

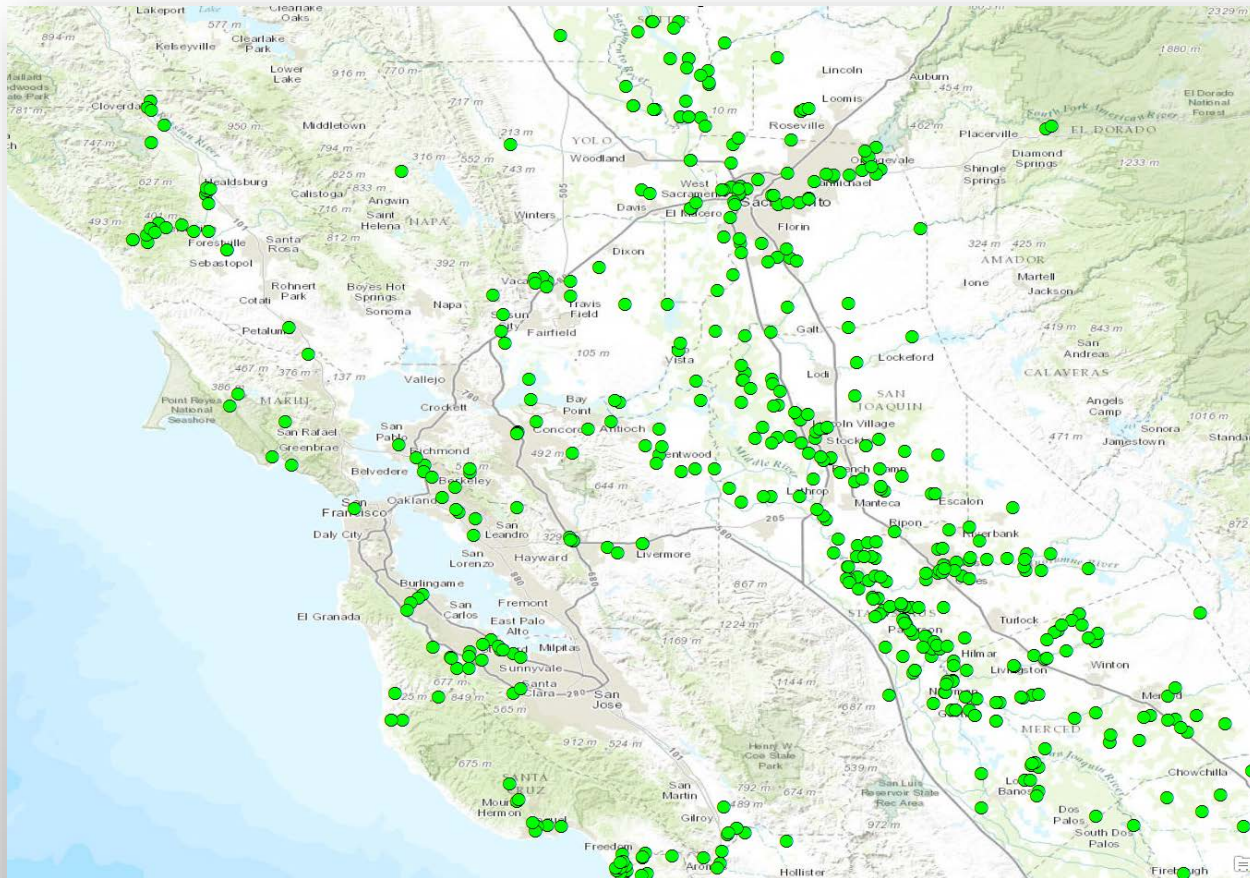
Prioritizing Pesticides for Surface Water Monitoring in Agricultural and Urban Areas of California

Yuzhou Luo, Xin Deng, Robert Budd, Michael Ensminger

Surface Water Protection Program
California Department of Pesticide Regulation

Pesticide monitoring in surface water

- Where, when, and what to sample?



Historical and active monitoring sites (by DPR and other agencies) reporting pesticide concentrations (DPR Surface Water Database)

Pesticide monitoring in surface water

- Where, when, and what to sample?
- Example: Agricultural monitoring in Central and Southern California
 - DPR study 304 (Deng, 2018), Table 7: number of samples collected for pesticide analysis in 2018 (<http://cdpr.ca.gov/docs/emon/pubs/protocol.htm>)

Analyte Group	March	May	July	September	October	November	Total Number of Samples
	Imperial	Central Coast	Central Coast	Central Coast	Imperial	Central Coast	
Multi-analyte Screen	6	10	10	10	6	10	56
Dinitroaniline	6	10	10	10	6	10	52
Pyrethroid Water	6	10	10	10	6	10	52
Pyrethroid Sediment				10	6		16
Grand Total	18	30	30	40	24	30	160

Annotations: A yellow box highlights the months (March, May, July, September, October, November) with an arrow labeled "When". A red box highlights the locations (Imperial, Central Coast) with an arrow labeled "Where". A green box highlights the analyte groups (Multi-analyte Screen, Dinitroaniline, Pyrethroid Water, Pyrethroid Sediment) with an arrow labeled "What".

Pesticide prioritization

- DPR's early efforts

- 2007, Assessment of acute aquatic toxicity of current-use pesticides in California, with monitoring recommendations

Chemical	Toxicity	Use	Monitoring Priority
Malathion	very high	high	high
Diazinon	high	high	high
Carbaryl	very high	moderate	high
Thiram	high	moderate	high
Trifluralin	moderate	very high	high

- 2009, Procedure for identifying pesticides with a high potential to contaminate surface water

Pesticide prioritization

- DPR's early efforts
- Surface Water Monitoring Prioritization model
 - A computer program to prioritize pesticides of interest (POIs) and areas of interest (AOIs) for surface water monitoring
 - With considerations of pesticide use, toxicity data, physicochemical properties, landscape/hydrology characteristics, and historical monitoring results

Conceptual Model



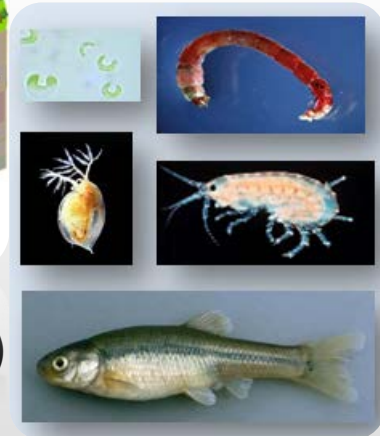
Pesticide application



Off-site movement to water



Fate and transport within stream network (watershed)



Impacts on ecosystem

Required data:

Pesticide use data

Landscape characteristics

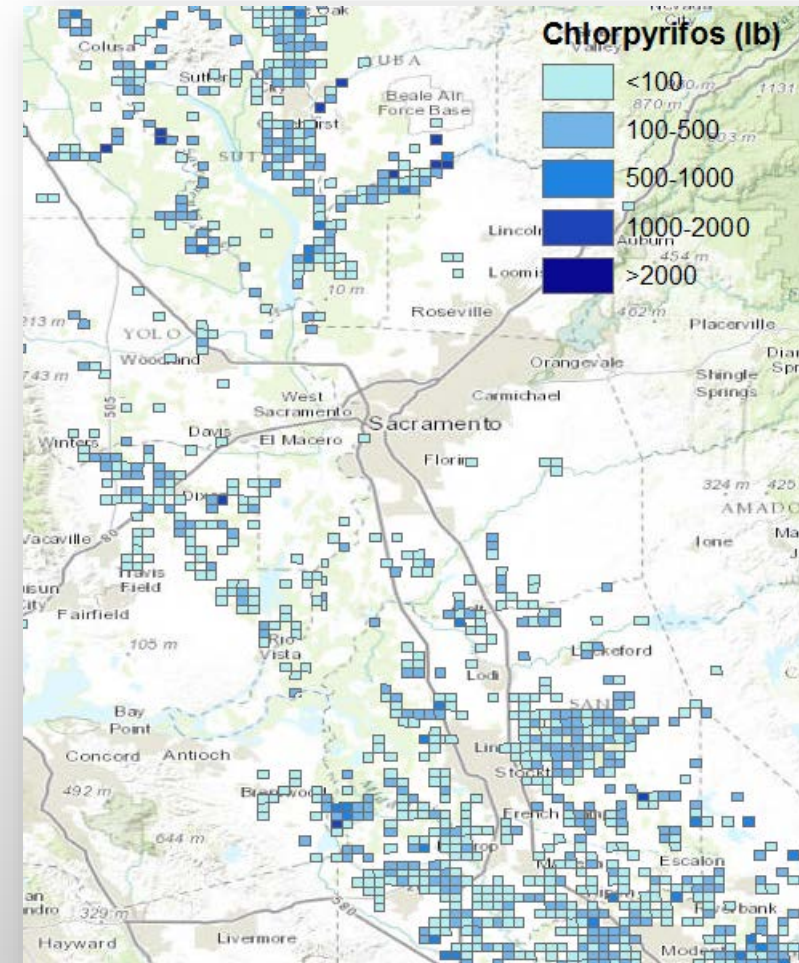
Hydrology data

Ecotoxicology data

Chemical properties

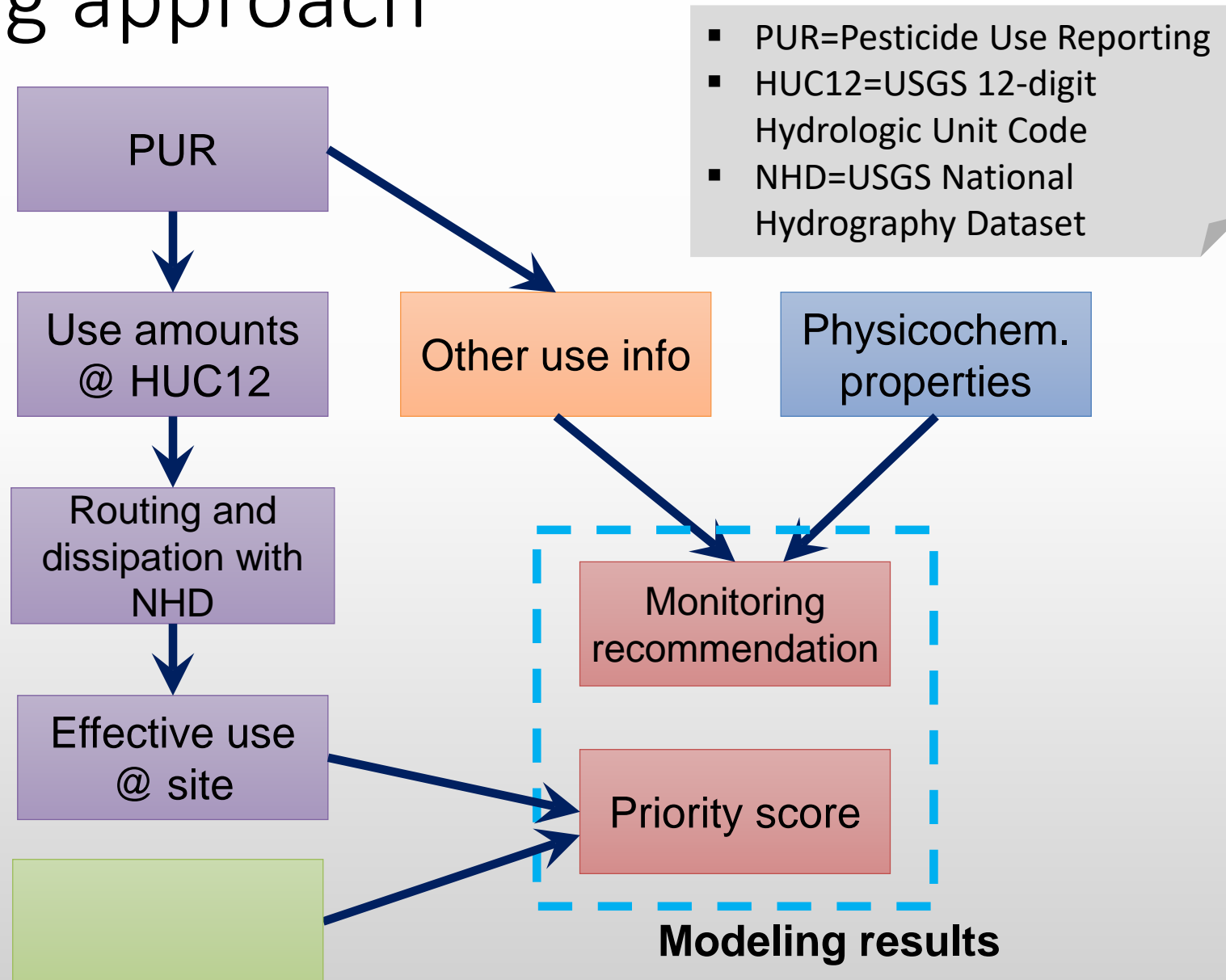
DPR's PUR database

- Pesticide Use Reporting (PUR)
 - Released annually, 1989-2016
 - Agricultural uses: daily data, for each section (1x1mi²)
 - Non-agricultural uses: monthly data, for each county
 - <http://www.cdpr.ca.gov/docs/pur/purmain.htm>



Chlorpyrifos use data in 2013 (lb/section) →

Modeling approach



Example model run

- California statewide, annual agricultural uses, PUR data 2014-2016

Pesticide Prioritization for Surface Water Monitoring, Ver. 4

Tools Options Help

Configuration Advanced Options Watershed

Use patterns

Agricultural use Urban use "Rights of way" (site_code=40)

Or, user-specified site_code(s)=

PUR data

Based on PUR data from to

Toxicity data

Acute Chronic Both

USEPA Aquatic Life Benchmarks

Supplemented by Benchmark Equivalent (based on FOOTPRINT PPDB)

USEPA Drinking Water Standard

USEPA Human Health Benchmark

Note: if multiple toxicity databases are selected, the lowest toxicity value for each pesticide will be used for prioritization

Results

**[Priority score]=
[use score]×[toxicity score]**

**Use (lb)
→ use score (1~5)**

**Benchmark (ppb)
→ toxicity score (1~8)**

**Monitoring
recommendation**

chem_code	CHEMNAME	use	usescore	benchmark	toxscore	finalscore	recom
253	CHLORPYRIFOS	1102887.2	5	0.05	6	30	True
1601	PARAQUAT DICHLORIDE	1051157.6	5	0.396	5	25	True
1973	OXYFLUORFEN	774548.4	5	0.29	5	25	True
367	MALATHION	378571	4	0.05	6	24	True
2300	BIFENTHRIN	195452.6	4	0.075	6	24	True
2297	LAMBDA-CYHALOTHRIN	63332.1	3	0.0035	7	21	True
1929	PENDIMETHALIN	2077891.8	5	5.2	4	20	True
677	CHLOROTHALONIL	1030997.9	5	1.8	4	20	False
629	ZIRAM	737047.4	5	4	4	20	False
3849	IMIDACLOPRID	335201.3	4	0.385	5	20	True
418	NALED	179069.5	3	0.07	6	18	False
2008	PERMETHRIN	108120.7	3	0.0106	6	18	True
597	TRIFLURALIN	441484.1	4	9.25	4	16	True
5133	S-METOLACHLOR	418975.9	4	8	4	16	True
383	METHOMYL	273916.2	4	2.5	4	16	True
445	PROPARGITE	221836.2	4	7	4	16	True
531	SIMAZINE	187797	4	2.24	4	16	True

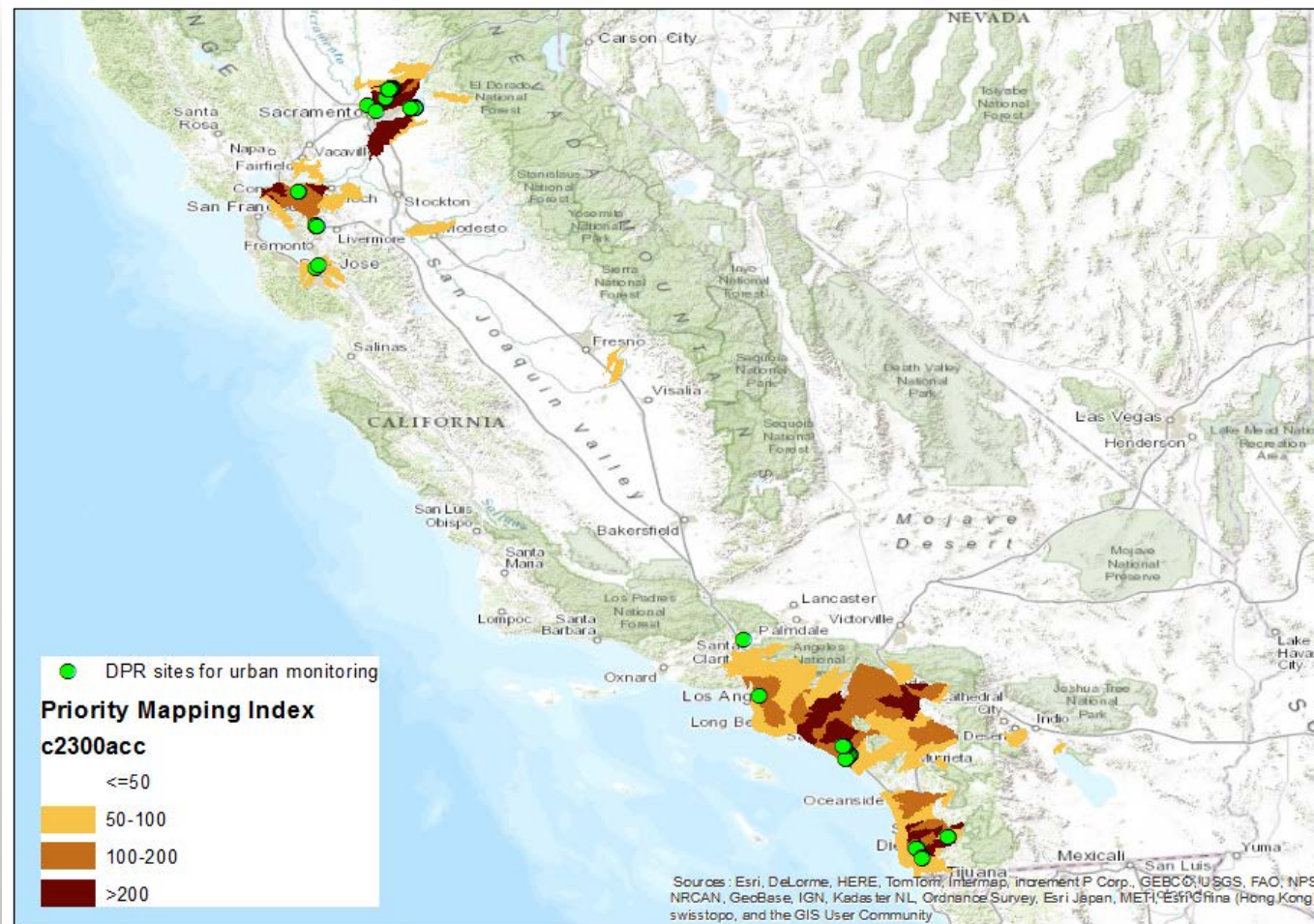
Model applications

- ***Site-specific prioritization***: to prioritize chemicals @ predefined monitoring site(s)
- ***Spatially continuous mapping***: to prioritize monitoring sites for predefined chemicals
- ***AOI/POI determination***: by running the above functions iteratively, to develop *new* monitoring studies or evaluate existing studies

- AOI = Area of interest
- POI = Pesticide of interest

Example 2

- Spatially continuous mapping for non-agricultural use of *bifenthrin*



Example 3

- AOI/POI determination for agricultural uses in Central Coast

AOI/POI Determination Wizard (page 1 of 4)


Study Domain

Specify study domain

Statewide

by HUC4

- 1801 Klamath-Northern California Coastal
- 1802 Sacramento
- 1803 Tulare-Buena Vista Lakes
- 1804 San Joaquin
- 1805 San Francisco Bay
- 1806 Central California Coastal
- 1807 Southern California Coastal
- 1808 North Lahontan
- 1809 Northern Mojave-Mono Lake
- 1810 Southern Mojave-Salton Sea



Next >

Pesticides of interest

AOI/POI Determination Wizard (page 2 of 4)

POI Selection

Part 1: Select POIs from model-prioritized pesticides:

	POI?	ChemCode	ChemName	UseScore	ToxScore	FinalScore
	<input checked="" type="checkbox"/>	367	MALATHION	5	6	30
	<input checked="" type="checkbox"/>	3849	IMIDACLOPRID	4	7	28
	<input checked="" type="checkbox"/>	2008	PERMETHRIN	4	7	28
	<input checked="" type="checkbox"/>	383	METHOMYL	4	5	20
	<input checked="" type="checkbox"/>	1973	OXYFLUORFEN	4	5	20
	<input checked="" type="checkbox"/>	253	CHLORPYRIFOS	3	6	18
	<input type="checkbox"/>	361	LINURON	3	6	18
	<input checked="" type="checkbox"/>	1992	DIFLUBENZURON	2	8	16
	<input type="checkbox"/>	1601	PARAQUAT DICHLORIDE	3	5	15
	<input type="checkbox"/>	5946	SPINETORAM	3	5	15
	<input checked="" type="checkbox"/>	2300	BIFENTHRIN	2	7	14
	<input checked="" type="checkbox"/>	2297	LAMBDA-CYHALOTHRIN	2	7	14
	<input type="checkbox"/>	179	CHLORTHAL-DIMETHYL	4	3	12
	<input type="checkbox"/>	1020	DENDIMETHALIN	2	4	12

Part 2: Additional POIs specified by a user (comma-delimited chem_code)

Next >

Select All
Select None
Invert Selection

Areas of interest @ HUC8

AOI/POI Determination Wizard (page 3 of 4)

HUC8 Analysis

Part 1: Select HUC8s from model-prioritized pesticides:

	AOI?	HUC8	HUC8Name
	<input checked="" type="checkbox"/>	18060015	Monterey Bay
	<input checked="" type="checkbox"/>	18060005	Salinas
	<input checked="" type="checkbox"/>	18060008	Santa Maria
	<input type="checkbox"/>	18060002	Pajaro
	<input type="checkbox"/>	18060009	San Antonio
	<input type="checkbox"/>	18060006	Central Coastal
	<input type="checkbox"/>	18060010	Santa Ynez
	<input type="checkbox"/>	18060007	Cuyama
	<input type="checkbox"/>	18060013	Santa Barbara Coastal
	<input type="checkbox"/>	18060004	Estrella
	<input type="checkbox"/>	18060003	Carrizo Plain
▶	<input type="checkbox"/>	18060014	Santa Barbara Channel Islands

Select All
Select None
Invert Selection

Part 2: Additional HUC8s specified by a user (comma-delimited chem_code)

Next >

Final results @ HUC12

AOI/POI Determination Wizard (page 4 of 4)

HUC12 Analysis

Options

of HUC12s per selected HUC8:

(Mainstem only) threshold (by use amount) for relevant POIs, %:

Threshold (by coverage) for relevant landuse, %:

Model-prioritized HUC12 and stream type Update Export

HUC12	HUC12Name	Type	Irrelevant POI(s)
▶ 180600150103	Alisal Slough-Tembladero Slough	Mainstem	2171,1868,
180600150102	Nativdad Creek-Gabilan Creek	Mainstem	1973,2171,1868,
180600150103	Alisal Slough-Tembladero Slough	Tributary	
180600150102	Nativdad Creek-Gabilan Creek	Tributary	
180600051505	Johnson Creek	Mainstem	
180600051311	Paraiso Springs-Arroyo Seco	Mainstem	
180600051004	Lower San Lorenzo Creek	Mainstem	
180600051501	Lasher Canyon-Salinas River	Tributary	
180600051509	Alisal Creek-Salinas River	Tributary	
180600051505	Johnson Creek	Tributary	
180600080503	Corralitos Canyon	Mainstem	2171,105,
180600080502	Lower Orcutt Creek	Mainstem	2008,2171,1868,
180600080404	Santa Maria Canyon-Sisquoc Ri	Mainstem	2300

Close

Summary

- SWMP is based on PUR data analysis, with considerations of toxicity data and pesticide routing within stream network
- Not a fully mechanistic model, but includes components for pesticide fate and transport
- Future directions
 - Incorporation of physically-based modeling approaches, e.g., surface runoff generation and sediment transport
 - Development for higher spatial resolution at HUC14 level (i.e., “catchment”)

Thanks

The screenshot shows the website for the California Department of Pesticide Regulation. The header includes the CA.GOV logo, the department name, and navigation links for 'About DPR', 'Join E-Lists', 'A-Z Index', and 'Contact Us'. A search bar is also present. The main navigation menu includes 'HOME', 'PROGRAMS', 'DATABASES', 'NEWS/PUBLICATIONS', and 'QUICK LINKS'. On the left, a 'MONITORING' sidebar lists various categories like 'Fumigant Regulatory Issues', 'VOC Emissions', 'Surface Water', 'Ground Water', 'Air', 'Publications', and 'Air Monitoring Network'. The main content area is titled 'Surface Water Models' and includes a link back to the 'Surface Water Protection Program'. The text explains that scientists use simulation models for pesticide risk assessments. A section titled 'SWMP (Surface Water Monitoring Prioritization Model) Yuzhou Luo, 2015' describes the model's purpose and provides a list of resources: a quick start guide, an executable database, a user manual, and several technical reports and analysis memos.

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MONITORING

- Fumigant Regulatory Issues
- VOC Emissions
- Surface Water
- Ground Water
- Air
- Publications
- Air Monitoring Network

Surface Water Models

[Back to Surface Water Protection Program](#)

Scientists in the Surface Water Protection Program (SWPP), California Department of Pesticide Regulation (CDPR) frequently use simulation models for pesticide risk assessments in product registration evaluation, post-use monitoring, and data analysis. Listed below are selected SWPP models with technical reports and user's manual.

SWMP (Surface Water Monitoring Prioritization Model) Yuzhou Luo, 2015

SWMP model is developed to prioritize pesticides for surface water monitoring in agricultural and urban areas of California. For the generation of monitoring priority lists of pesticide ingredients and their degradates, the model incorporates pesticide use and toxicity data, as well as chemical properties, monitoring results, and application information. Advanced options are also provided in the model for monitoring prioritization at various spatial and temporal scales, with user-defined months, years, counties, and watersheds.

- [SWMP Quick Start Guide, PDF \(124 kb\), Video](#)
- [Executable and supporting database \(.zip compressed file\), version 3.0 \(8.9 mb\)](#)
- [User's manual, PDF \(1.2 mb\)](#)
- **Technical Reports**
 - [Analysis Report, PDF \(1.1 mb\)](#). Yuzhou Luo, Xin Deng, Robert Budd, Keith Starner, Michael Ensminger. 2013. May 28, 2013.
 - [Analysis Memo, PDF \(536 kb\)](#). Yuzhou Luo, Michael Ensminger, Robert Budd, Xin Deng, and April DaSilva, 2014. II: Refined Priority List.
 - [Analysis Report, PDF \(763 kb\)](#). Yuzhou Luo and Xin Deng, 2015. III: Watershed - Based Prioritization.
 - [Analysis Memo, PDF \(471 kb\)](#). Yuzhou Luo, Michael Ensminger, Robert Budd, Dan Wang, Xin Deng 2017. Methodology for prioritizing areas of interest for surface water monitoring of pesticides in urban receiving waters of California.

dpr

www.cdpr.ca.gov/docs/emon/surfwtr/review.htm

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