# Passive Sampling of Surface Waters in the Sierra Region of Northern California for Pesticides used in *Cannabis* and Timber Cultivation

M.M.MCWAYNE[1,2] , J.L. ORLANDO[1] AND M.L.HLADIK [1]

[1]USGS CALIFORNIA WATER SCIENCE CENTER, SACRAMENTO, CA

[2]CALIFORNIA STATE UNIVERSITY SACRAMENTO

# Problem



- Illegal and “legal” cannabis grows are occurring throughout the Sierra Nevada foothills.
- Documented widespread use of pesticides (including compounds not available in CA)
- Grows are sited in watersheds that are critical habitat for listed salmonids.
- Timing of use is uncertain.
- Additional use of pesticides in commercial forestry in these same watersheds.
- No current program to monitor for pesticides in these watersheds.

# Goal



- To develop an effective, cost-efficient method/tool to monitor the occurrence of cannabis and forestry pesticides in small, critical habitat, streams in the Sierra Nevada foothills.

# Unique Pesticide Concerns




**Figure 2.** Map of California Forest and Rangeland
http://frap.fire.ca.gov/projects/frap_veg/methods/Methods_Development_Habitat_Data_02_2.pdf

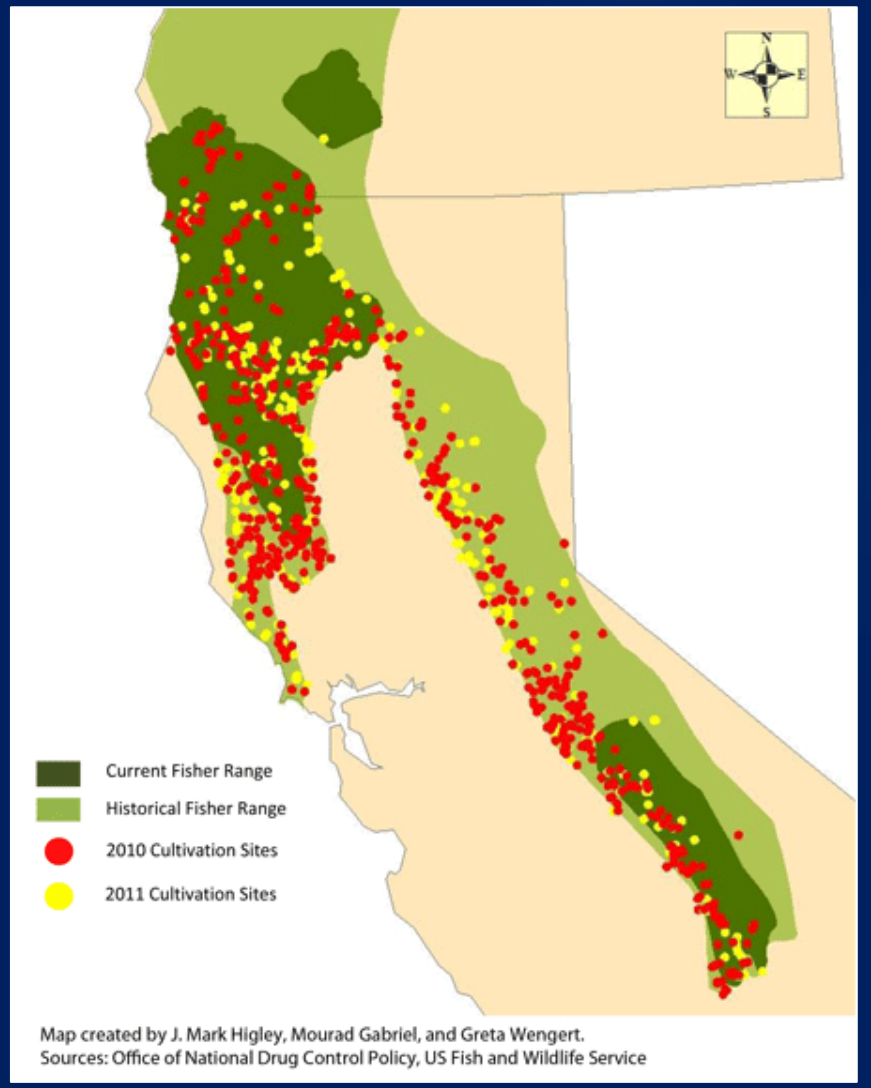



**Figure 3.** Map of know Cannabis cultivation sites.
http://www.motherjones.com/blue-marble/2014/10/marijuana-fisher-threatened-rat-poison

# Environmental Impacts of Pesticide Use in Forested Areas



- Sensitive forest ecosystem
- Water quality
- Sensitive species


Native vegetation growing in a clearcut, killed by herbicides
http://www.cnps.org/cnps/conservation/forestry/herbicides/herbicides_on_nonfederal_forests.php

# Timber Production and Pesticides



- Herbicides are typically aerially applied to prevent competition of grasses and shrubs with desired hardwood conifers
- They are applied during site preparation and conifer release

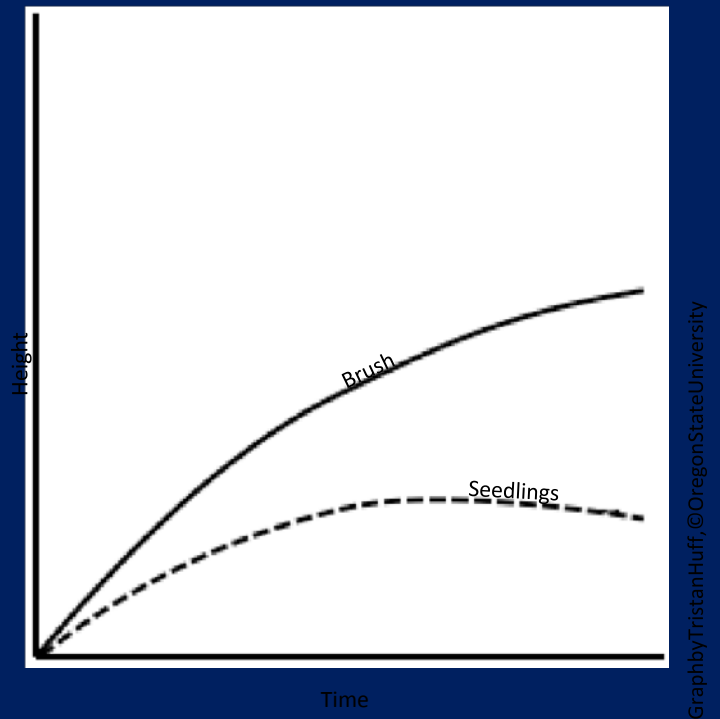



**Figure 4. a.** No release

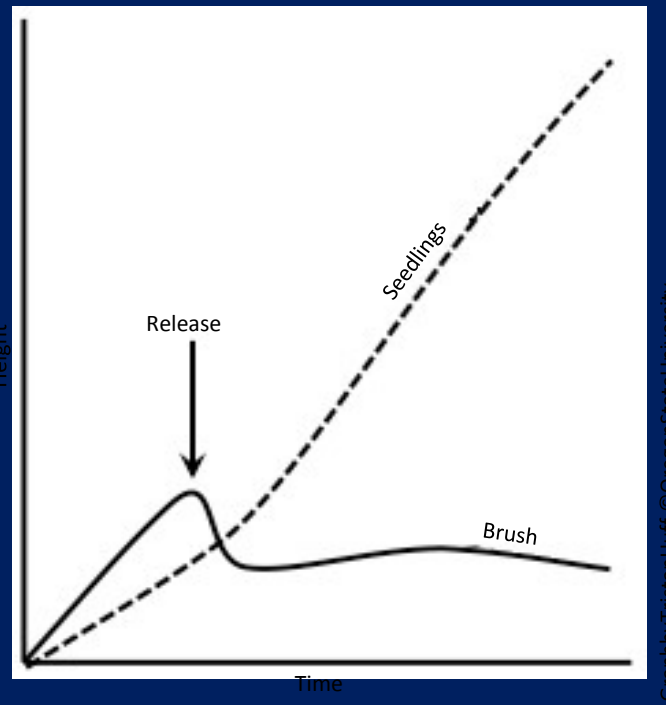



**Figure 4b**. Release

Huff, Tristan, Mike Cloughesy, and Ralph E. Duddles. *Introduction to conifer release*. Corvallis, Or.: Extension Service, Oregon State University, 2014.

# *Cannabis and* Pesticide Use



- *Cannabis* can be negatively affected by mildew, fungus, insects and animal pests, therefore, a broad range of pesticides are applied
- Banned substances are potentially applied
- Applications are not tracked
- Quantities may be hazardous to non-target plants and animals

*Chemicals and trash found at illegal marijuana grow site in California's Shasta-Trinity National Forest. Credit: USFS Region 5*

# Study Location- Upper Sacramento River Watershed



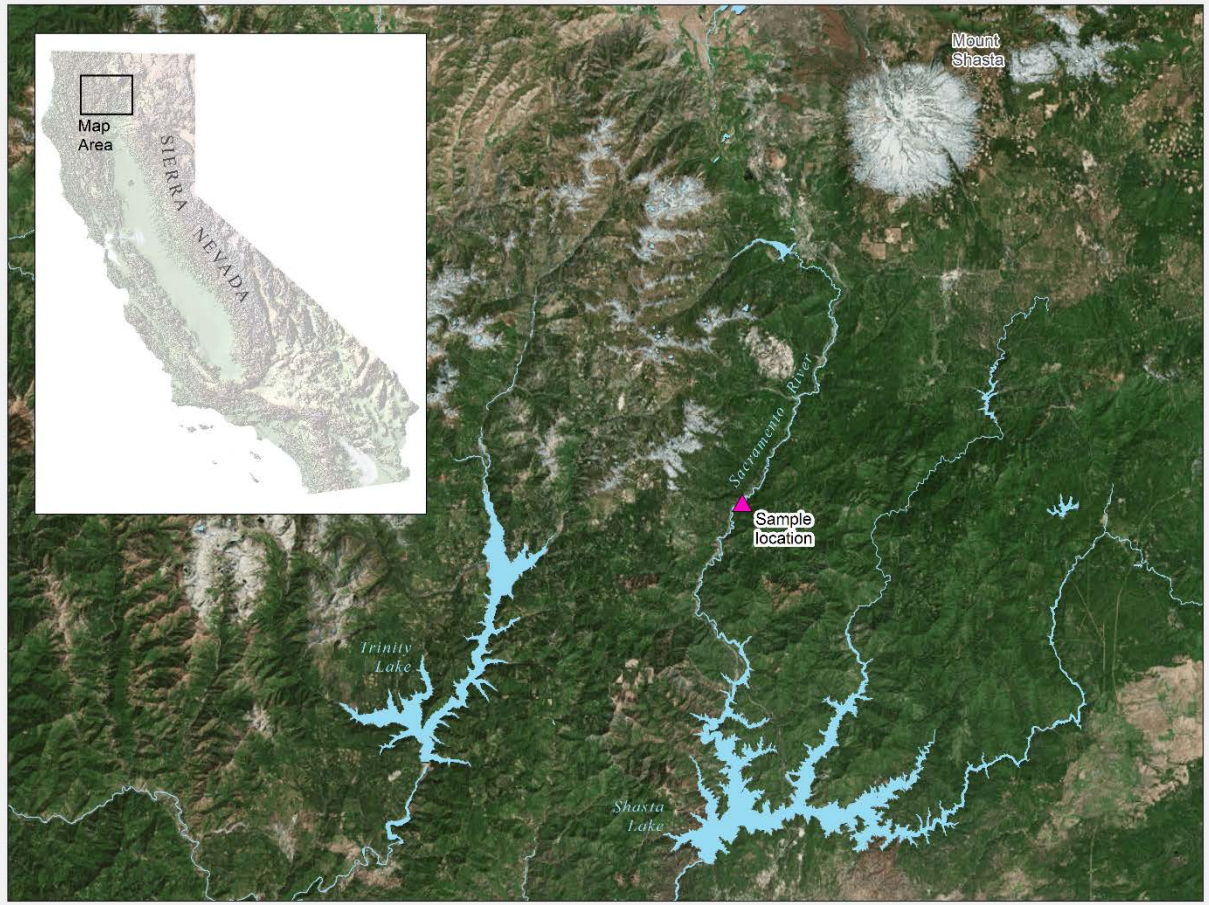



**Figure 1**. Map of Upper Sacramento River Site

- Fed by snowmelt and rainfall year-round that originates from Shasta (north) and Klamath (west) mountains
- Watershed contains more than 250,000 acres of forested area
- Downstream of timber and *Cannabis* cultivation

# Field Study



- Utilizes Passive Sampling
- Fall (flush) and summer (base flow) sampling events
- 24 hr deployment no DLM
- 30 day deployment with DLM

Upper Sac River Fall Sampling Event

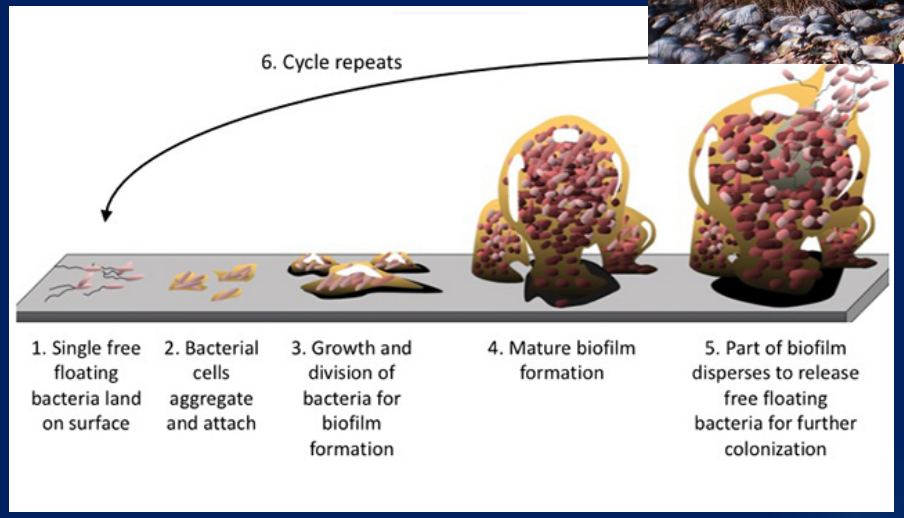
# Benefits of Passive Samplers



- *In situ* sampling
- Extended sampling times
- Concentration of analytes
- Good strategy for episodic pulses

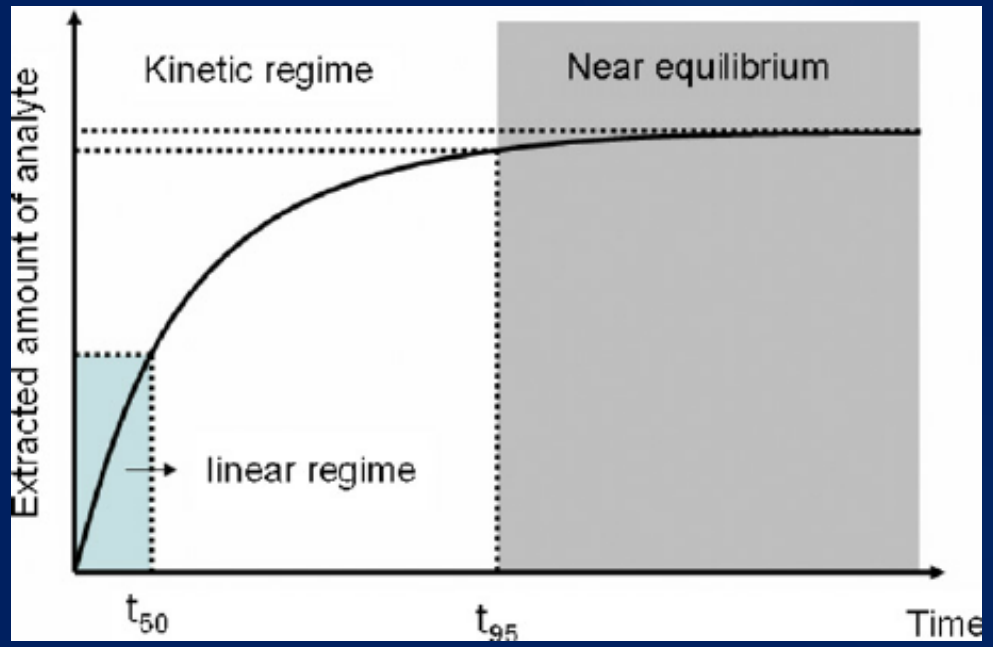
# Limitations of Passive Sampling

- Time weighted average concentrations are not “true” concentrations
- Theft
- Water levels
- Extrinsic factors
  - Fluctuating hydrodynamics
  - Biofouling



# Chemcatchers®

- Kinetic sampling
- Benefits of solid phase extraction
- Multiple sorbents
- In house extraction
- Diffusion Limiting Membranes (DLMs)



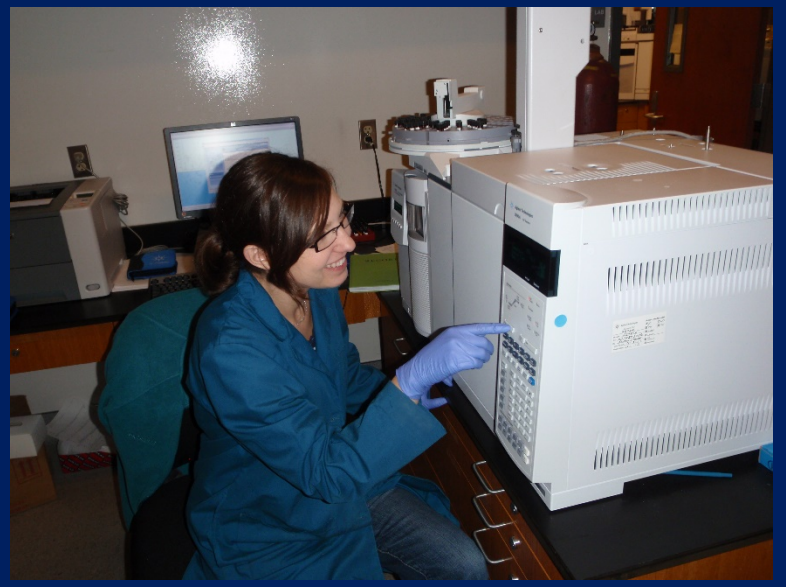

# Lab Elution-Current Work

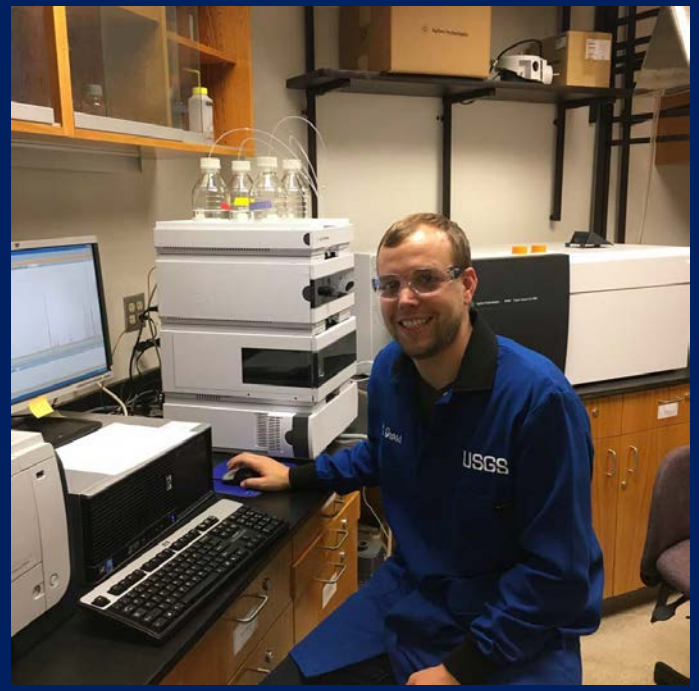


- Oasis HLB-hydrophilic lipophilic balanced copolymer
- Empore SDB-RPS-Polystyrenedivinylbenzene Reverse Phase Sulfonated
- Drying
- Elution
- Concentration

# Analysis by Gas and Liquid Chromatography Mass Spectrometry

- Extracts will be analyzed for a large suite (**>150**) of current-use pesticides and pesticide degradates





# Unexpected Problems



- Extreme winter/spring flows
- Disk drying


# Pesticide Detects to Date



- First deployment (10/17/16-10/18/16)
  - **Hexazinone and Thiabendazole**
- Second deployment (10/26/16-10/27/16)
  - **Trifluralin, Dithiopyr, DCPA, Hexazinone, and Imazalil**.
- Uncharacteristic water year
- Spring deployment moved to a summer deployment

# Future Work



- Build on results of current pilot project
- Approx. 200K project with current cooperator to further current development work and expand to additional watersheds with more deployments.

# Acknowledgements




- Pesticide Fate Research Group at the USGS California Water Science Center
- Daniel Whitley at the Central Valley Regional Water Quality Control Board

| | Field ID | Trifluralin Results | Dithiopyr Results | DCPA Results | p,p'-DDE Results | Hexazinone Results | Imazalil Results | Thiabendazole Results |
|---|---|---|---|---|---|---|---|---|
| Name | | Final Conc. | Final Conc. | Final Conc. | Final Conc. | Final Conc. | Final Conc. | Final Conc. |
| MS1003 EMP | 101716-101816 | | | | | | | 6 |
| MS1004 EMP | 101716-101816 | | | | | 18 | | |
| MS1021 HLB | 102616-102716 | | 11 | | | | 33 | |
| MS1022 HLB | 102616-102716 | 13 | 14 | | 12 | | | |
| MS1023 EMP | 102616-102716 | 20 | 10 | 9 | 9 | 18 | | |
| MS1024 EMP | 102616-102716 | 16 | 12 | | 11 | 21 | | |