Occurrence and distribution of pesticides in surface waters of California

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INTRODUCTION

The SURF database

► Monitoring results for pesticides in California's surface water and sediment. Weblink:
https://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm

► Data sources:
- DPR urban and agricultural monitoring
- CEDEN (California Environmental Data Exchange Network)
- USGS NWIS (National Water Information System)
- USEPA WQX (Water Quality Exchange Database)
- Open literature

► Does not include legacy pesticides that were canceled for use in California before 1996
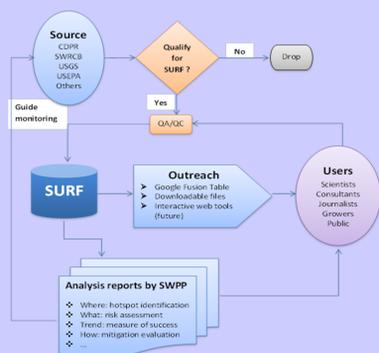

Fig. 1 SURF data management and use

Objectives

To evaluate the occurrence and distribution of pesticides in the surface waters of California including:
1) What? → identify top pesticides with widespread occurrence and high potentials to cause adverse effects to aquatic ecosystems
2) Where? → spatially identify areas with frequent detections and high concentrations
3) How? → evaluate the change of detections among different groups of pesticides over time (trend analysis)
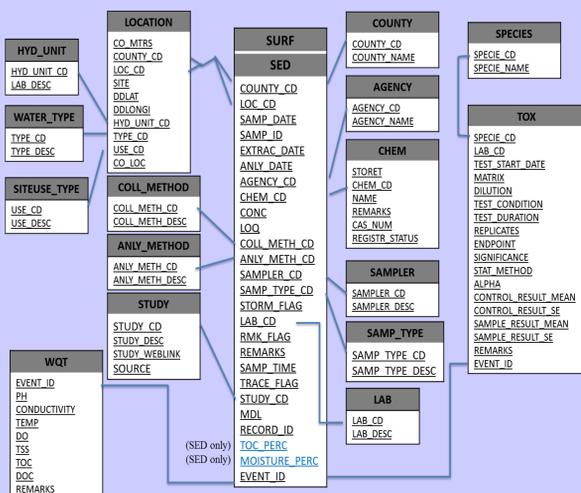4) Why? → identify key influencing factors (e.g. environmental, human practices); model building

Fig 2 Database schema of SURF

METHODS

► Data preparation: most recent data available in SURF with water samples taken between June 27,1925 and March 22, 2018 (>920, 000 records)

► Data selection: water data between 1992 and 2017 were selected for analysis (recent 26 years) (Fig. 3)

► Site selection: at least sampled in 5 out of the 26 years for improved temporal trend analysis (331 out of 2,579 sites were selected) (Fig. 4)

► Exposure assessment: pesticide concentrations were compared to the lowest aquatic life benchmark values developed by the USEPA (LALBM).

► Detection frequency = number of samples with concentration above level of quantification / total samples

► Exceedance frequency = number of samples with concentration above LALBMs / total samples

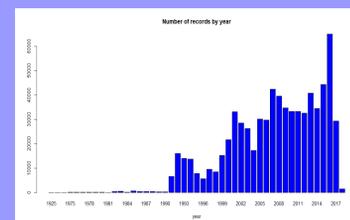► Data analysis using R statistical package and the ESRI ArcGIS software
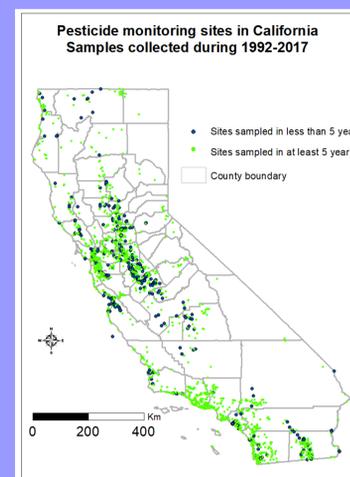

Fig. 3 Number of results per year

Fig. 4 Pesticide monitoring sites in CA

PRELIMINARY RESULTS AND DISCUSSIONS

What pesticides are in the surface water?

► Selected dataset contains 360 distinct pesticide chemicals and degradates with an overall detection frequency of 6%.

► Insecticides are the most frequently sampled followed by herbicides and fungicides. Chlorpyrifos and diazinon had the most samples (Fig 5).

► Most frequently detected insecticides: methoxyfenozide, chlorantraniliprole, imidacloprid, fipronil, diazinon and chlorpyrifos

► Most frequently detected herbicides: bensulide, MCPA dimethylamine, and oxadiazon. Diuron had the most number of samples.

► Most frequently detected fungicides: boscalid, azoxystrobin, carbendazim, fluxapyroxad, propiconazole and myclobutanil

► Top pesticides exceeding US EPA LALBM: imidacloprid with 52% of samples exceeding the LALBM, followed by fipronil (22%) and bifenthrin (20%) (Table 1).
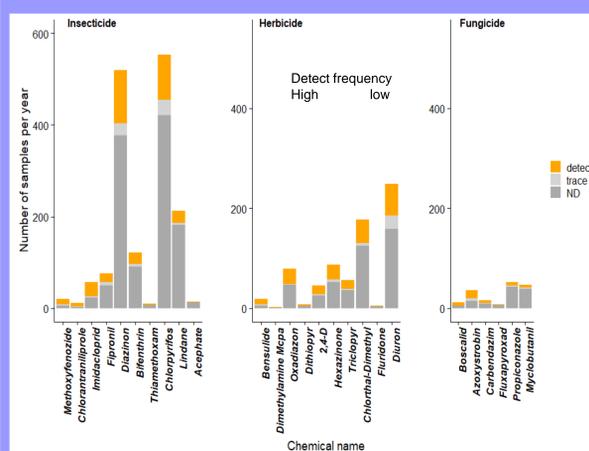

Fig. 5 Pesticide with the highest detection frequencies within each use type group

Table 1: top pesticides detected with concentration exceeding the lowest USEPA aquatic life benchmarks

Pesticide name	No. detection	No. exceedance	Total sample	% detection	% exceedance benchmarks
Imidacloprid	780	760	1468	53.1	51.8
Fipronil	493	433	1971	25.0	22.0
Bifenthrin	667	637	3161	21.1	20.2
Diazinon	3023	765	13497	22.4	5.7
Chlorpyrifos	2583	742	14395	7.9	5.2
Bensulide	308	18	496	62.1	3.6

Yearly trend of benchmark exceedance

► Exceedance frequencies of imidacloprid, bifenthrin and fipronil increased in recent years.
► Exceedance frequencies of diazinon and chlorpyrifos decreased and stayed at similar levels in recent years.
► Exceedance frequencies of bensulide are relative low, but increased slightly in recent years.
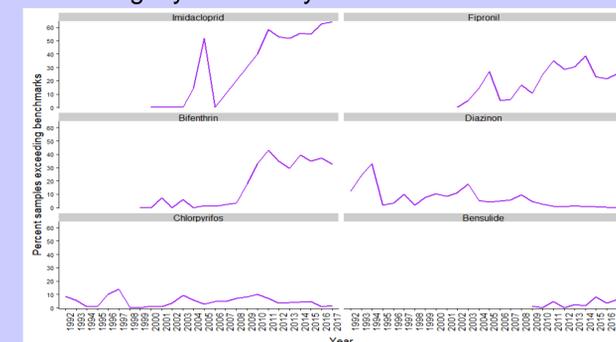

Fig. 6 Yearly trend of exceedance frequencies

Spatial distribution

► Exceedance hotspots are located in the Central Coast and Southern California sites.
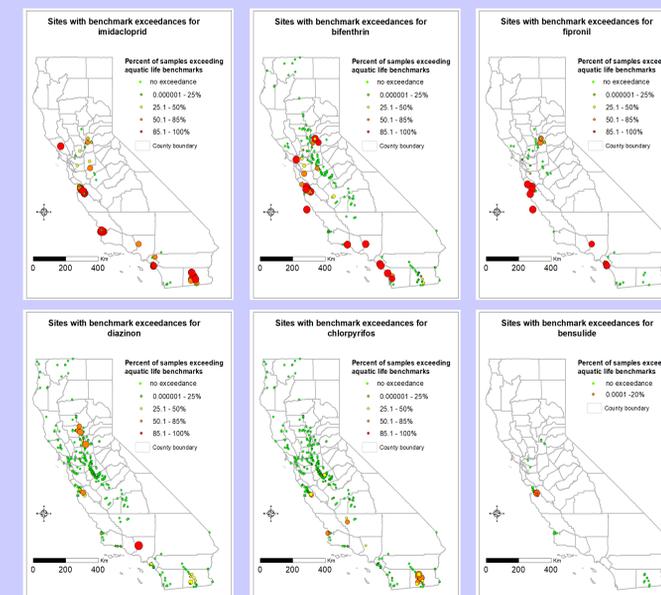► Bifenthrin exceedances are also observed in urban sites of Placer and Sacramento counties.

Fig. 7 Sampling locations and magnitude of exceedances for top chemicals with highest exceedances

CONCLUSIONS

Preliminary analyses show that a total of 360 non-legacy pesticides and their degradates have been sampled from surface water of California. About 6% of the samples are detections. Pesticides with frequent detections and exceedances include imidacloprid, fipronil and bifenthrin for which the yearly exceedance frequencies are increasing. Diazinon and chlorpyrifos are sampled most frequently. Their exceedance frequencies had leveled and stayed at relatively low rates. Exceedance hotspots are located in the Central Coast and Southern California sites. The next phase of the project will focus on: (1) spatial analysis of landuse and site types; (2) pesticide mixtures and toxicity indicators. The results generated by this study will provide an indication of California's aquatic ecosystem health. Moreover, the results will guide future monitoring in California.