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The Role of Rainfall on Pesticide Runoff in Urban Neighborhoods in Northern California

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Introduction

Urban pesticide use mainly includes structural pest control, landscape maintenance, rights-of-way, as well as applications to commercial, institutional, and industrials areas, and residential home-and-garden applications. Annually, professional applicators apply over 4 million kg ai of pesticides for urban (non-agriculture) pest control (CDPR 2010). However, total urban pesticide use in California is unknown because homeowners do not report individual use. Based on pesticide products sold in home improvement stores, high homeowner pesticide use is anticipated (Osienski et al. 2010). The US EPA has estimated that non-agricultural pesticide use accounts for approximately 20% of all total pesticide use in the United States; most of these uses are in urban areas (Grube et al. 2011). In 2009, excluding adjuvants, the total reported pesticide use in California was over 68 million kg ai (CDPR 2010). Although the exact amount of urban pesticide use is unknown, we can deduce that large amounts of pesticides are applied in California urban areas. With this high volume of urban pesticide use and perhaps lack of consumer awareness, urban pesticide runoff may exceed agricultural runoff (Wittmer et al. 2011). Rainfall is a big contributor to this runoff (Revitt et al. 2002; Weston et al. 2009; Wittmer et al. 2011). CDPR's Environmental Monitoring Branch has been monitoring urban pesticide runoff since 2008; in these studies, rainfall also has been a major contributor to urban pesticide runoff (Ensminger and Kelley 2011). In 2009, we further explored the effect of rainfall on urban pesticide runoff.

Objectives

Compare the first flush rainfall of the 2010 water year to:
1) the pesticide runoff immediately prior to the first flush rain event; and
2) the pesticide runoff from a spring rainfall event, at one of the two final main rain events of the 2010 water year.

Materials & *Methods*

Study Sites and Sampling

- Thirteen stormdrain outfalls and urban creeks were sampled in northern California; four in the San Francisco Bay area and eight in the Sacramento area (Figures 1- 3).
- Grab water samples were taken during the first flush rainfall of the 2010 water year, 1 – 2 days immediately prior to the first flush rainfall, and at one of the last two rainfall events of the 2010 water year.

Chemical Analysis

- California Department of Food and Agriculture (CDFA) analyzed for bifenthrin, cyfluthrin, cypermethrin, deltamethrin/tralomethrin, esfenvalerate/fenvalerate, fenpropathrin, λ-cyhalothrin, permethrin (cis and trans isomers), resmethrin, diazinon, chlorpyrifos, malathion, fipronil (and five degradates), carbaryl, simazine (and degradate diamino chlorotriazine), diuron, prometon, bromacil, hexazinone, 2-4-D, dicamba, triclopyr, and MCPA.
- Reporting limits (RL) were 0.05 ppb for all pesticides except for diazinon and chlorpyrifos (both 0.01 ppb), malathion (0.04 ppb), and pyrethroids (0.005-0.015 ppb). CDFA reported detections below the RL but above the method detection limit (MDL) as trace detections, which were not quantified.

Statistical Analysis

- Statistical analyses were conducted using the non-parametric Mann-Whitley mean comparison test, significance at the 0.05 level, with Minitab® Statistical Software (Release 15).

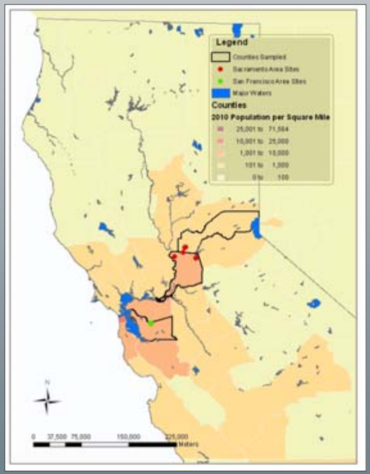

Figure 1. Monitoring sites in the San Francisco Bay and Sacramento areas.

Figure 2. Sampling a tributary of Pleasant Grove Creek, Roseville, CA (Sacramento area).

Figure 3. Stormdrain outfall in Dublin, CA (San Francisco Bay Area).

Poster and photos by Mike Ensminger mensminger@cdpr.ca.gov 916-324-4186

Results & *Discussion*

- Bifenthrin, malathion, carbaryl, fipronil, 2,4-D, dicamba, diuron, MCPA, and triclopyr were detected in at least 20% of the samples.
- The first flush rainstorm had more pesticide runoff than either the dryflow sampling event immediately preceding the first flush or the spring rainstorm. The number of pesticides detected were significantly greater during the October rainstorm than the October dryflow sampling event (p=0.0002) or during the spring rainstorm (p=0.012; Figure 4).
- The number of pesticides detected during the spring rainstorm and the October dryflow sampling event were also were significantly different (p=0.001; Figure 4).
- Detection frequencies of the individual pesticides were between 17%-67% higher during the first flush rainfall than during the October dryflow sampling event (Figure 5).
- The October first flush rainfall had between 10%-60% higher detection frequencies than the spring rainstorm except for bifenthrin and dicamba (equal during both rains) and 2,4-D, which had higher detections in the spring rainstorm (Figure 5).
- All sites except PGC010, MCC030, and PGC040 had higher detection frequencies with the first flush rainstorm (Figure 6). PGC010 was unusual in that the October dryflow sampling event had highest detection frequency. Including trace detections, the October first flush rainstorm had the most detections of all three events at PGC010.

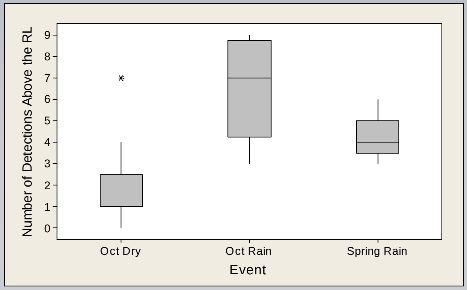

Figure 4. Number of pesticides detected during the different sampling events.

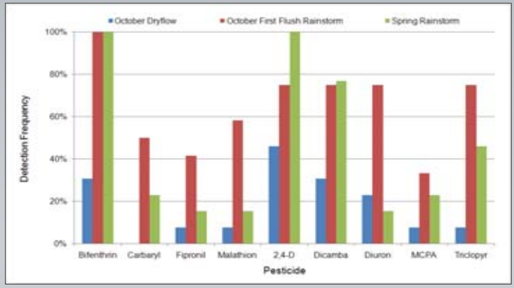

Figure 5. Detection frequency of pesticides at the different sampling sites at the three sampling events.

Conclusions

- More pesticides were transported to urban waterways during a first flush rain event than at other times of the year, likely due to accumulated pesticide deposition over California's dry season (May – October). Dryflow runoff only appeared to remove a small percentage of pesticides.
- Less pesticide runoff was observed with later rainstorm, even though reported professional use is similar (CDPR 2010). Exception:
  - Bifenthrin and dicamba were detected at the same frequency at both rain events.
  - 2,4-D was detected more frequently during the spring rainstorm, perhaps reflecting increased homeowner use at this time of the year.

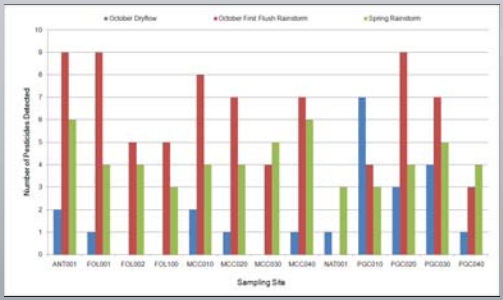

Figure 6. Number of pesticides detected at the different sampling sites with each sampling event (NAT001 was not sampled in October first flush rainstorm).

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