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Progress Report

Brief Summary of Chlorpyrifos Temporal Trends Analysis from Surface Water Monitoring Data for the Westside Coalition from 2004 -2009

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Project Description

The objective of this pilot study was to conduct temporal trends analysis for chlorpyrifos monitoring data collected from the Westside Coalition from 2004 to 2009. A total of 765 chlorpyrifos measurements from 25 mainstem and tributary sites were included in this analysis. The analysis considered both water body size (mainstem and tributary sites) as well as season (irrigation season from March through August and non-irrigation season from September through February). Standard regression analysis was used to determine temporal trends along with the associated r^2 and p values. If r^2 values (a measurement of the relationship of annual 90th centiles to each other) exceeded 0.25, the regression was considered to be reasonable. The p value – which measures the risk of being wrong – was interpreted in the content of the data set size. Because only six annual 90th centile values were used in the regression analysis, this data set is considered fairly small. Therefore, highly restrictive (low) p values are not needed to suggest a trend. For example, a p value as low as 0.05 (being wrong only 5% of the time), which is typically used for most environmental data analysis, is not always needed to suggest a meaningful finding such as a declining trend.

The values used in the regression to represent annual concentrations by site size and season were 90th centiles. The 90th centile is a well accepted value used in ecological risk assessments and pesticide trends analysis that represents the tail of the data distribution. For example, a 90th centile of 8 ug/L means that 90% of the values in the data are below 8 ug/L or only 10% of the values exceed 8 ug/L.

For chlorpyrifos measurements that were below the detection limit (DL), an assigned value of ½ the detection limit (a common approach) was used in the analysis. If only the reporting limit (RL) was reported, then ½ the reporting limit was used in the analysis. There are other options for addressing non-detected concentrations, such as selecting a random value between 0 and the detection limit, but for this initial analysis ½ the DL or RL was used. J values were also used if reported.

Results

Chlorpyrifos concentrations from the entire 6 year data set ranged from non-detected to 1,800 ng/L. Results of 90th centile trends analysis considering both water body size (all

sites, tributary sites and mainstem sites) and season (all seasons, irrigation season and non-irrigation season) are presented in Figures 1-9. Figure 1 which represents a "Big Picture" result for the entire data set - all sites over all seasons - suggests a declining trend in chlorpyrifos concentrations from 2004 to 2009 as the r^2 value of 0.327 exceeds 0.25. The p value of 0.236 is also supportive of a declining trend. Temporal trends for all sites during the irrigation season in Figure 2 also suggests a declining trend in chlorpyrifos concentrations as reported in Figure 1. The temporal trend in chlorpyrifos concentrations for all sites during the non-irrigation season in Figure 3 also suggests a decline but the slope of the regression is not as steep (not as much decline) as reported for Figures 1 and 2.

For the three tributary/season scenarios in Figures 4-6, a declining trend was reported for all seasons (Figure 4) and the irrigation season (Figure 5). However, for tributary sites during the non-irrigation season there was a slight increase in 90^{th} centiles over the 6 year period. However, r^2 and p values were weak thus suggesting that this trend is suspect.

Regression analysis for mainstem sites for all seasons (Figure 7), the irrigation season (Figure 8) and the non-irrigation season (Figure 9) suggests declining chlorpyrifos concentrations for all three season scenarios. In particular, declining chlorpyrifos concentrations were statistically significant at a p of < 0.05 with a high r^2 of 0.79 for all mainstem sites during all seasons in Figure 7.

It is noteworthy that the relatively high chlorpyrifos concentrations reported from some sites in 2008 were highly influential in the temporal trends analysis for this data set. For example, the annual 90^{th} centiles three years prior to 2008 in Figure 1 were all much lower than in 2008. In order to determine the significance of the 2008 data, additional regression analysis was conducted for all sites and all seasons excluding the 2008 data (Figure 10). The results from this analysis showed a statistically significant decline in chlorpyrifos concentrations ($r^2 = 0.802$ and $p = 0.04$) from 2004 to 2009 for all sites and all seasons.

Summary

The results from this analysis showed the following:

- Based on a "weight of evidence" interpretation considering both waterbody size (mainstem and tributary sites) and season (all seasons, irrigation season and non-irrigation season) our analysis clearly suggests a declining trend in chlorpyrifos concentrations in the Westside Coalition sampling sites from 2004 to 2009.
- Declining trends in chlorpyrifos concentrations were more apparent for all sites and mainstem sites for all seasons, the irrigation season and the non-irrigation season.
- Declining trends in tributary chlorpyrifos concentrations, although apparent for all seasons and the irrigation season, were not as strong as reported for all sites and mainstem sites. In addition, a slight but statistically inconclusive increase in chlorpyrifos concentrations was reported for tributary sites during the non-irrigation season.

- Chlorpyrifos concentrations in 2008 were higher than reported for the three previous years and were highly influential in impacting the temporal trends analysis. Regression analysis conducted for all sites and all seasons, with the 2008 data removed, showed a statistically significant ($p < 0.05$) decline in chlorpyrifos concentrations over time.

Figure 1. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for all sites and all seasons (r^2=0.327, p=0.236).

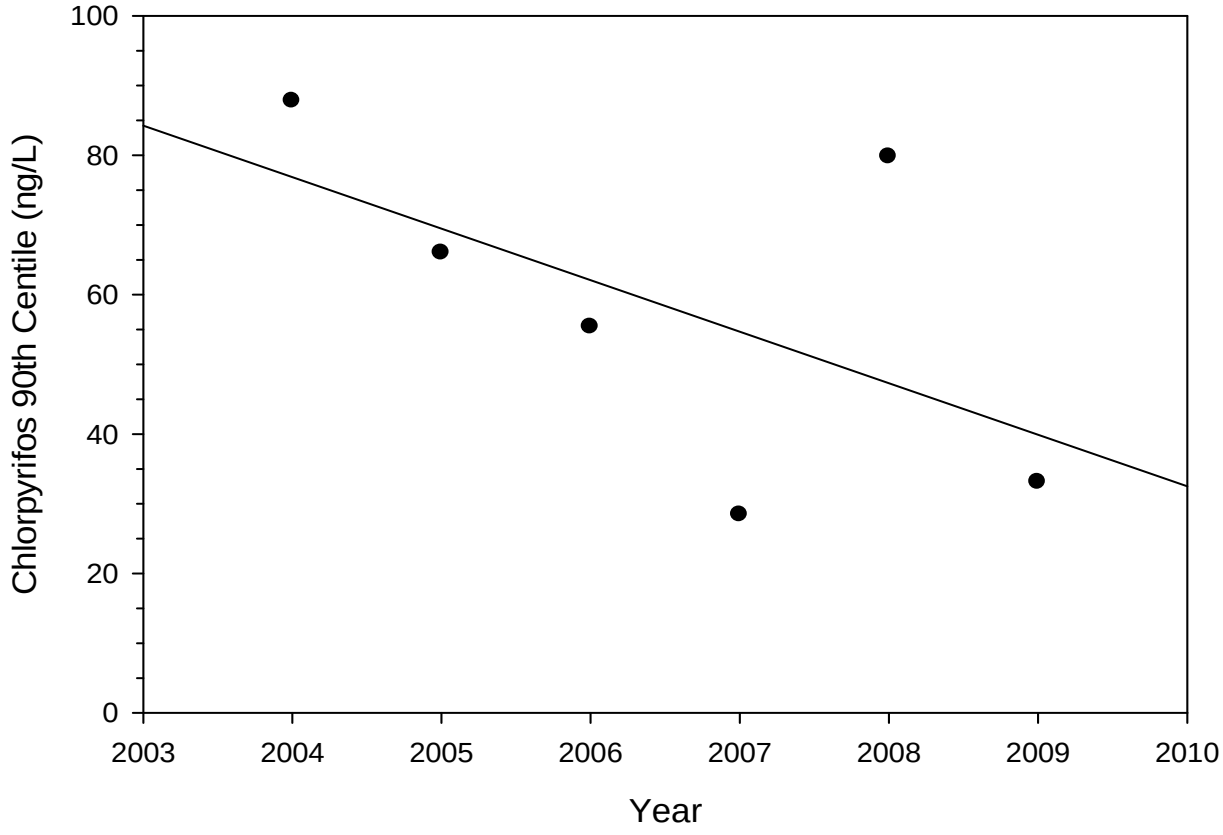

Figure 2. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for all sites during the irrigation season (r^2=0.382, p=0.191).

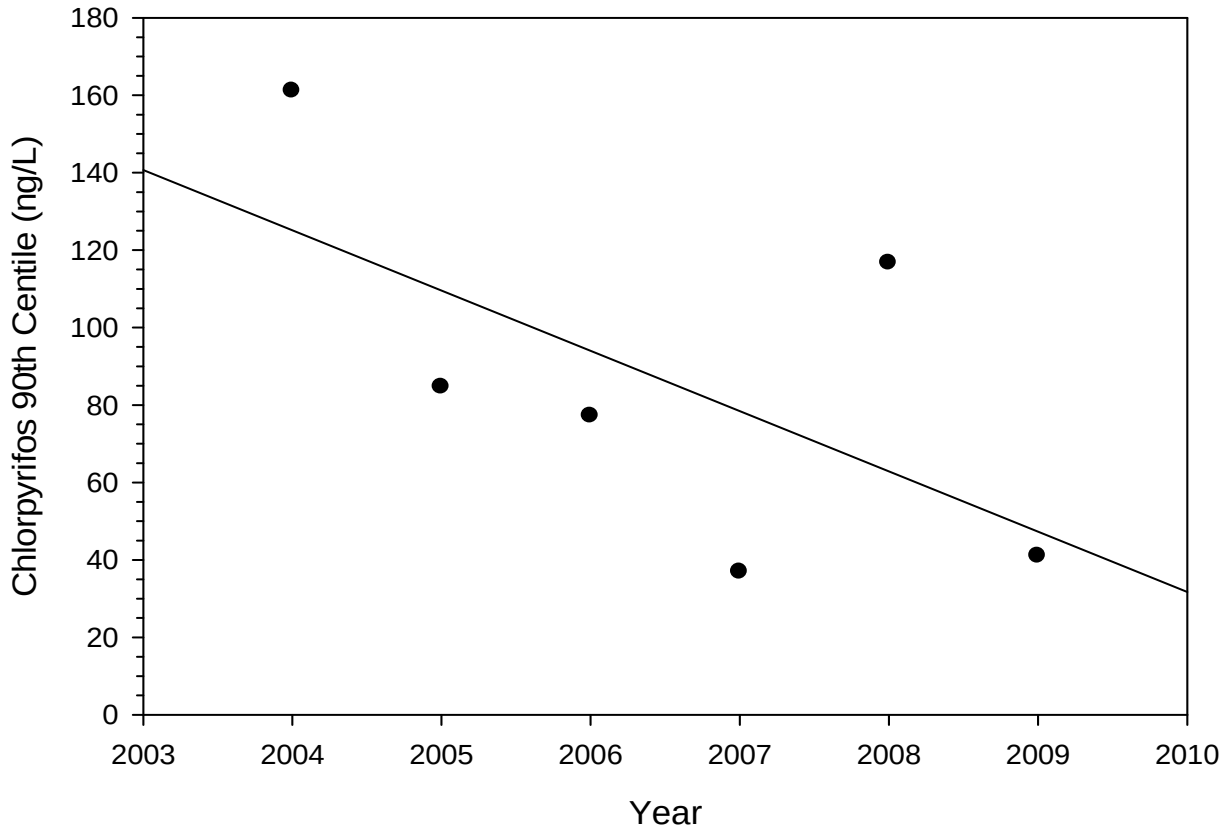

Figure 3. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for all sites during the non-irrigation season (r^2=0.109, p=0.523).

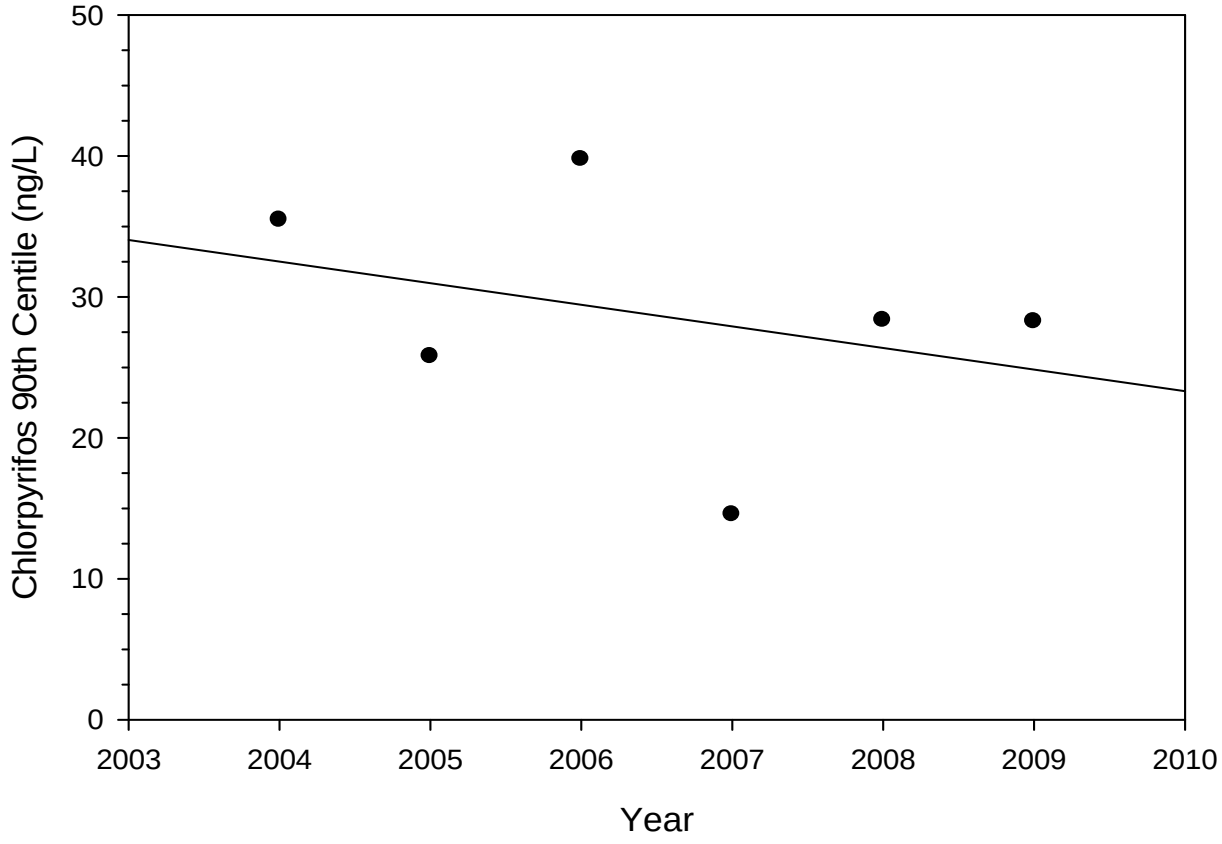

Figure 4. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for tributary sites during all seasons (r^2=0.105, p=0.530).

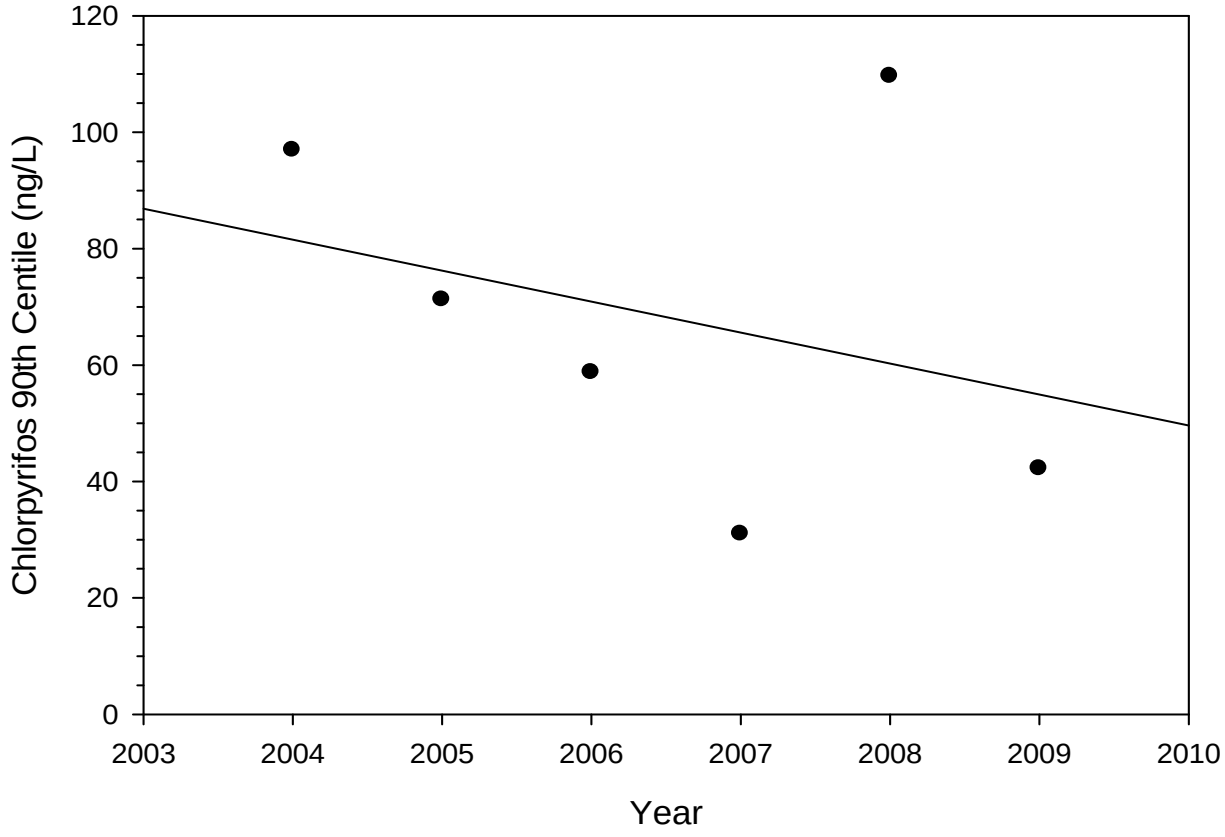

Figure 5. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for tributary sites during the irrigation season (r^2=0.220, p=0.349).

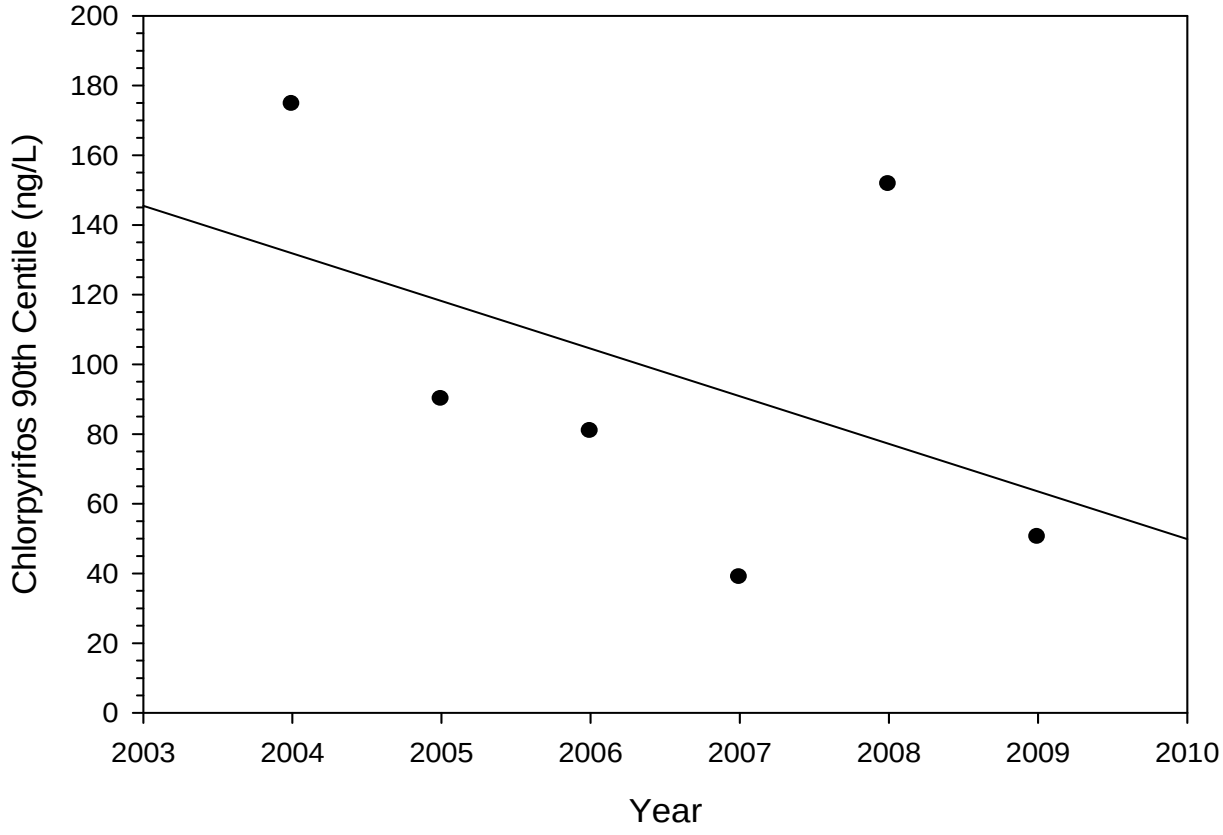

Figure 6. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for tributary sites during the non-irrigation season (r^2=0.053, p=0.660).

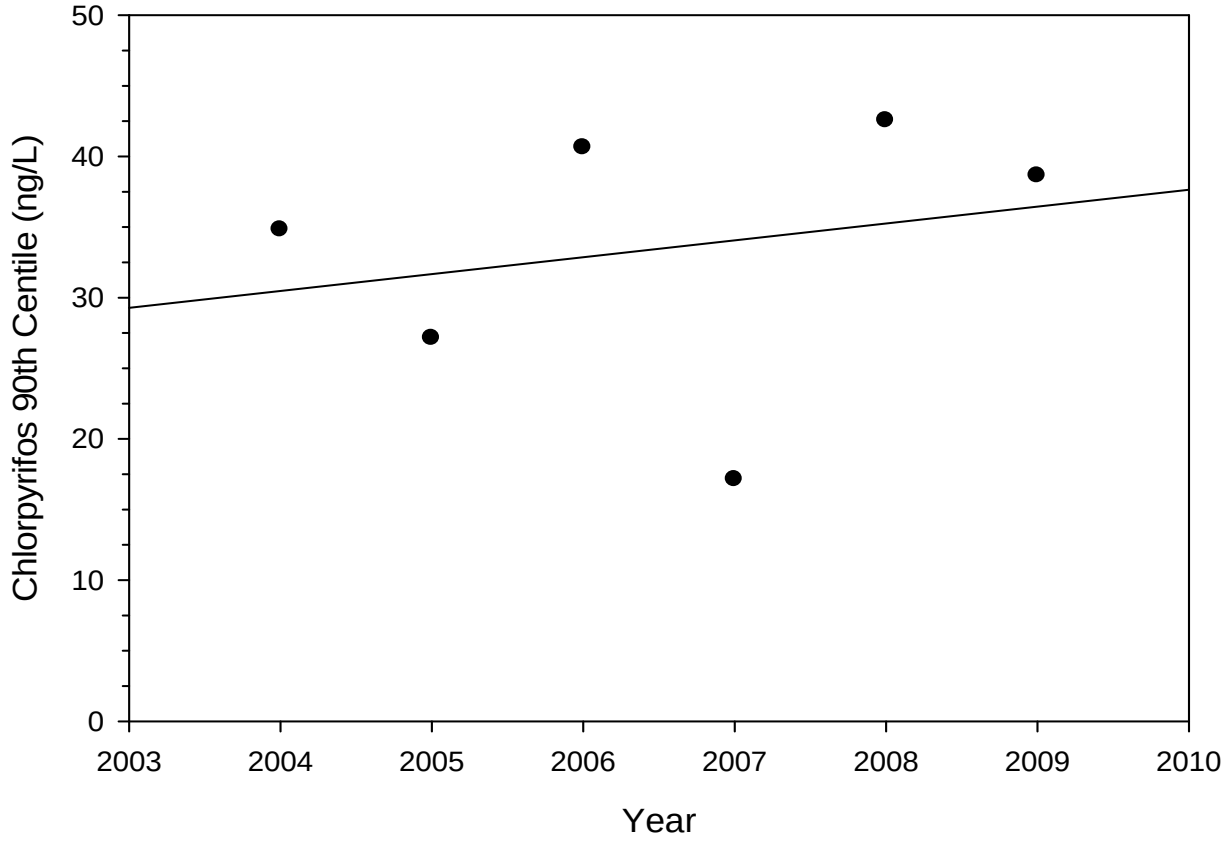

Figure 7. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for mainstem sites during all seasons (r^2=0.789, p=0.044). The 90th centile for 2005 could not be calculated (CNC) due to a lack of variance in the chlorpyrifos data for that year.

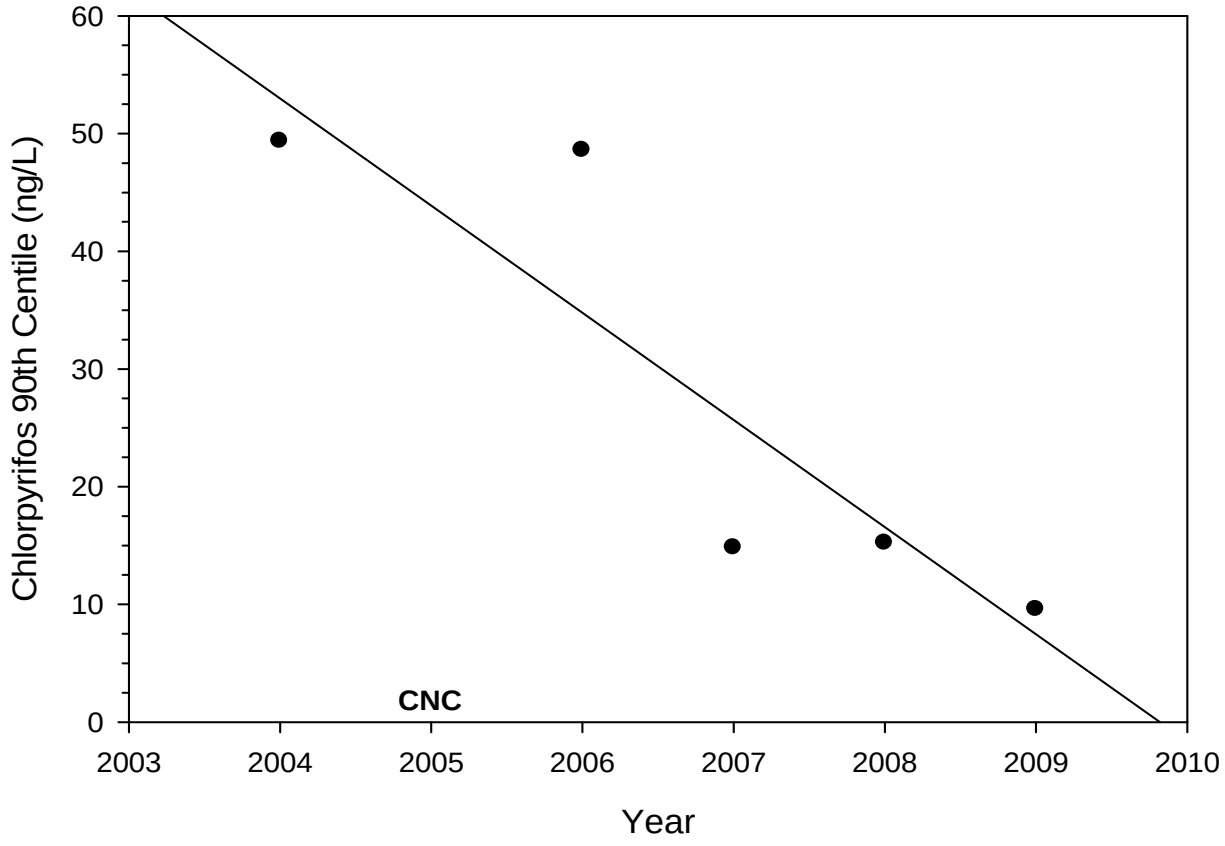

Figure 8. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for mainstem sites during the irrigation season (r^2=0.997, p=NV). The p-value was not valid (NV) due to unequal variance among the 90th percentiles. The 90th centiles for 2004-2006 could not be calculated (CNC) due to a lack of variance in the chlorpyrifos data for those years.

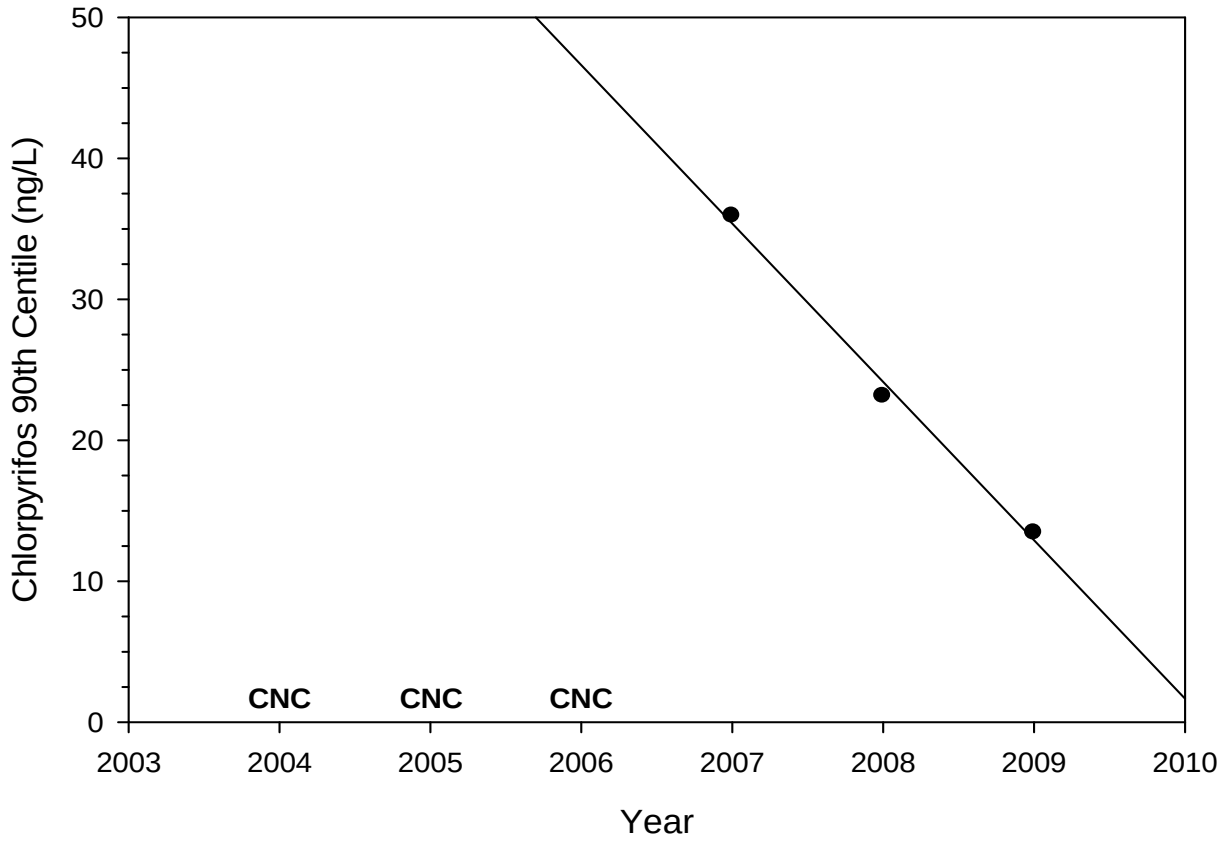

Figure 9. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for mainstem sites during the non-irrigation season (r^2=0.561, p=0.145). The 90th centile for 2005 could not be calculated (CNC) due to a lack of variance in the chlorpyrifos data for that year.

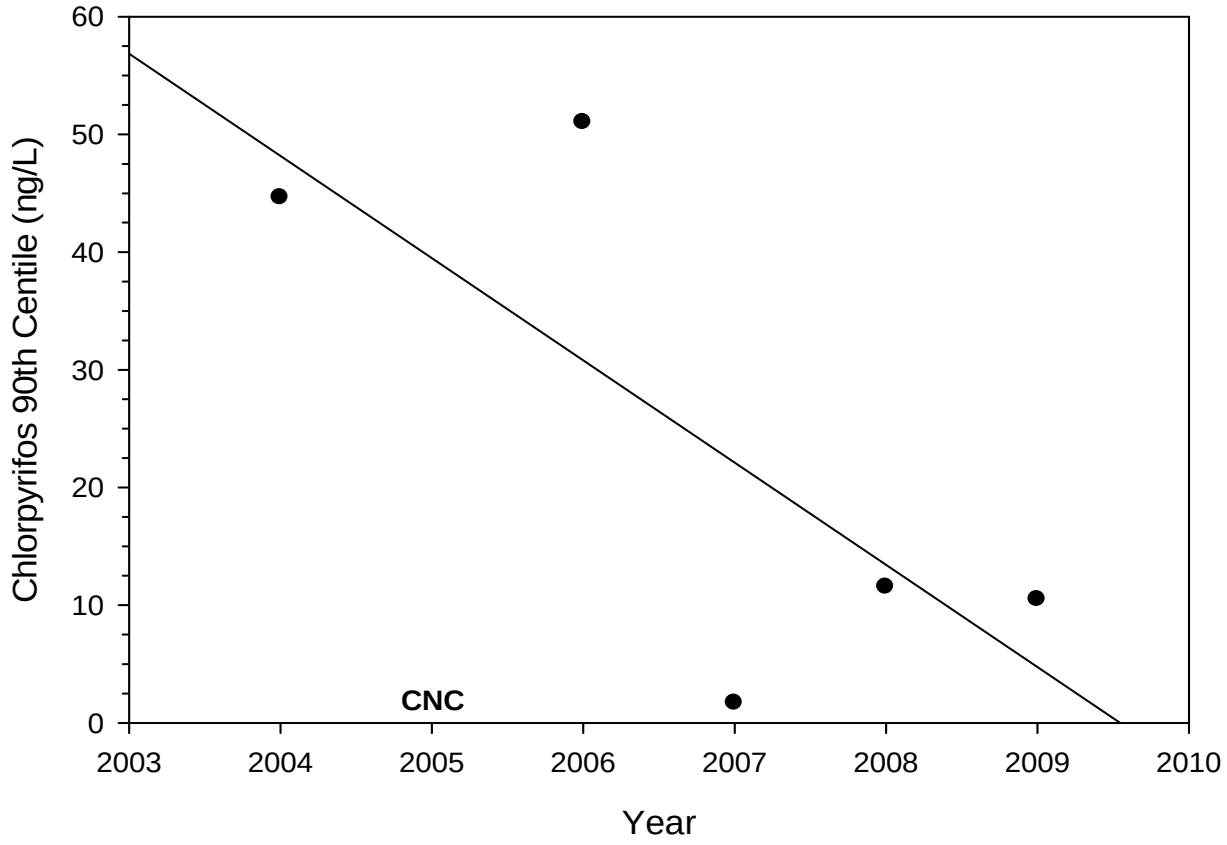

Figure 10. Regression analysis of chlorpyrifos 90th centiles from 2004 to 2009 for all sites and all seasons excluding 2008 data (r^2=0.802, p=0.040).