Protecting Non-Target Wildlife from the Effects of Pesticides

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Background

- Department of Fish and Wildlife is responsible for protecting fish and wildlife in California.
- DFW Wildlife Investigations Laboratory is responsible for monitoring pesticide impacts on fish and wildlife in California.
- Receive animal carcasses from suspected pesticide poisonings all over the State.
- Department of Pesticide Regulation regulates pesticide use in California.
- Work with County Agricultural Commissioner's offices on pesticide-related wildlife incidents.

Pesticide Investigations: Some trends

- Fewer agricultural incidents.
- Fewer problematic ingredients.
- Smaller incidents.
- Fewer fish kills.

Typical pesticide case: 1990

- Agriculture: Rice, alfalfa, grapes
- Average of 539 animals per episode
- Most common pesticides: carbofuran (carbamate insecticide) and endosulfan (organochlorine insecticide)

Typical pesticide case:2010

- Urban/residential pesticide use
- Small number of animals (average of 17/episode)
- Most common pesticide: anticoagulant rodenticide

We've come along way, but still have a few issues to solve.

LET'S START WITH VERTEBRATE TOXICANTS!

No rodenticide is completely safe for wildlife (or humans).

- They are designed to kill vertebrates!
- Anticoagulants cause secondary toxicity but there is an antidote.
- Acute toxicants kill quickly – very little danger of secondary toxicity but accidents can be costly.

Vertebrate Toxicants

- First generation anticoagulants: chlorophacinone, diphacinone, warfarin
- Second-generation anticoagulants: brodifacoum, bromadiolone
- Strychnine
- Cholecalciferol
- Bromethalin
- Zinc phosphide
- Fumigants

Anticoagulant Rodenticides

- Cause death by impairing clotting – animal takes several days to die.
- In the early 1990's, DFW began receiving animals with signs of anticoagulant toxicosis. Symptoms include unexplained bleeding in the body cavities and subcutaneously and lack of clotting in blood.
- Mostly result of secondary exposure.

Two different kinds of ARs.

1st Generation (FGAR)

Multiple feedings
Less persistent in tissues
Commensal and outdoor use
Chlorophacinone, diphacinone, warfarin

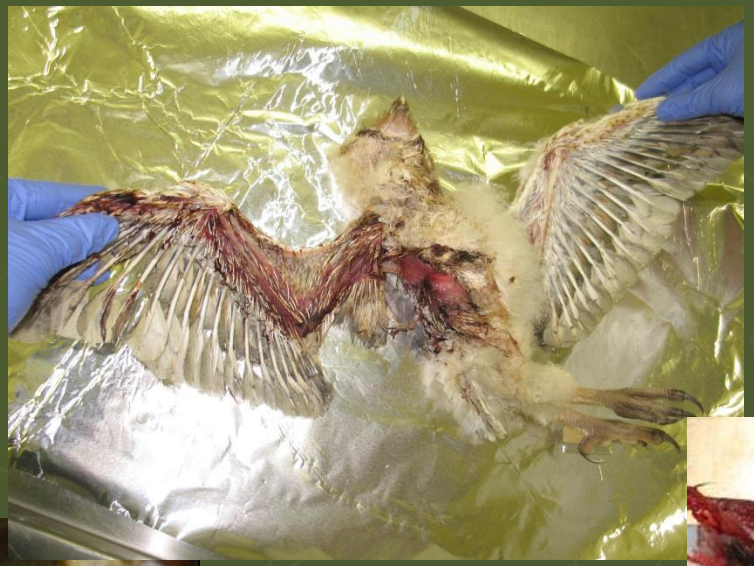
2nd Generation (SGAR)

Intended for single feeding (more toxic)
More persistent in tissue
Registered only for commensal use
Brodifacoum, bromadiolone, difethialone, difenacoum

Species Impacted

- Golden Eagle
- Bald Eagle
- Great-horned Owl
- Barn Owl
- Red-tailed Hawk
- Red-shouldered Hawk
- Cooper's Hawk
- American Kestrel
- Turkey Vulture
- Canada Goose
- Black bear
- Fisher
- Red Fox
- Gray Fox
- SJ Kit Fox
- Coyote
- Mountain Lion
- Bobcat
- Kangaroo Rat
- Raccoon
- Badger
- Wild Pig

Necropsies of Anticoagulant Cases

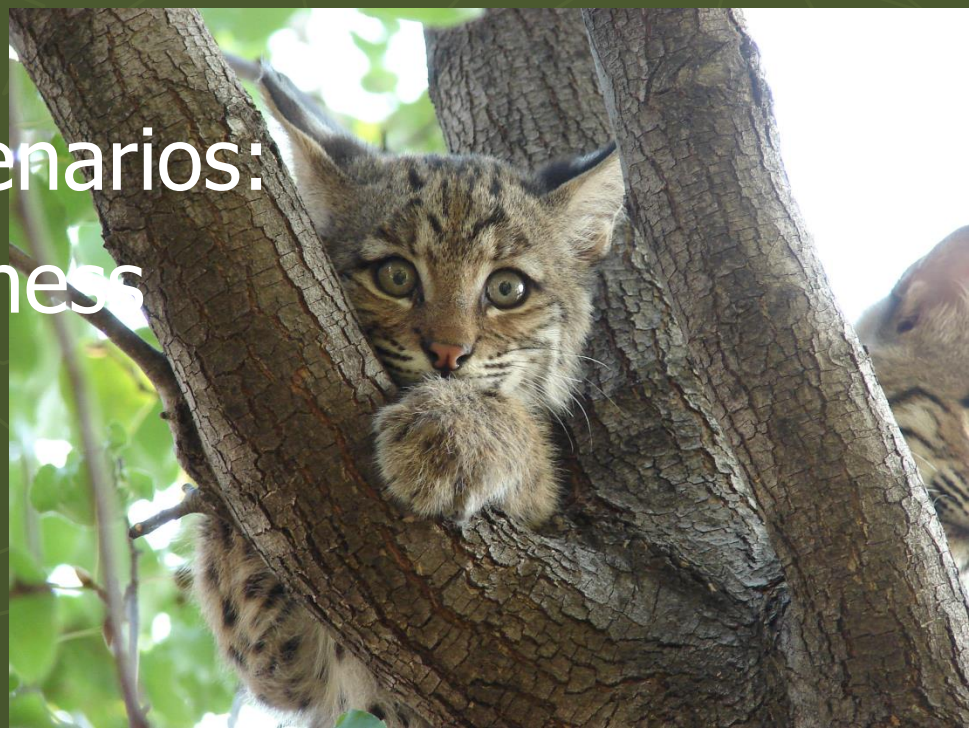


Monitoring Studies Confirm Widespread Exposure

- 79% of San Joaquin Kit Foxes in Bakersfield had been exposed to ARs.
- Mountain Lions (DFW files): 14/14 mt lions collected in last year had AR detections.
- Raptors (Lima and Salmon, 2010): In San Diego 49/53 detections. In Central Valley 37/43 detections.
- Fishers (Mourad Gabriel, UCDavis): 79% had AR detections.

Conclusions from Mortality and Monitoring Data

- Widespread AR exposure to predators and scavengers
- Mortalities caused by exposure
- Sublethal Effects?
- Multiple exposure scenarios:
  Urban, Rural, Wilderness
- Illegal/Legal Use?



CDFW Action

- CDFW has recommended that Department of Pesticide Regulation make SGARs Restricted Use Materials (need a license to buy or use).
- Available only to certified applicators.
- We are waiting for a decision soon.
- USEPA is also acting to remove the products from consumer venues.

Acute Rodenticides

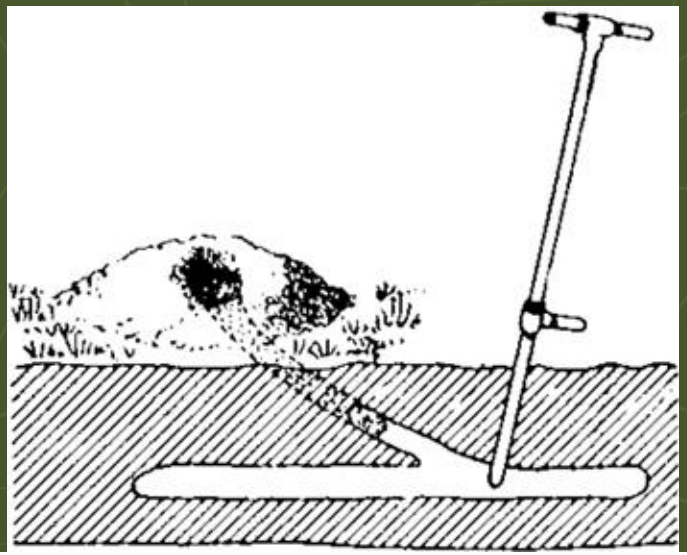
- Strychnine
- Zinc phosphide
- Bromethalin
- Cholecalciferol

Strychnine

- Animal show neural signs (tremors, convulsions) while alive, or stiff-legged when dead.
- No problem with secondary poisoning.

Strychnine

- Strychnine is a general use pesticide but is only legally applied underground for gopher control.
- It is the one of the most common pesticide used for intentionally poisoning wildlife and pets.



Which one was strychnine?

Photo credit: Jaime Rudd

Strychnine Concerns

- California went from 1999 to 2011 without a reported strychnine loss.
- 2011-2012: 50 losses in several different incidents.
- Use practices that have caused recent losses have not been determined.
- San Joaquin kit fox: Federally Endangered Species.
- Tricolored blackbird: Species of Special Concern.

Possible reasons for increased incidents

- Coincidence.
- Better tracking.
- Increased use of strychnine.
- Increased regulation on other rodenticides.

Other acute rodenticides

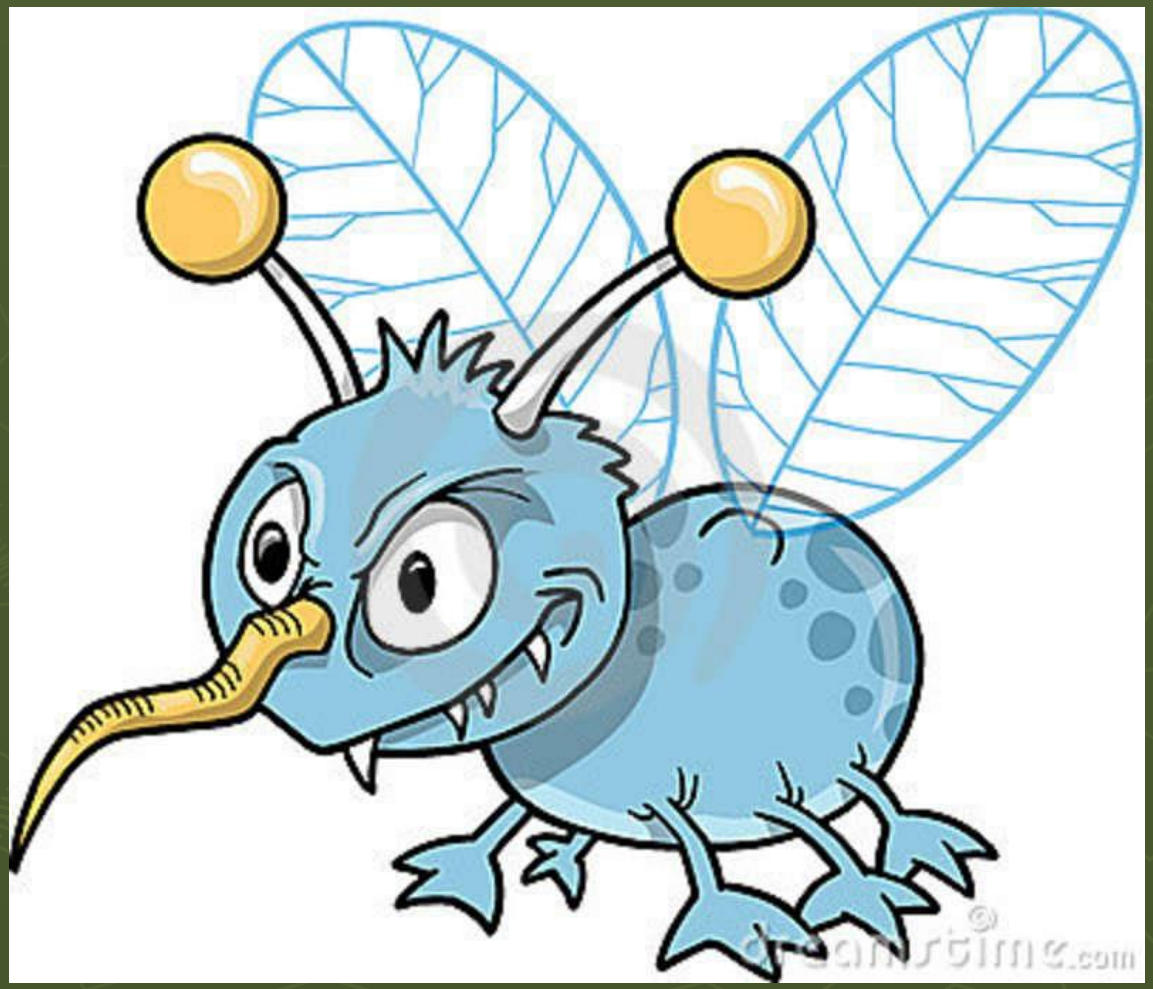
- Bromethalin, zinc phosphide, cholecalciferol
- Fewer incidents than either anticoagulants or strychnine.
- Much less possibility of secondary poisoning than anticoagulants.
- But...they will still kill non-target wildlife if used incorrectly.

Fumigants

- Aluminum phosphide, gas cartridges
- Little to no danger of secondary exposure.
- Critical to determine if your target pest and only your target pest is in the burrow before fumigation.


What's in that burrow?

Now some insecticides!



BACK IN THE GOOD OLD DAYS

- Agricultural and residential insecticides were mainly organophosphates and carbamates.
- Toxic to invertebrates, fish, birds, mammals.
- Hazard to farm workers.
- Soluble in water.

WILDLIFE LOSSES FROM ORGANOPHOSPHATES AND CARBAMATES

NEW KIND OF PESTICIDE WILL SOLVE EVERYTHING!

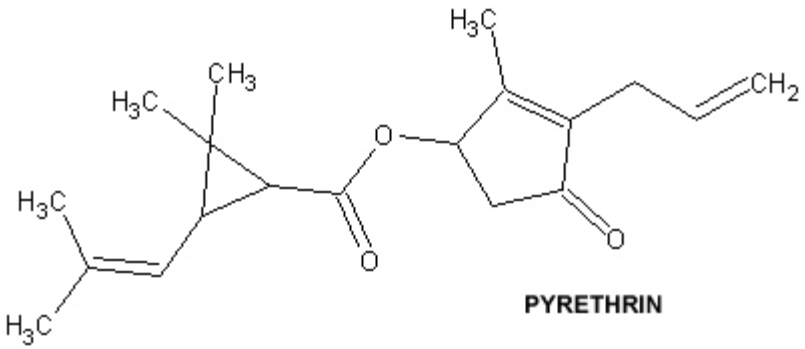
- Synthetic pyrethroids were developed in the 1970s by modifying pyrethrins which is a naturally occurring insecticide derived from chrysanthemums.
- Increasing use in the 1990s as the organophosphates were phased out.

SOME PYRETHROIDS

- Permethrin (Dragnet)
- Cyfluthrin (Cy-kick)
- Bifenthrin (Talstar)
- Cypermethrin (Demon Max)
- Cyhalothrin (Karate, Optimate)
- Esfenvalerate (Asana)

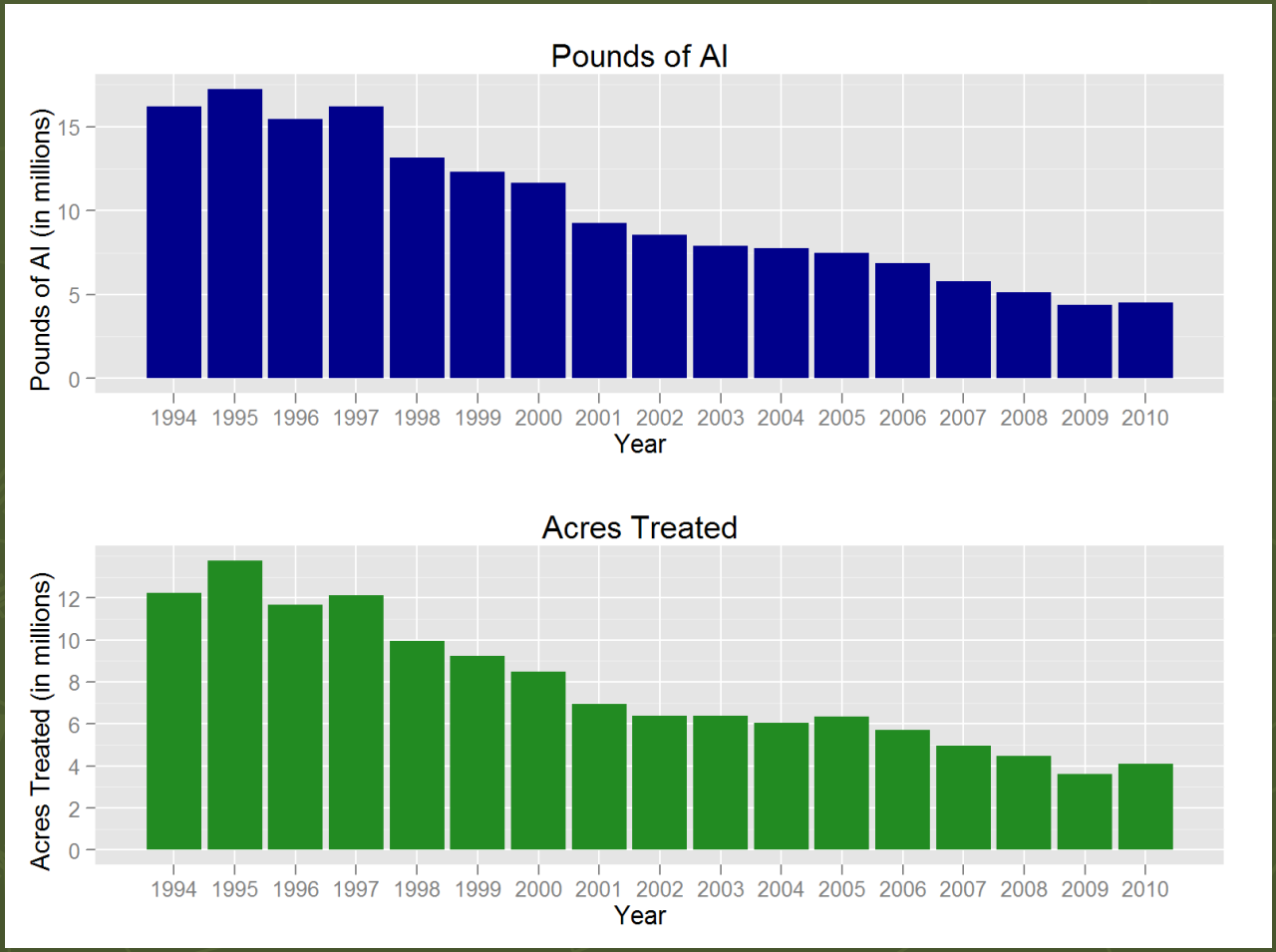
CHEMICAL CHARACTERISTICS OF PYRETHROIDS

- Low solubility in water.
- High adsorption coefficient (clings to sediment).
- Fairly stable in sediment.
- Highly toxic to fish and invertebrates.
- Low toxicity to birds and mammals.

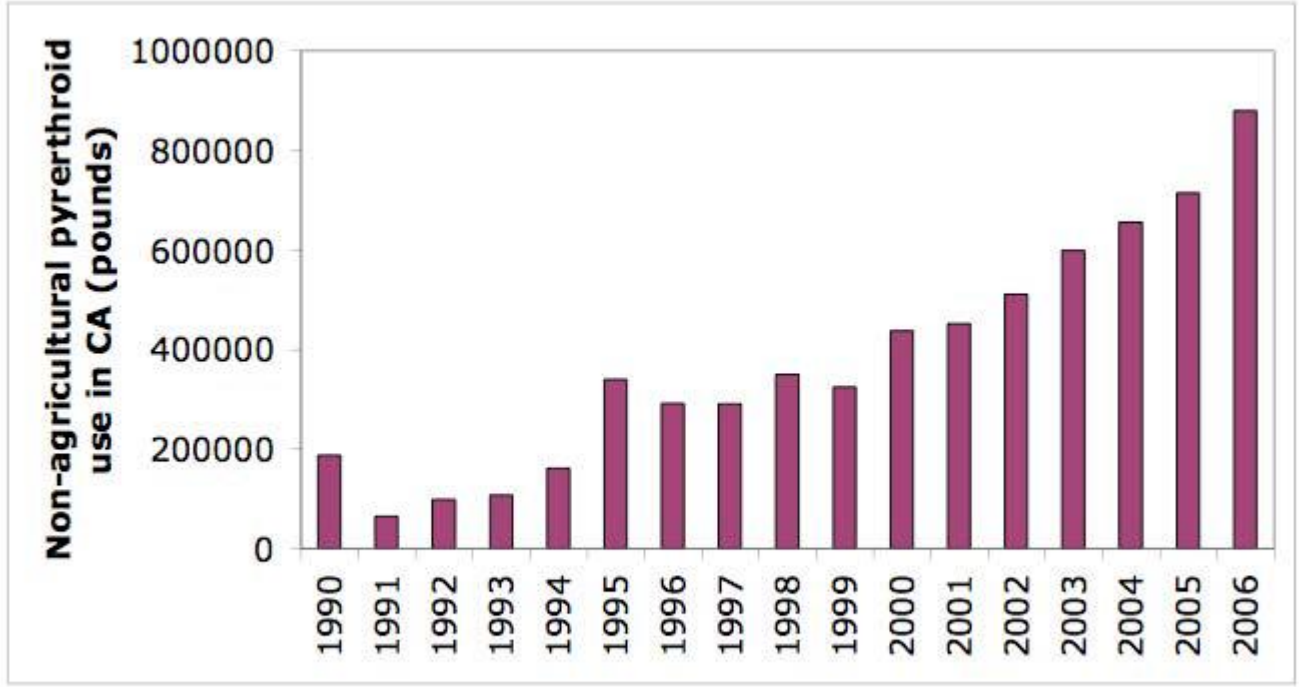


PYRETHRIN

CHANGING PESTICIDE USE: LESS ORGANOPHOSPHATES AND CARBAMATES



MORE PYRETHROID USE (ESPECIALLY URBAN)



In 2004, 40% of all insecticide lbs sold were pyrethroids.

AND EVERYONE LIVED HAPPILY EVER AFTER

OR DID THEY?

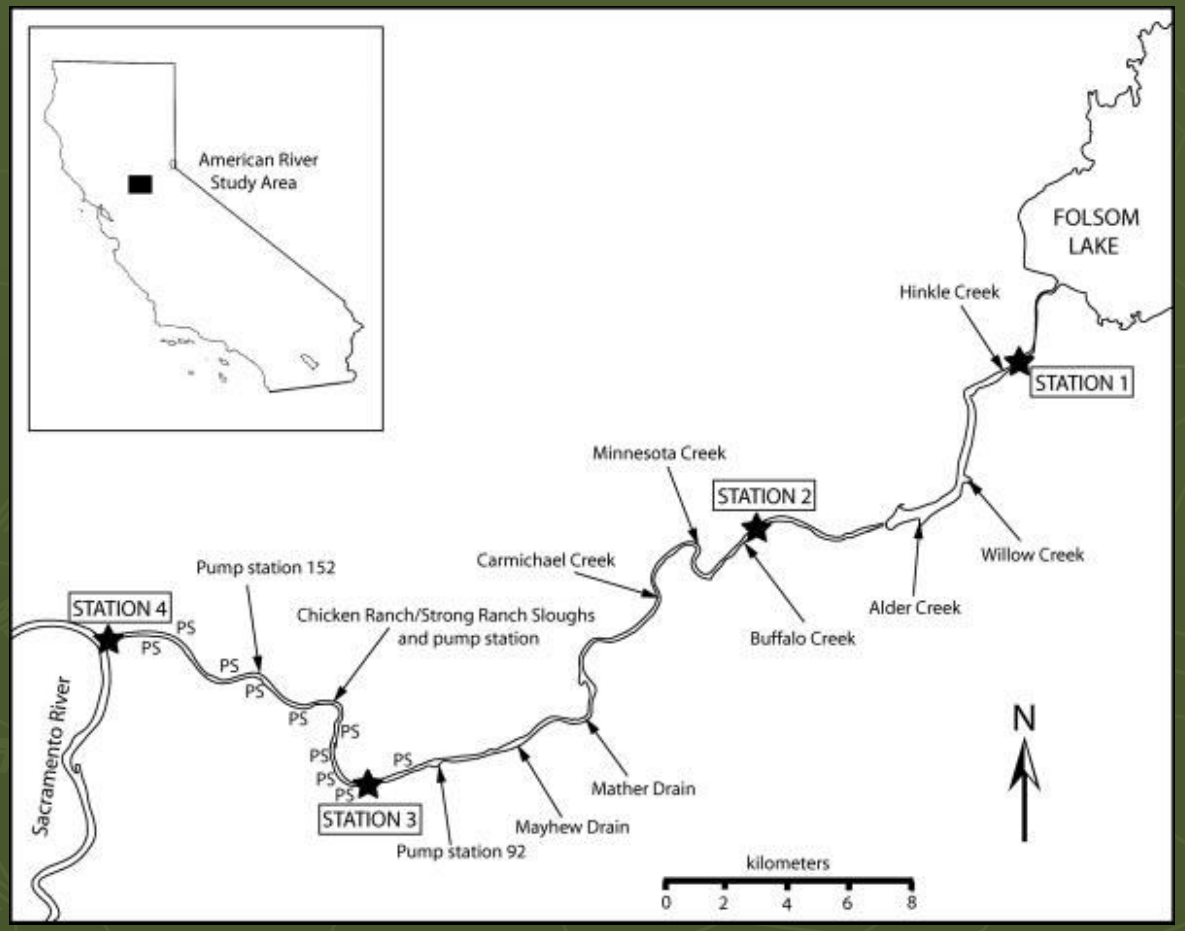
THE STUDIES THAT CHANGED EVERYTHING

- Don Weston: UC Berkeley
- 2004: Sampled water in creeks in Sacramento, Stockton, and Vacaville after rain events
- Chemistry: pyrethroids, OPs
- Toxicity: amphipod

THE STUDIES THAT CHANGED EVERYTHING.

- Found toxicity in most creeks sampled and pyrethroids in concentrations 4X the toxic threshold.
- Bifenthrin found most often at toxic concentrations.
- Found in effluent from wastewater treatment plants – not removed by treatment.

AND IF THAT WASN'T BAD ENOUGH

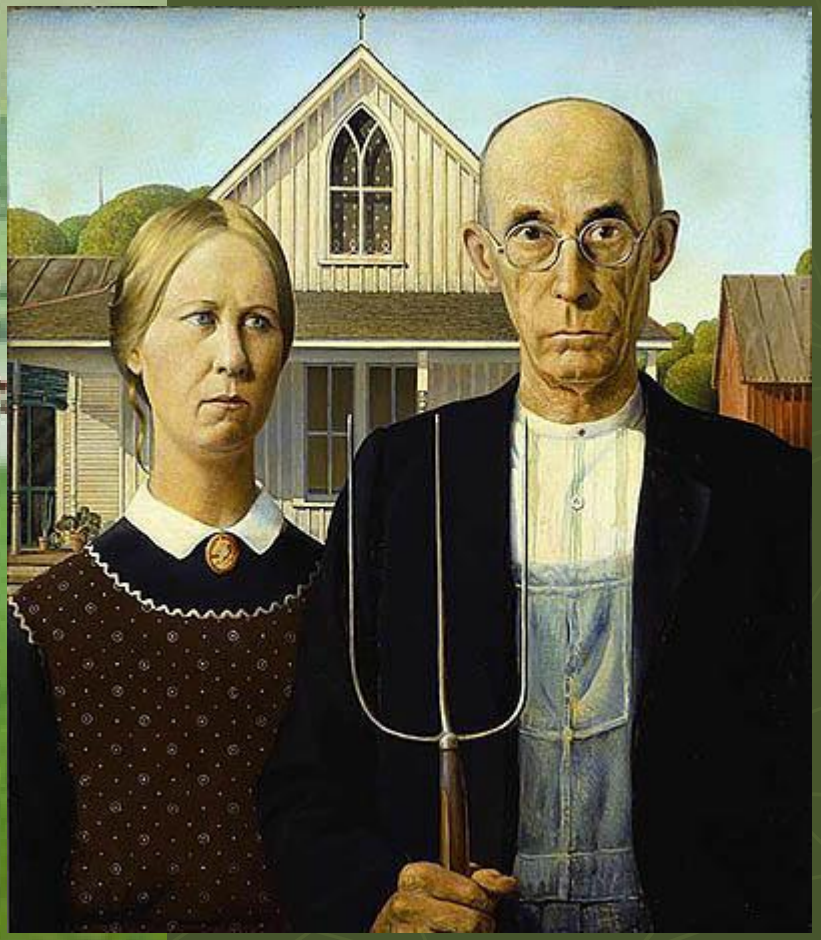


Found toxicity in 20 mile stretch of the American River after storm events!

Shortcomings of the original registration analysis

- Used toxicity studies for water flea but amphipod much more sensitive.
- Focused on water column toxicity but sediment toxicity more significant.
- Detection limits for pyrethroids were higher than toxic levels.
- Pyrethroids more toxic at lower temperatures. Common testing temperature 25C.
- Additivity.

IT'S THE FARMERS, RIGHT?



NOT REALLY

- Toxicity was found in virtually all urban creeks and a smaller percentage (30%) of agricultural creeks.
- The pesticide found most commonly in toxic concentrations was bifenthrin (used by professional pest control companies for pest control outside of homes).

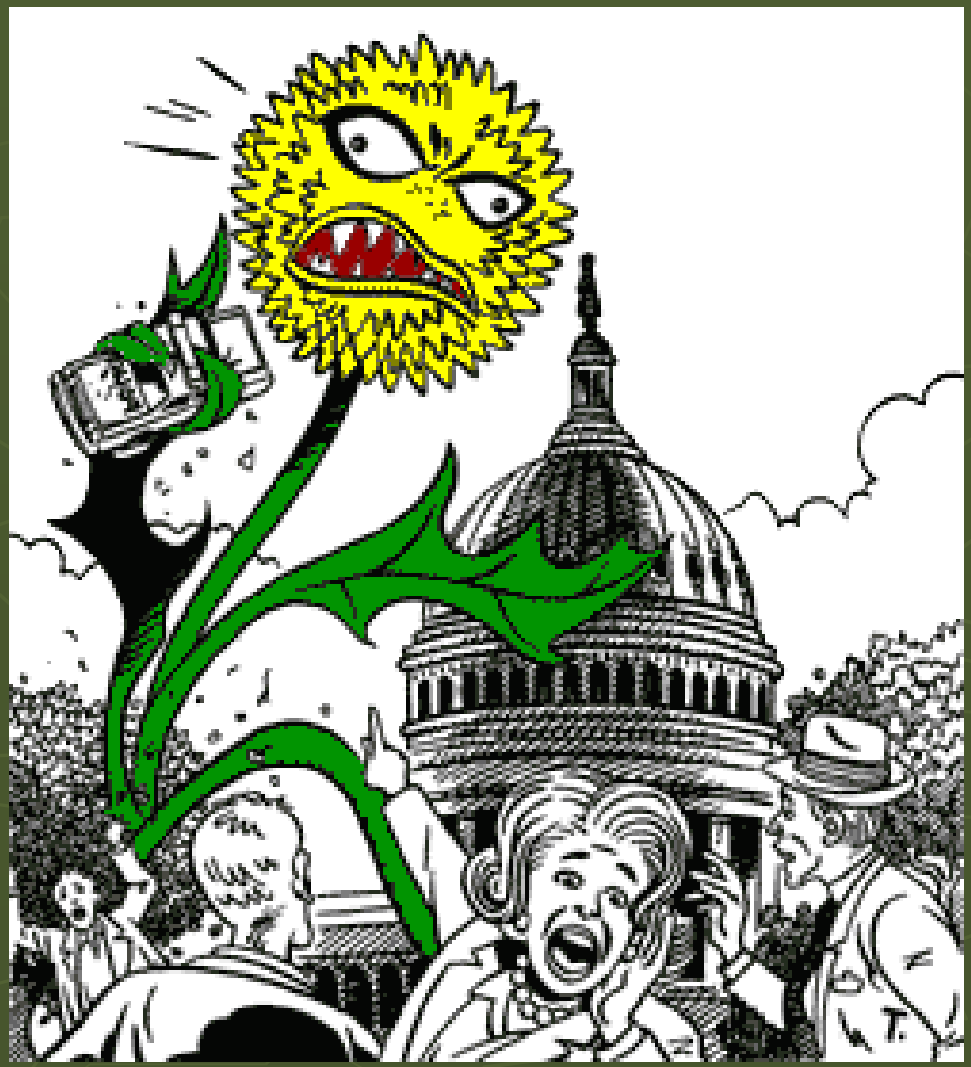
2009 URBAN USE PATTERN STUDY

- 83% of home applications by pest control companies were made outdoors.
- Bifenthrin and deltamethrin most commonly used.
- Most pyrethroids were used all year (low seasonal variation).
- Patios: 47% almost always treated. 45% treated as needed.
- Driveways: 39% almost always treated. 50% treated as needed.

New Regulations to Protect Aquatic Organisms

- Restrict outdoor pyrethroid applications - particularly on impervious surfaces.
- Restrict applications before and during rain events.
- Restrict applications near aquatic habitat.

Herbicides



Nothing to worry about with herbicides, right?

- Herbicides less toxic to animals than insecticides or vertebrate toxicants.
- Herbicides are also very valuable in restoring native habitats.

Weeds, Herbicides & Butterflies

- Winter 2012 Cal IPC newsletter article
  - Antioch Dunes NWR
  - Lange's metalmark butterfly *Apodemia mormo langei*
  - The host plant… naked stem buckwheat *Eriogonum nudum psychicola*
  - The villains…
    - winter vetch *Vicia villosa*
    - yellow starthistle *Centaurea solstitialis*
    - ripgut brome *Bromus diandrus*

Herbicides & Butterflies

- J.D. Stark University of Washington; Environmental Pollution 164 (2012) 24-27
- evaluated potential toxic effects on Behr's metalmark, a close relative of Lange's metalmark.
- First instars caterpillars were used
- "Field level" rates of…
  - Triclopyr ester (Garlon 4)
  - Sethoxydim (Poast)
  - Imazapyr emulsifiable conc (Stalker)
- Sprayed directly on caterpillars and their food plants

Herbicides & Butterflies

- Herbicide exposure thru direct spray and dietary routes reduced the number of adults that emerged from pupation (24-36%).
- The authors speculated that…
  - Because each herbicide has a different mode of action, the effects are due to inert ingredients or indirect effects on food plant quality.
  - Continued use of these herbicides at the site.. "may contribute to the decline of this species."

It's not the data…
it's the interpretation.

- Well-collected data is always good, but we have to be careful about our conclusions.
- Stark's study brings up several important points.
  - Let's be cautious about assuming that herbicides are safe *solely because they're herbicides*.
  - Few studies have studied the effects of herbicides on butterflies or any other invertebrates.

Insects & Herbicides

EPA only requires one terrestrial invertebrate toxicity study for pesticide registration…an acute contact honeybee test.

Honeybees? Butterflies? Whatever.

- are honeybees a suitable surrogate for assessing herbicide risks to other invertebrates?
- A review of the available bee contact test data for the three herbicides is less than convincing.
  - sethoxydim? “no significant impact.”
  - triclopyr ester? “no impact”
  - imazapyr? “no impact”

What's going on here?

- Maybe the honeybee test isn't adequate for other invertebrates.
- These studies all used the active ingredients and not the formulation

What's going on here?

- With mammals and birds, the formulated products* are not much more toxic than the active ingredients alone.

- The results from fish tests, however, indicate a greater toxicological risk

* Poast, Garlon 4 and Stalker

Stay on the safe side with herbicides

- avoid using herbicides that have toxicity "red flags" for fish when invertebrates are involved.
- Use less "fish-toxic" formulations
  - Use Garlon 3A (amine) instead of Garlon 4 (ester)
  - Use Habitat (aqueous) instead of Stalker? (an EC)
  - Poast (80% naphthalene) can be replaced with another grass-specific herbicide with low fish toxicity Envoy (A.I. is clethodim)

Low Exposure = Low Risk

- avoid direct application or significant drift to sensitive invertebrate host plants.
  - Poast is harmless to naked stem buckwheat
  - Garlon 4 or Stalker? Lethal to broadleaf plants.
- make herbicide applications when the most sensitive life stage isn't present.
  - Caterpillar feeding exposure

Protecting Wildlife

- Some active ingredients cause more harm than others (e.g. brodifacoum).
- But for all pesticides, careful use practices are important.

1. Read and follow the label.
2. Keep the pesticide on target.
3. Be aware of wildlife.
4. Stay informed.

Sources of Information

- DPR's PRESCRIBE database (online)
- County Agricultural Commissioners
- UC Integrated Pest Management


Thank you for helping protect wildlife!