Using Water Quality Ponds to Mitigate Pesticides in Urban Runoff

R. Budd*, M. Ensminger, E. Kanawi, and K. Goh
California Department of Pesticide Regulation, Sacramento, CA

INTRODUCTION

Pesticides transported with urban runoff often reach concentrations toxic to aquatic invertebrates[1]. Water quality ponds (WQP) have proven to be an effective best management strategy in agricultural areas[2,3]. This study is part of a long term monitoring program conducted by the Department of Pesticide Regulation evaluating the efficiency of two WQPs (Figures 3 and 4) receiving runoff from residential landscapes to reduce pesticide loading to receiving streams. Water and sediment samples are collected from the inlet (Figure 1) and outlets (Figure 2) of each WQP. Samples are analyzed for pyrethroids, organophosphates, fipronil, imidacloprid, and synthetic auxin herbicides. The analytes represent a wide range of physiochemical properties, allowing for a more comprehensive evaluation of analyte transport within the systems. In addition to water quality parameters, toxicity to invertebrates is evaluated. We have installed flow equipment, which will allow for a mass balance of pesticide load. Bifenthrin and 2,4-D will be highlighted in this presentation. Not only are they the two most frequently detected pesticides in our systems, they represent opposite ends of the spectrum in terms of physiochemical properties.

Figure 1. Storm drain entering pond

Figure 2. Pond outlet

OBJECTIVES

1) Monitor inputs to evaluate presence and concentrations of pesticides typical of urban runoff
2) Determine removal efficacy of WQPs at reducing concentrations and improving water quality
3) Evaluate discrepancies between wetlands to help establish environmental factors that influence transport

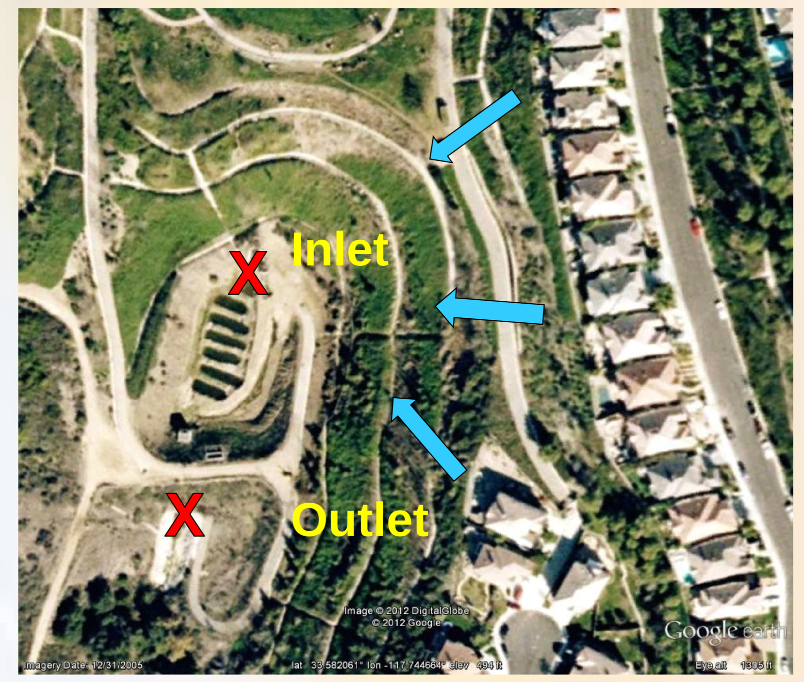

Figure 3. Wetland 1 with flow schematic

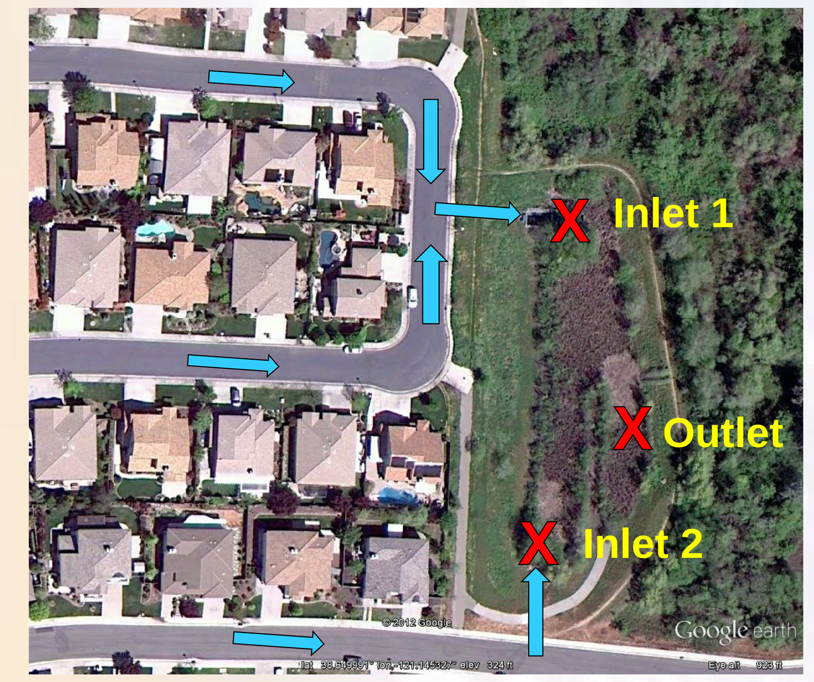

Figure 4. Wetland 2 with flow schematic

METHODS

- Water and sediment grab and composite samples collected at inlets and outlet of each water quality ponds
- Sampling occurred during dry season and storm events
- Water samples analyzed for presence of pyrethroids, organophosphates, fipronil, imidacloprid, synthetic auxin, and photosynthetic inhibitor herbicides
- Sediment samples analyzed for pyrethroid concentrations
- Toxicity units (TU) calculated [TU = OC normalized concentration / $LC50_{OC}$]

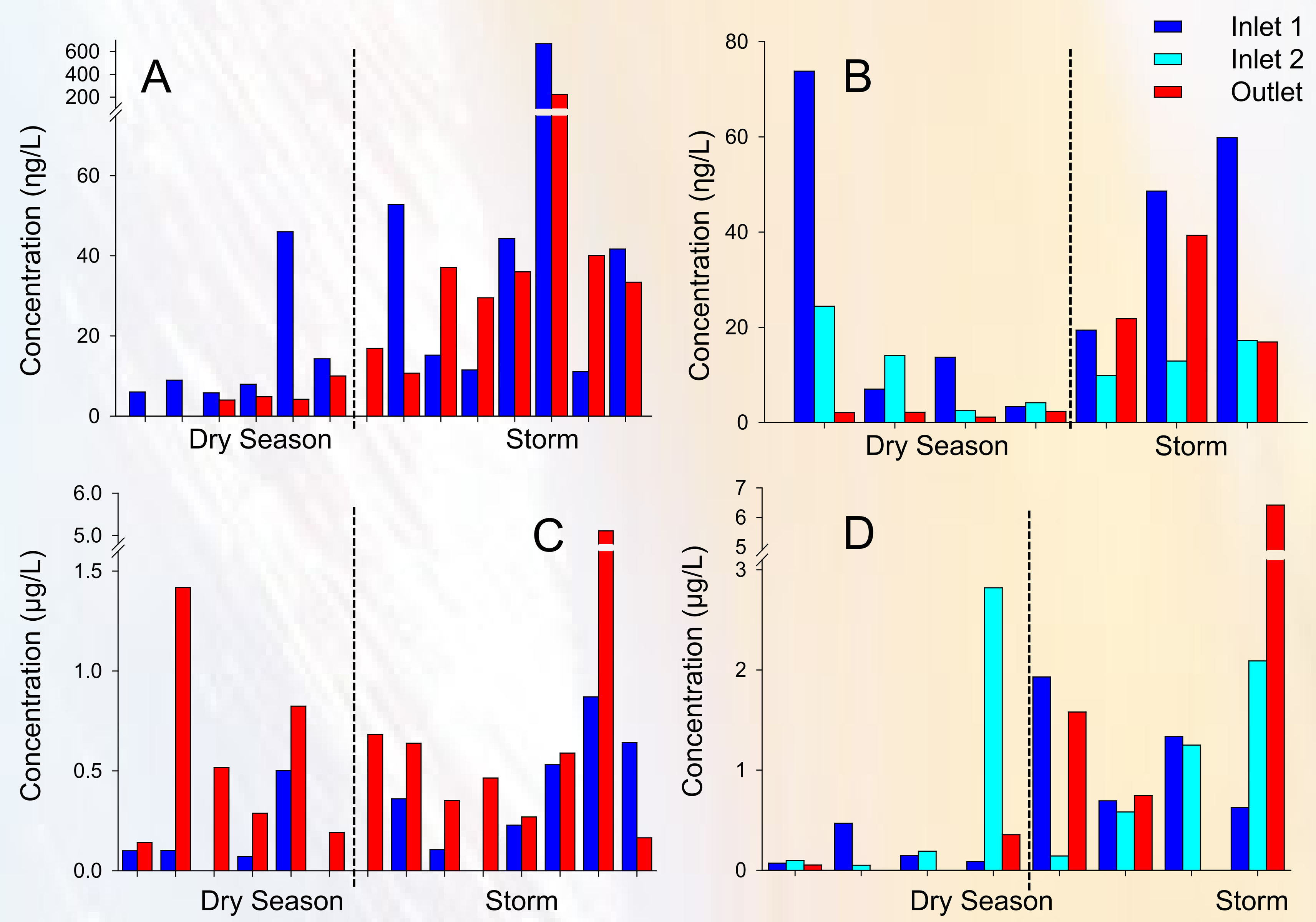

Figure 3. Sampling event concentrations; A) Bifenthrin in Wetland 1, B) Bifenthrin in Wetland 2, C) 2,4-D in Wetland 1, and D) 2,4-D in Wetland 2

RESULTS and CONCLUSIONS

- Higher reduction of bifenthrin concentrations compared with the more water soluble 2,4-D (Figure 3)
- Removal efficacies generally decrease during storm events (Figure 3)
- Average 67% reduction in sediment toxicity units display importance of deposition in removal of sediment bound pesticides (Figure 4)
- Toxicity to *Hyallela azteca* reduced at outlets of WQP (Figure 5) highlight improvement in water quality as passes through system
- Median frequency of detections of all monitored pesticides generally lower at outlets during storms and dry season events (Figure 6)
- Inverse relationship observed between water pyrethroid concentrations and *Hyallela azteca* survival (Figure 7)

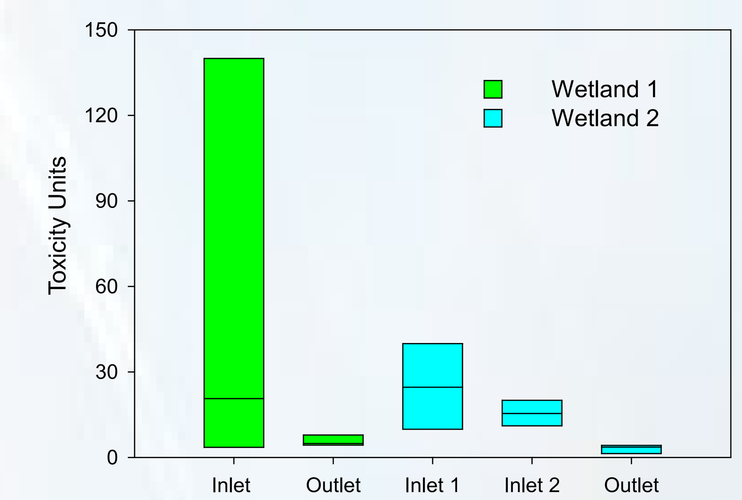

Figure 4. Box plots of sediment toxicity units

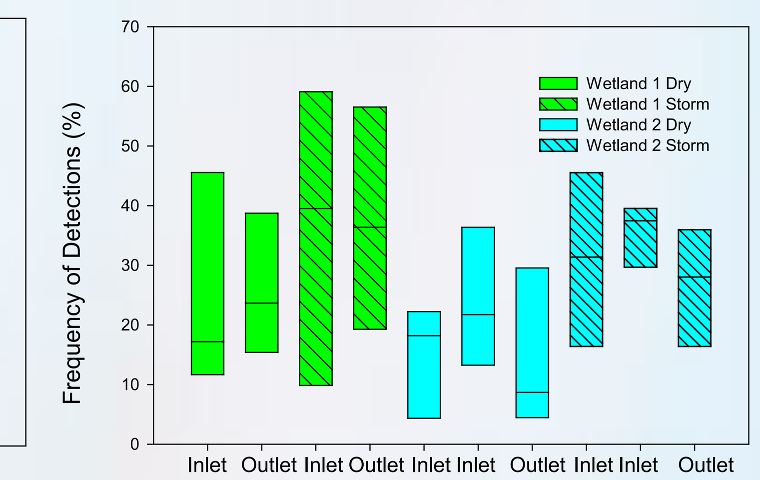

Figure 6. Box plots of frequency of detections of all monitored pesticides within ponds 1 and 2

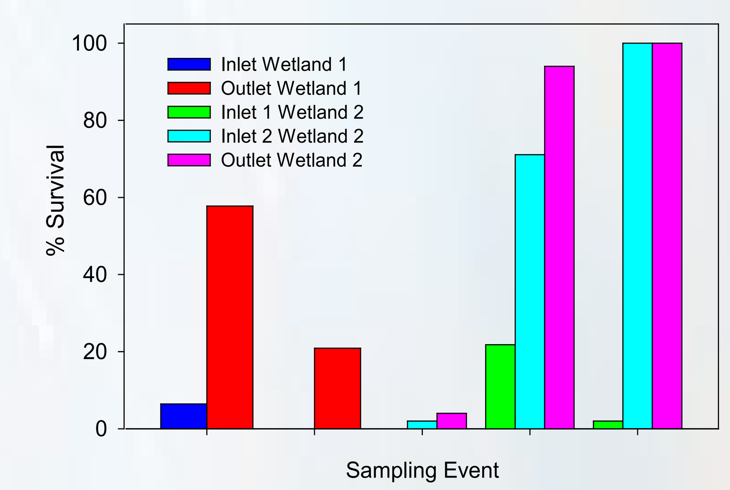

Figure 5. 96-hr percent survival of *Hyallela azteca* at inlets and outlets of ponds

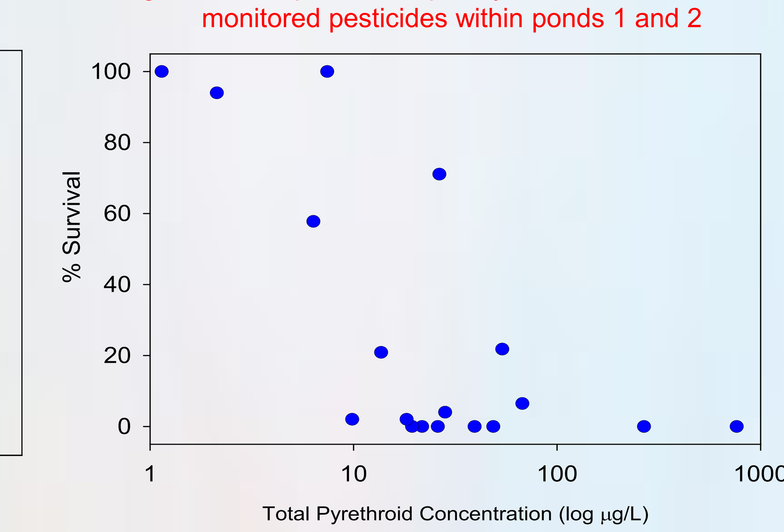

Figure 7. Total pyrethroid water concentrations plotted against 96-hr survival (%) of *Hyallela azteca*

FUTURE EFFORTS

- Calculate mass balance of pesticides using flow data from newly installed sensors
- Evaluate subsurface transport using piezometer monitoring
- *In situ* evaluation of pesticide concentrations on benthic macroinvertebrate communities

REFERENCES

1. Ensminger, M., Budd, R., Kelley, K., and S. Goh. 2012. Pesticide occurrence and aquatic benchmark exceedances in urban surface waters and sediments in three urban areas of California, USA, 2008-2011. Environmental Monitoring and Assessment, online at DOI:10.1007/s10661-012-2821-8.
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3. Budd, R., O'Geen, A., Goh, K., Bondarenko, S., and J. Gan. Efficacy of constructed wetlands in pesticide removal from tailwaters in the Central Valley, California. Environmental Science and Technology, 43, p. 2925-2930.

*Corresponding author: rbudd@cdpr.ca.gov