Monitoring Pesticides in Urban Runoff in Northern and Southern California

[Studies 269 and 270]

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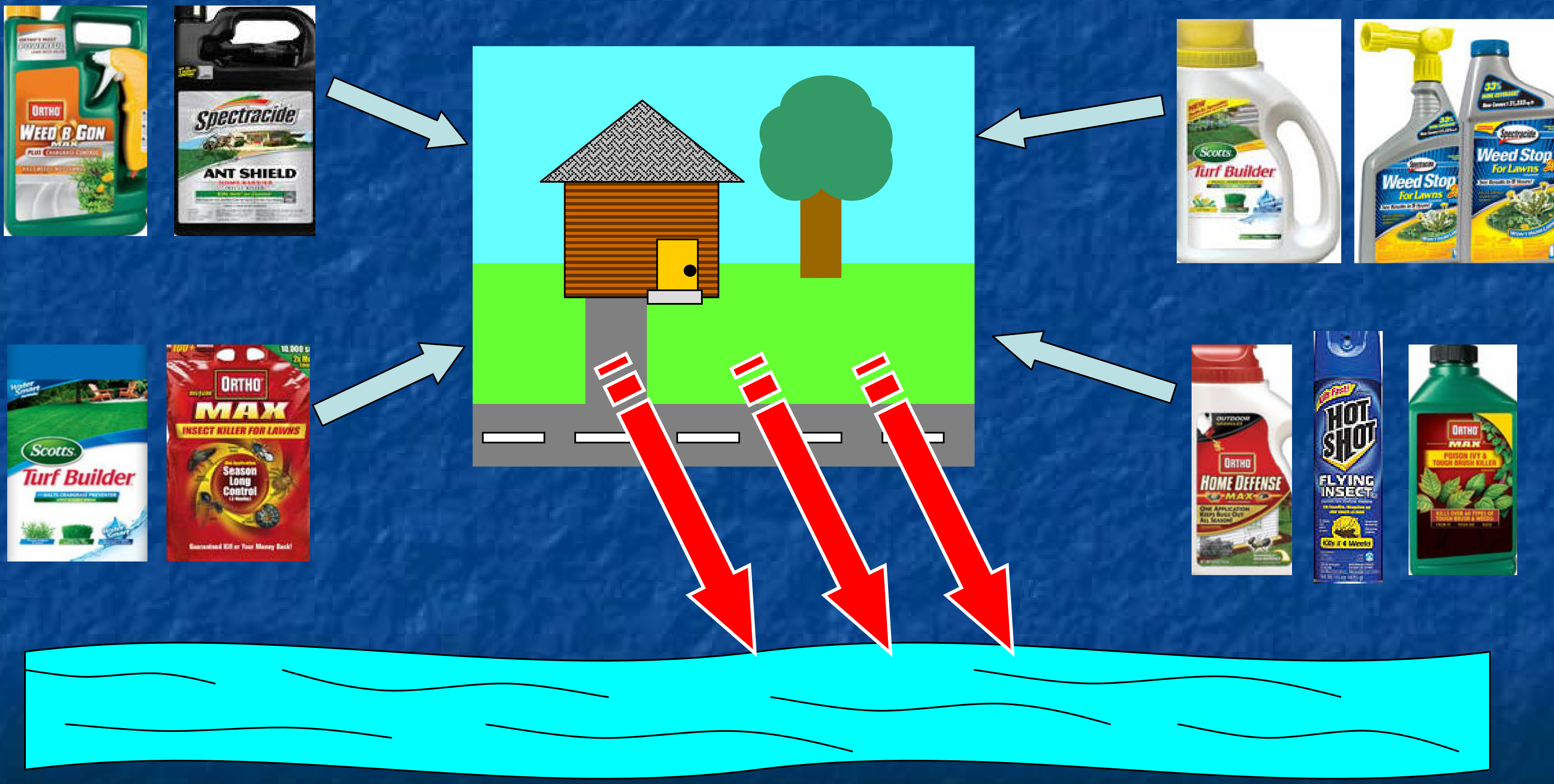
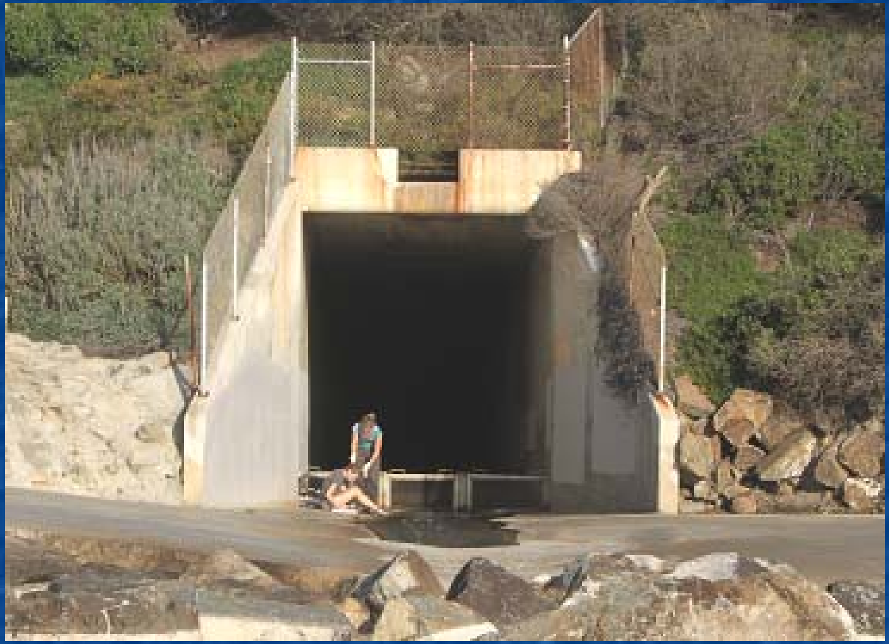
Objective 1: What Pesticides are in Urban Surface Waters?



Objective 2: Seasonal Differences



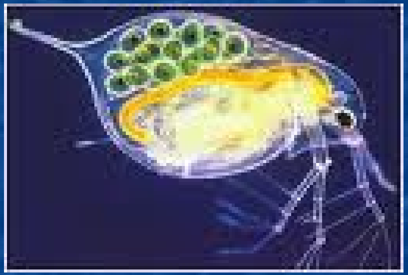
Dry Season

Storm Event

Objective 3: Toxic to Aquatic Species?

Dinoflagellates

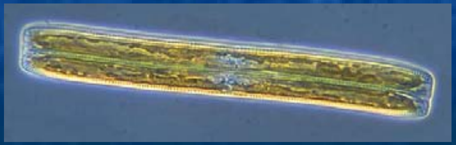
Euglenozoans



Ceriodaphnia

Rainbow Trout

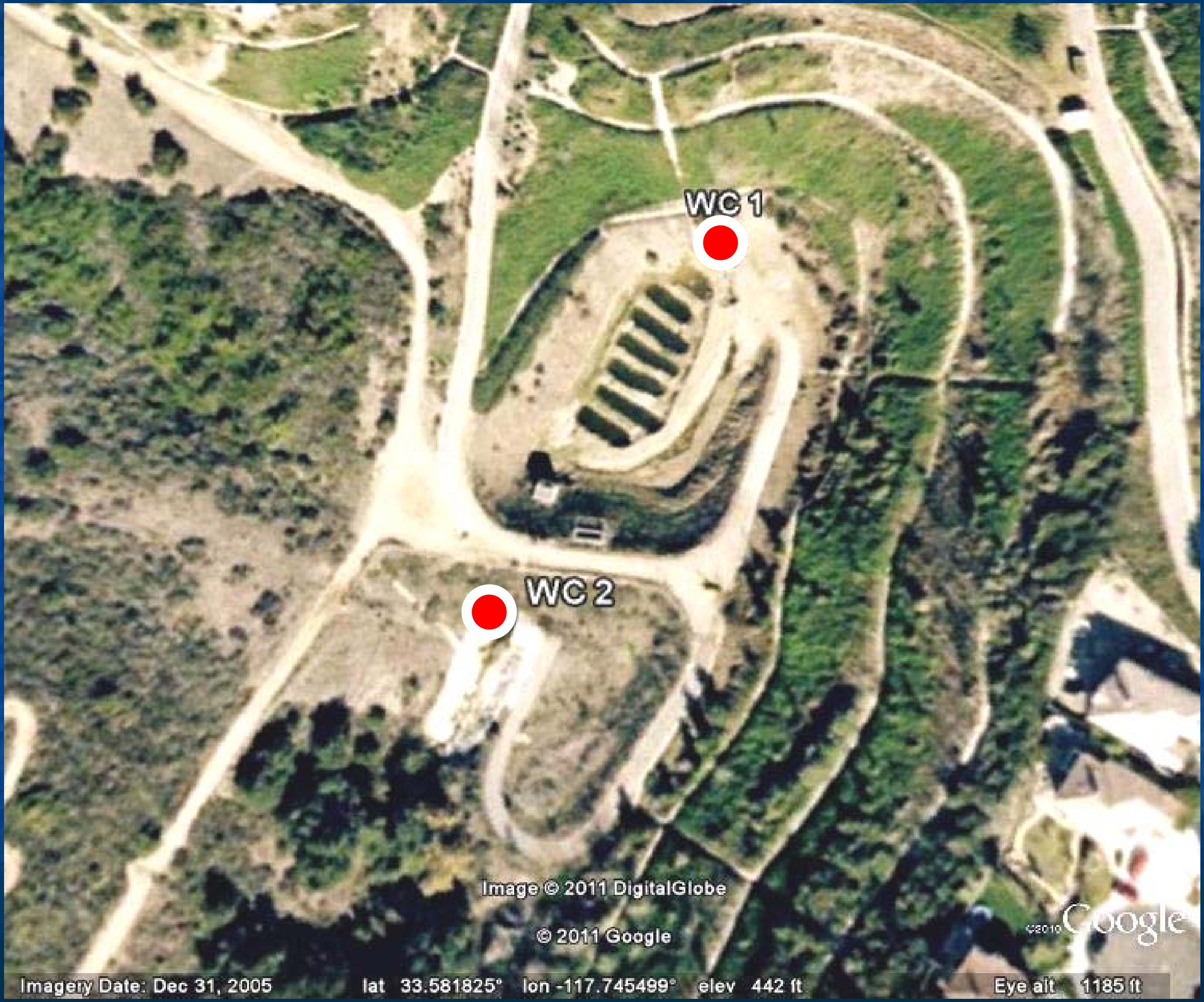
Green algae



Diatoms

Hyalella

Objective 4: Mitigation Measures



Flow Paths

Monitoring Plans

- 2 Dry Season Events [May – Sept]
- 2 – 3 Storm Events [Oct – Apr]
- Water samples at 9 locations
- Sediment samples during dry events

Sampling Methods

Pesticide Analysis

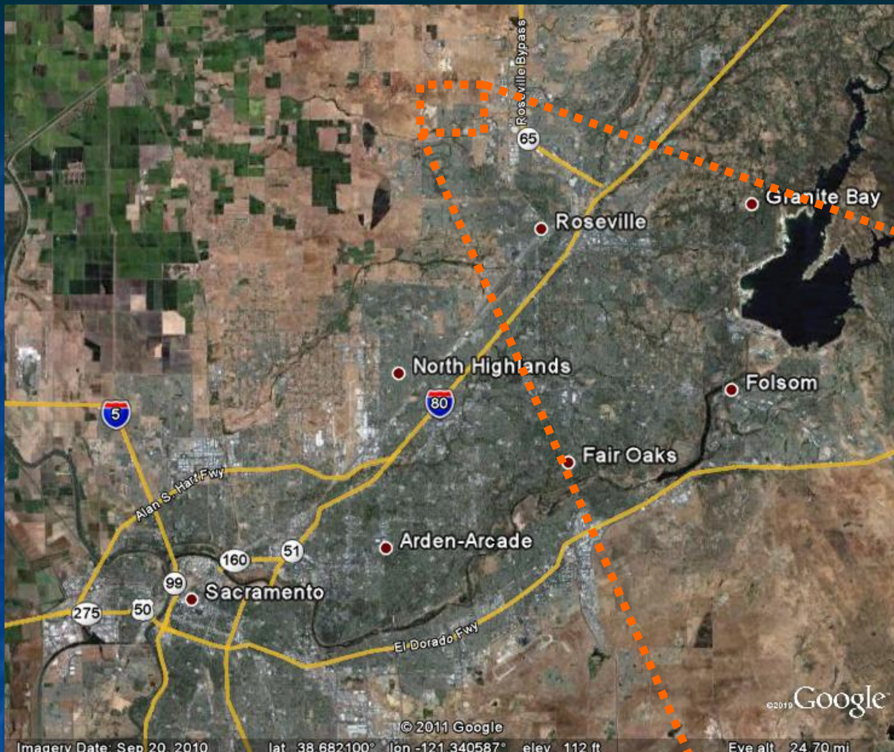
Insecticides

- Carbamates – Carbaryl
- Fipronil + Degradates
- Neonicotinoids – Imidacloprid (SoCal)
- Organophosphates
  - Chlorpyrifos, Diazinon, Dimethoate, Malathion, Methidathion
- Pyrethroids
  - Bifenthrin, λ-Cyhalothrin, Cyfluthrin, Cypermethrin, Deltamethrin, Fenpropathrin, Esfenvalerate, Permethrin, Resmethrin

Herbicides

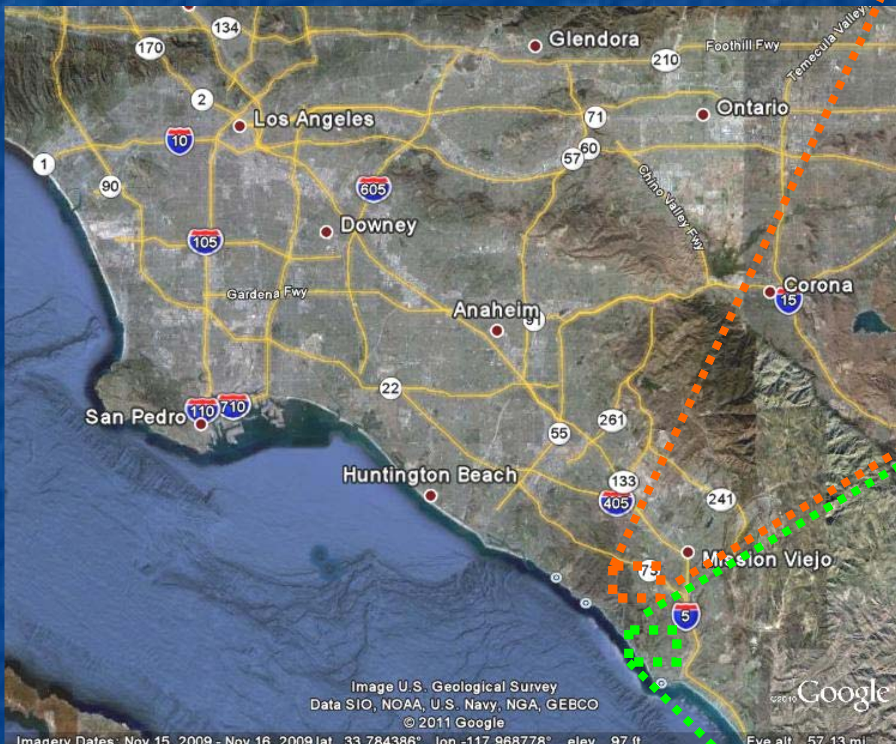
- Synthetic Auxins
  - 2,4-D, Dicamba, MCPA, Triclopyr
- Photosynthesis Inhibitors
  - Bromacil, Diuron, DACT, Hexazinone, Simazine

Northern California Sampling Locations



Study 269

Southern California Sampling Locations



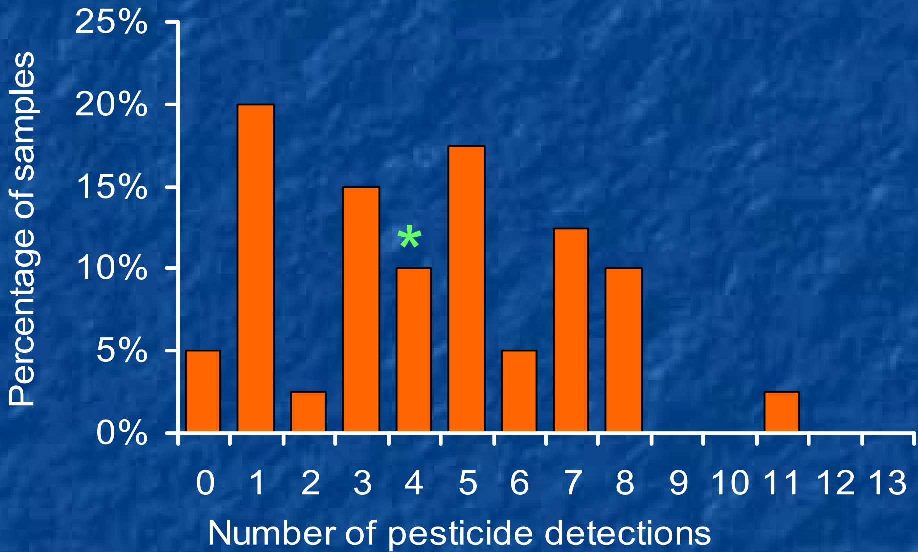
Study 270

Preliminary Results

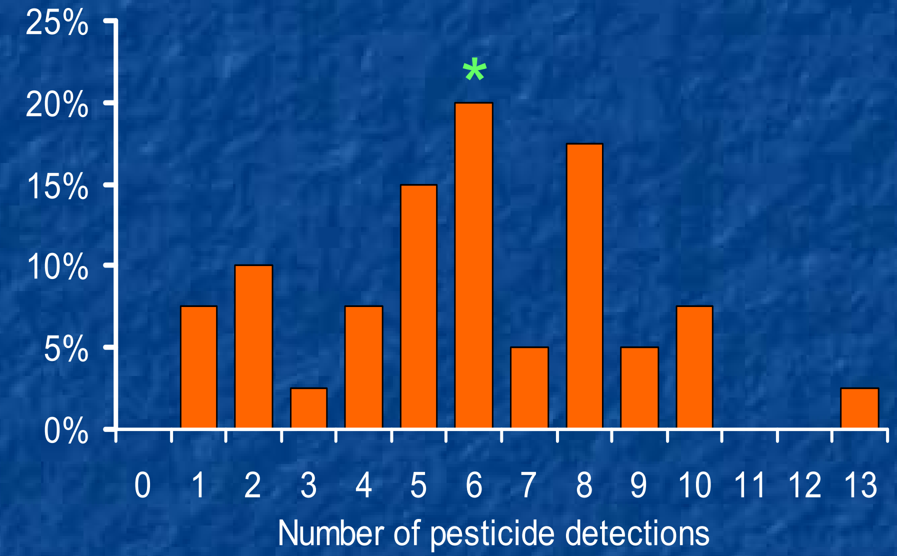
- Data from Ensminger, M. and Kelley, K. 2011. Monitoring Urban Pesticide Runoff in California 2008-2009. Department of Pesticide Regulation. Available at:
  - www.cdpr.ca.gov/docs/emon/pubs/ehapreps/study_249_ensminger.pdf

- Monitoring data from 2008-2009
- Four sites in Pleasant Grove Creek
- Three sites in Salt Creek
- Three sites in Wood Creek

Number of Pesticides per Water Sample



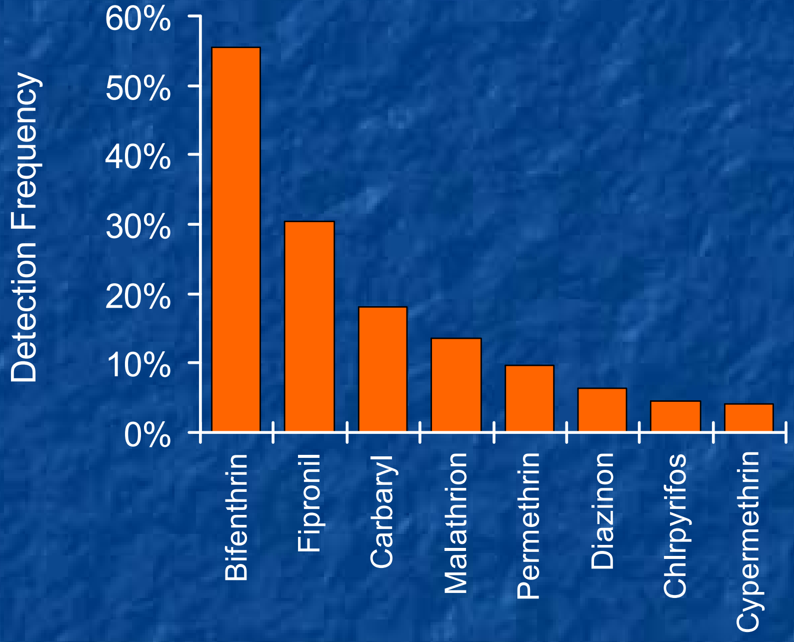
Northern California



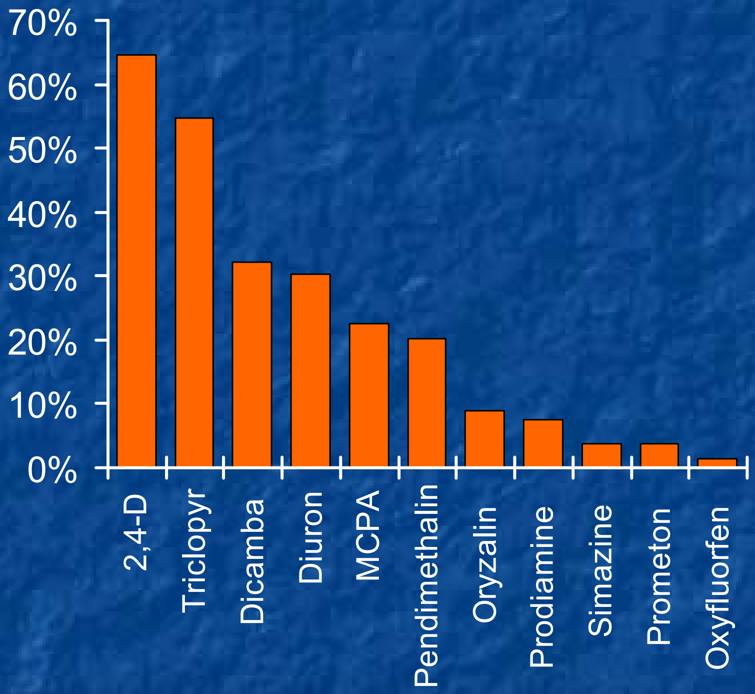
Southern California

* = Median #

Most Frequently Detected Pesticides At All Locations

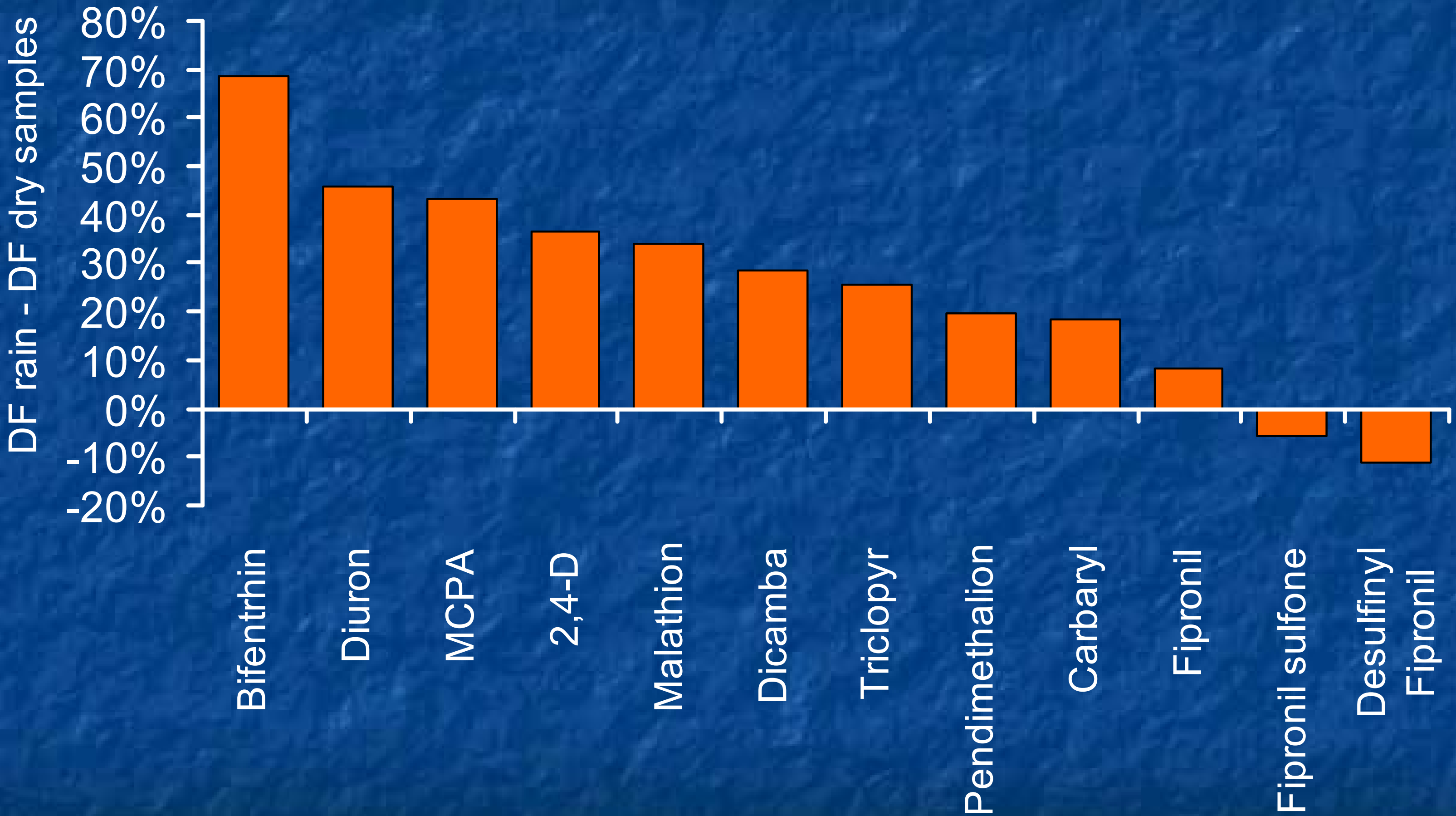


Insecticides



Herbicides

Influence of Rain



Questions?


Surface Water Monitoring
in Agricultural Areas
of California
Imperial Valley
Mar01-2011 Starner

Background

Monitoring focused on pesticides with:

- High current use in California (PUR)
- High aquatic toxicity (WQC, EPA Benchmarks)
- *Little or no recent monitoring data from areas/time periods of high use – (i.e., monitoring data needed)*
- Use in the vicinity of surface water
- *AIs not in reevaluation by DPR*

Background

Primarily insecticides:

- Organophosphates
- Carbamates

Also includes some herbicides

Recent Monitoring Regions

High use density

Multiple AIs

Irrigation Season

Recent Results

Primarily detections:

- diazinon, chlorpyrifos
- malathion
- methomyl, dimethoate

DPR Documents

Contact: Keith Starner, California Dept. of Pesticide Regulation

kstarner@cdpr.ca.gov

Report:

DPR Study 238

http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps.htm?filter=surfwater

Protocol:

DPR Study 271

http://www.cdpr.ca.gov/docs/emon/pubs/protocol.htm

Modeling Approach for Pesticide Evaluation of New Active Ingredients

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Reference: Luo, Y., F. Spurlock, X. Deng, S. Gill, and K. Goh, 2011. Use-Exposure Relationships of Pesticides for Aquatic Risk Assessment, *PLoS ONE*, 6(4): e18234

Background

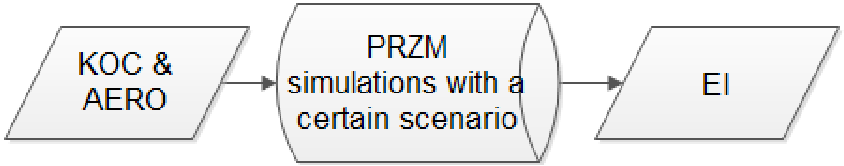
- Aquatic exposure to pesticide use is required in pesticide evaluations for *surface water* protection
- Field runoff test vs. environmental *modeling*
- DPR surface water protection program is developing a more consistent and transparent method for evaluating registration packages
- Existing modeling approaches
  - Advanced models: require a large set of input data
  - Simple models: ignore spatial variability in climate, soil, crop, and/or topography

Objective

- To develop a simple model to estimate aquatic exposure to pesticides in California field conditions
- *Use-exposure relationship*: a statistical relationship as an abstraction, highlighting selected inputs/outputs of an *existing model*
  - USE: use site (scenario), application rates (and intervals), and applied pesticide
  - EXPOSURE: peak concentration in a certain return period (USEPA)
  - exposure=*f*(scenario, label rate, chemical properties)

Development

- USEPA Pesticide Root-Zone Model (PRZM) and associated modeling scenarios for California
- Chemical properties
  - Aerobic soil metabolism half-life (AERO), and
  - organic carbon-normalized adsorption coefficient (KOC)
- Procedures
  1. Initialize PRZM model with one scenario
  2. Run stochastic simulations with random AERO and KOC
  3. Derive statistical relationships between inputs and output



AERO	KOC	EI
AERO1	KOC1	EI1
AERO2	KOC2	EI2
…	…	…

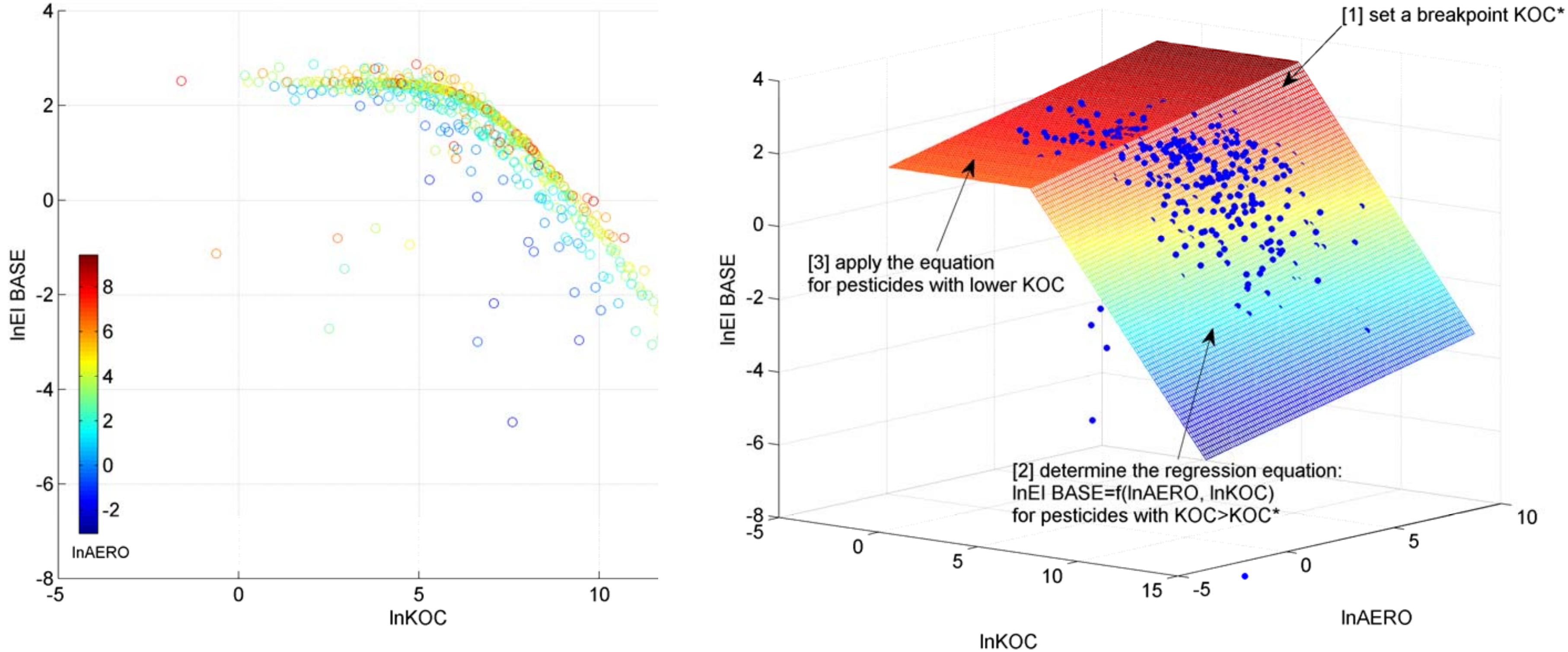


Figure 1. Use-exposure relationship for dissolved pesticides (EI_BASE in μg/L): (a) example results of Monte Carlo simulation and (b) conceptual model. doi:10.1371/journal.pone.0018234.g001

KOC*: a breakpoint for KOC

EI: exposure index (i.e., peak concentration)

BASE: base application rate, used to normalized the predictions

RATE: equivalent application rate based on label rates and intervals

Model: $\ln(\mathrm{EI\_BASE}) = b_1 + b_2 \ln(\mathrm{AERO}) + b_3 \ln[\max(\mathrm{KOC}, \mathrm{KOC}^*)]$

$\mathrm{EI} = \mathrm{EI\_BASE} * (\mathrm{RATE}/\mathrm{BASE})$

Coefficients

Table 5. Use-exposure relationships for dissolved pesticides in selected California crop scenarios.

Scenarios	Coefficients			R2	lnKOC*
	b1	b2	b3		
Alfalfa	5.2156	0.1907	−0.8288	0.9494	3.5
Almond	4.8131	0.1869	−0.7467	0.9335	4.5
Cotton	6.3173	0.1467	−0.7662	0.9102	5.5
Sugar beet	4.9105	0.2412	−0.8377	0.9193	3.0
Tomato	5.9979	0.1785	−0.7844	0.8970	4.0
Turf	3.3647	0.2821	−0.8248	0.9546	0.5
Wheat	6.0764	0.1853	−0.7954	0.9487	5.0
Tomato_FL	4.9362	0.2531	−0.8063	0.9422	4.0

Note: "Tomato_FL" denotes the standard USEAP crop scenario for tomato in Florida, which is provided as an example of the crop scenarios in other states.
doi:10.1371/journal.pone.0018234.t005