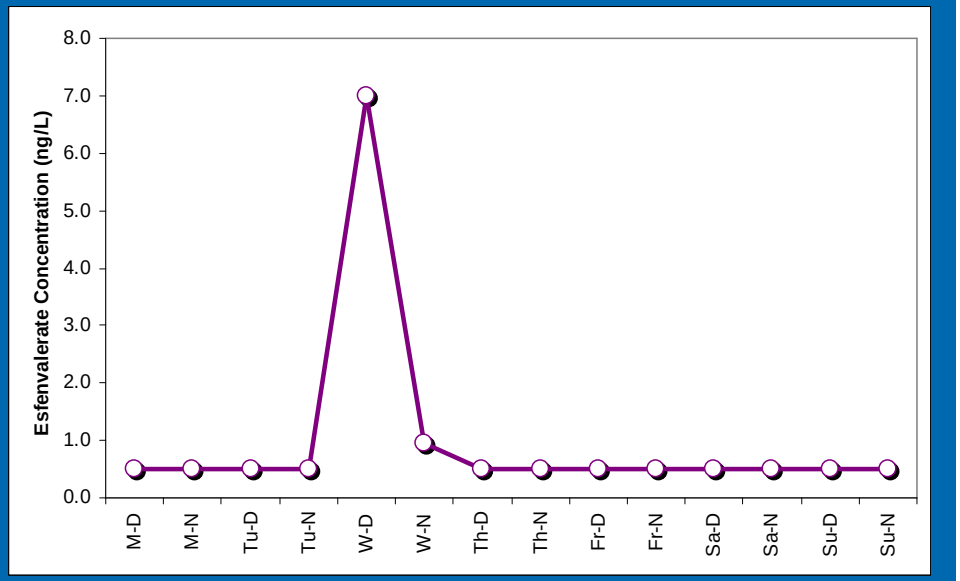



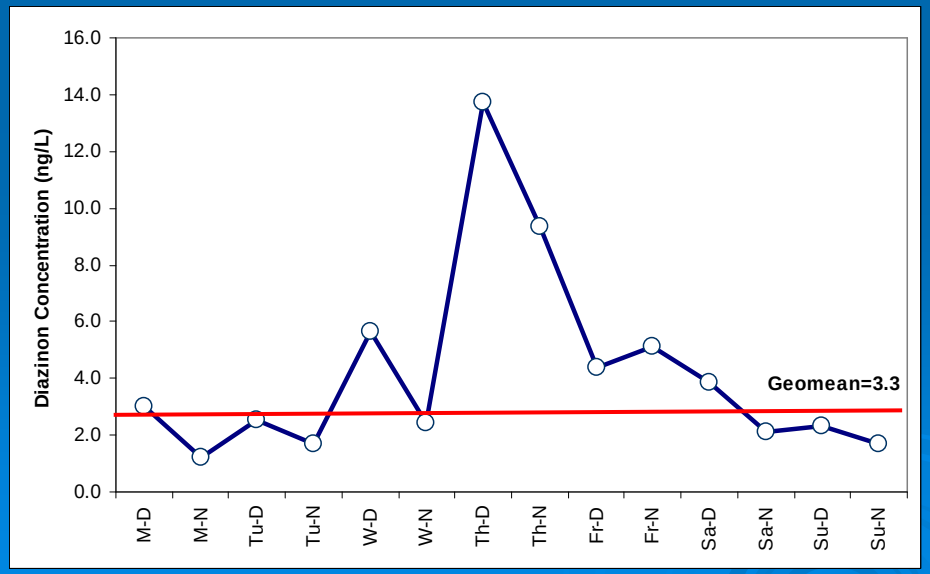



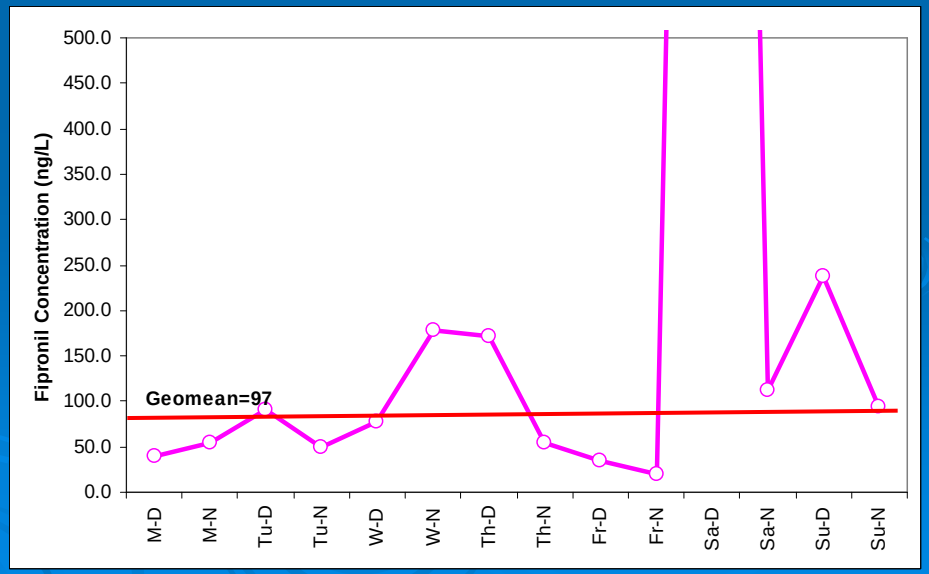



# Southern California Intensive Sampling
# June 16-23, 2008



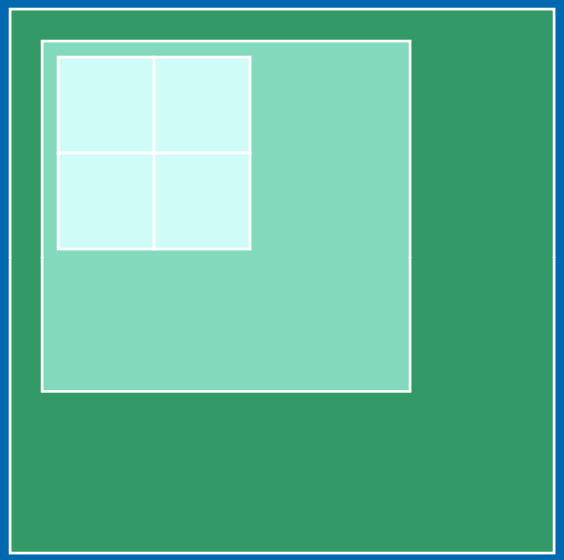



# Southern California Site Intensive Sampling Summary June 16-23, 2008

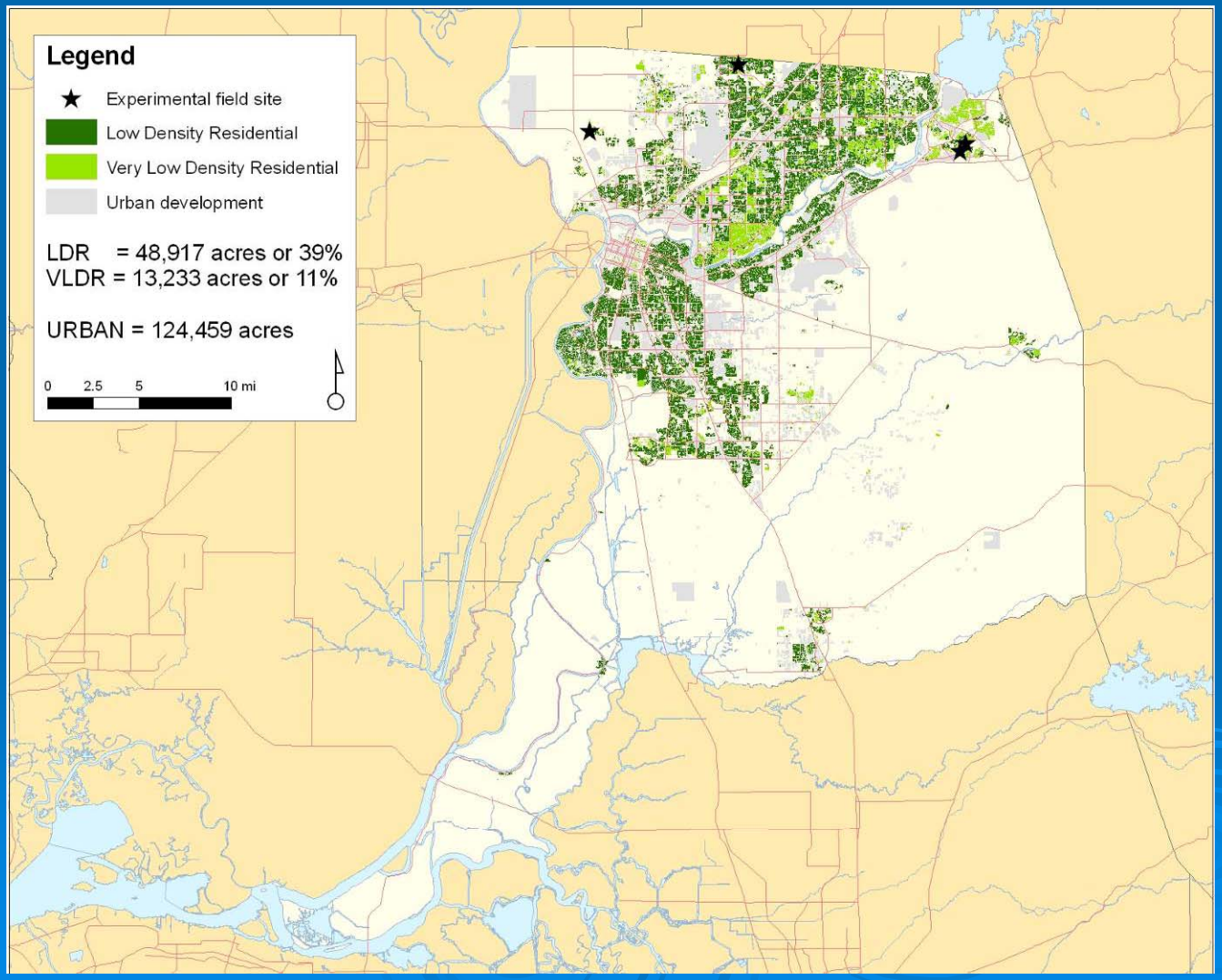
| Compound | Min (ng/L) | Max (ng/L) | Geomean (ng/L) | % Detect. |
|---|---|---|---|---|
| Bifenthrin | 5.5 | 21.5 | 13.0 | 100 |
| Fenpropathrin | 0.5* | 0.5* | * | 0 |
| L-Cyhalothrin | 0.5* | 4.8 | * | 42.9 |
| Permethrin | 2.3 | 221.7 | 15.6 | 100 |
| Cyfluthrin | 0.5* | 19.9 | 5.5 | 93 |
| Cypermethrin | 0.5* | 0.5* | * | 0 |
| Esfenvalerate | 0.5* | 7.0 | * | 14 |
| Deltamethrin | 0.5* | 325.2 | 78.4 | 93 |
| Diazinon | 1.2 | 13.7 | 3.3 | 100 |
| Chlorpyrifos | 0.5* | 0.5* | * | 0 |
| Fipronil | 19.6 | 2884.5 | 96.9 | 100 |

# Multi-scale Model

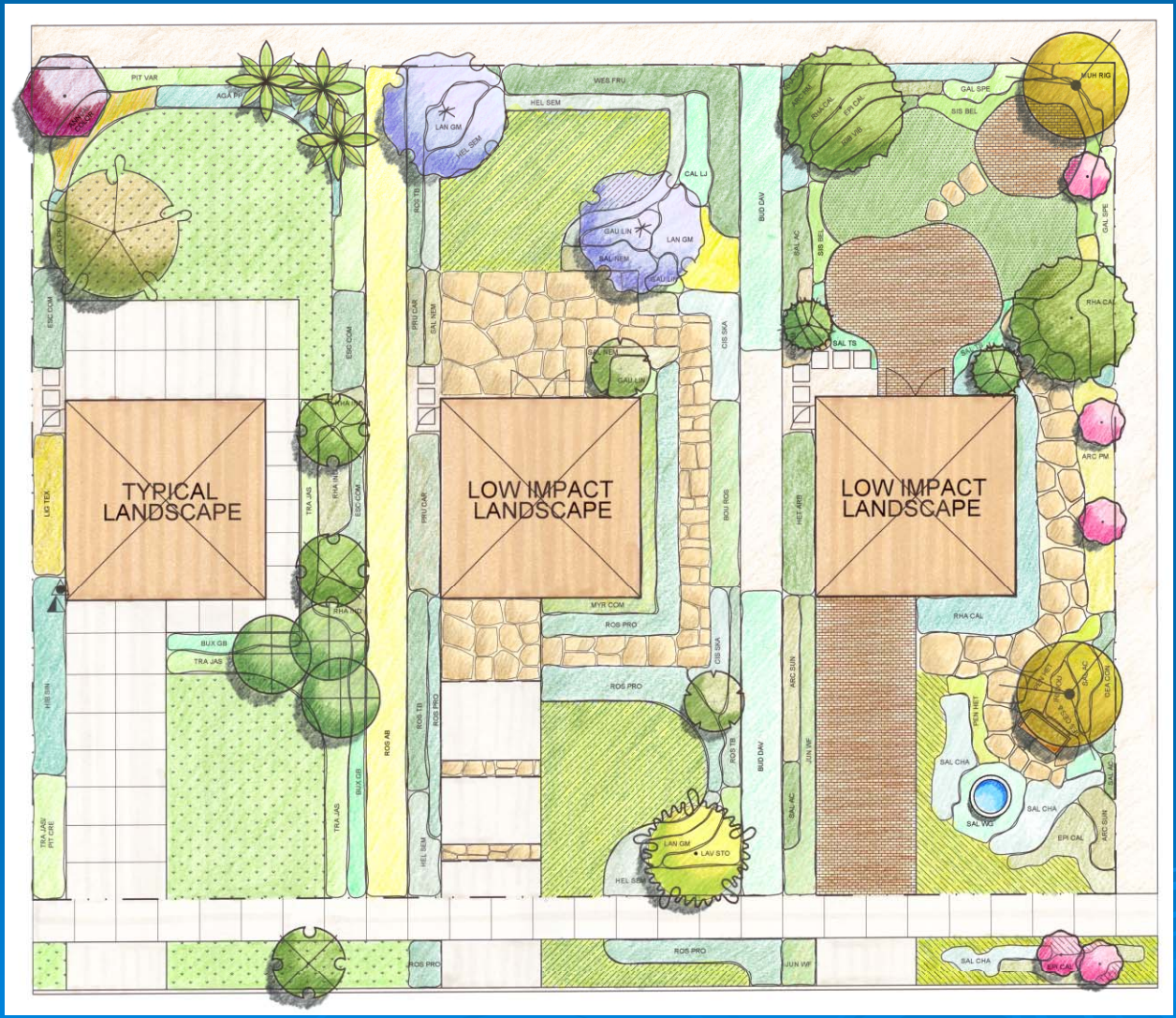


- Neighborhood drainsheds
- County LDR and VLDR
- 50 year projected additional LDR and VLDR

# Low & Very Low Density Residential Zones



# PRISM Experimental Landscapes




"Typical" "Low Impact I" "Low Impact II"

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)

$$L^e_{k,i} = \frac{V^e_k C^e_{k,i}}{A^e}$$

Neighborhood Reference Load (pounds/year)

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

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

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

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

Loading Ratios from PRISM Experimental Sites: $L_0$, $L_1$, $L_2$ (ratio)

$$L^e_{k,i} = (1 - \alpha_{k,i}) L^e_{0,i}$$

$$\alpha_{1,i} = (1 - \frac{L^e_{1,i}}{L^e_{0,i}})$$

$$\alpha_{2,i} = (1 - \frac{L^e_{2,i}}{L^e_{0,i}})$$

Regional Dry Season Loading (pounds/year)

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

# Future Research and Data Collection

- Continuation of controlled pesticide studies utilizing PRISM landscapes.
  - Currently conducting a fipronil and bifenthrin hardscape wash down study.
- Continue to collect flow data from CALFED sites in Sacramento and Orange County as long as funds can be found.
- Collaborate with local agencies in order to try and complete flow analysis and pollutant loading tasks of CALFED project.