

Chlorpyrifos in Surface Waters of Central Valley, California: Statistical Analysis of Environmental Monitoring Data

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Outline

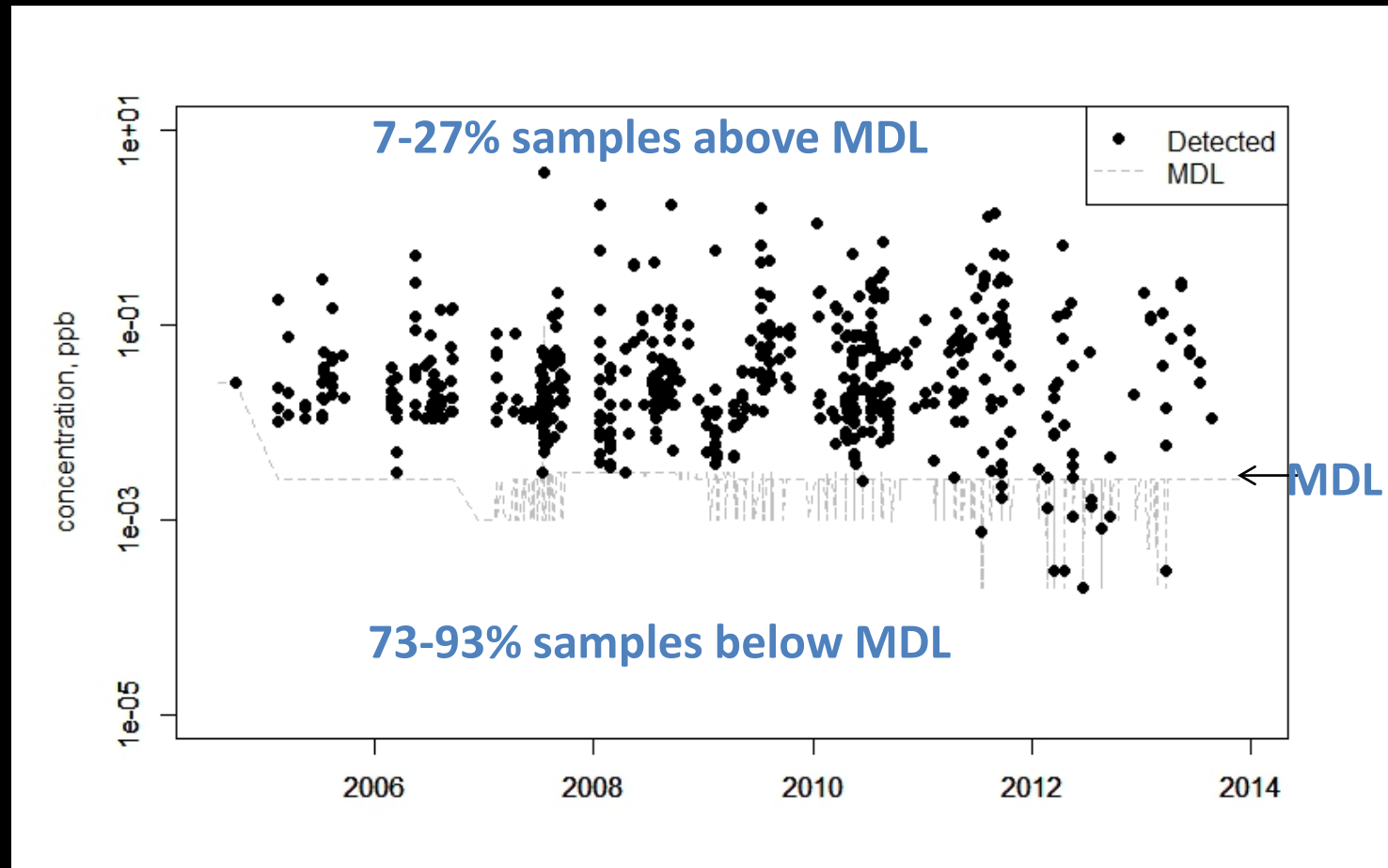
- Introduction on the monitoring dataset
- Challenges in interpreting monitoring data
- Conventional analysis on exceedance
- Special statistical approaches for:
 - Trend analysis
 - Ecological risk assessment

Chlorpyrifos Monitoring Data in Central Valley, California



- 3496 grab samples
- 175 sites
- 9 years from 2005-2013

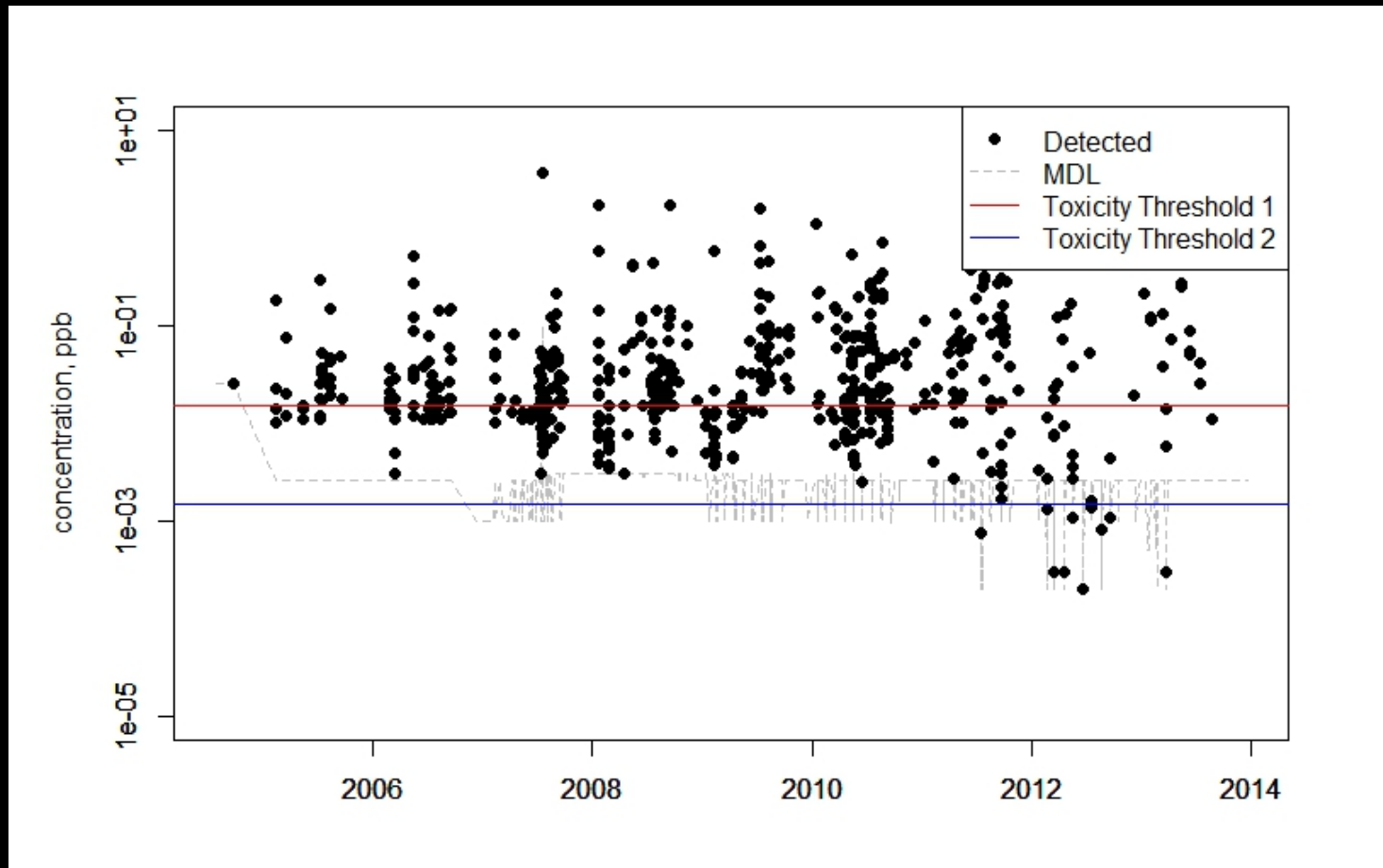
Challenges in Interpreting Monitoring Data



- censored data: annual 73-93% non-detect, detection limit vary with time
- intermittent: infrequent and irregular sampling

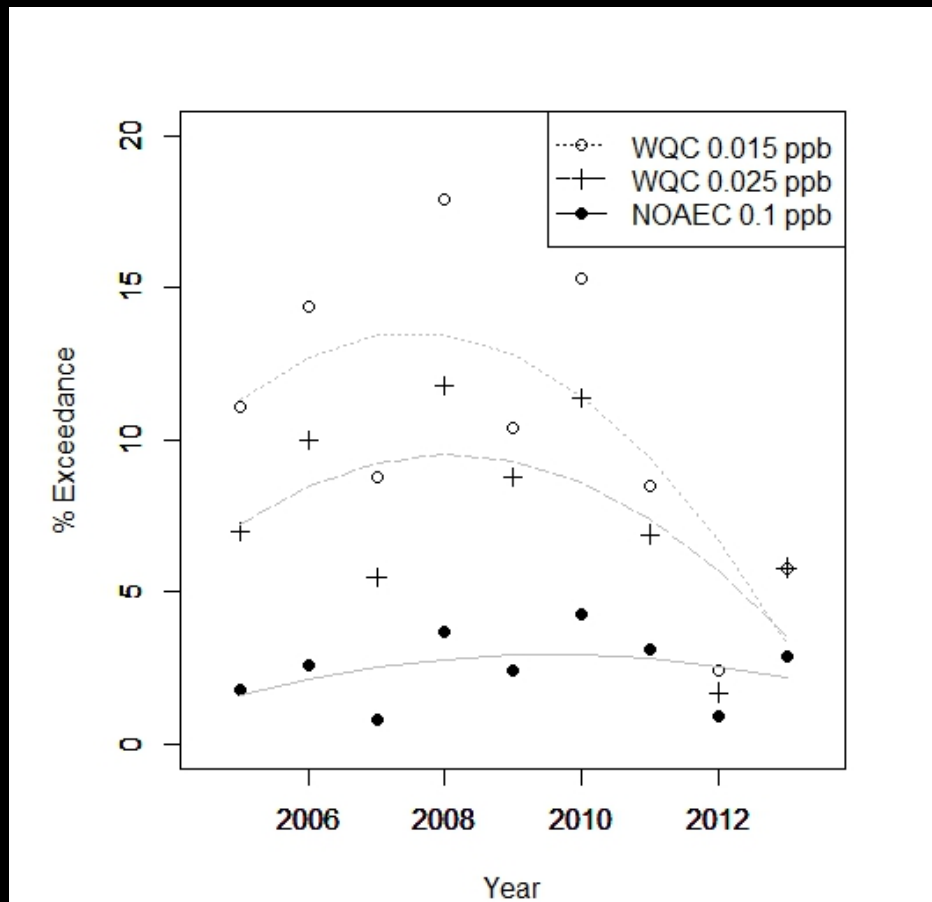
Conventional: Exceedance Frequency

- Toxicity thresholds vs. MDL



Conventional: Exceedance Frequency

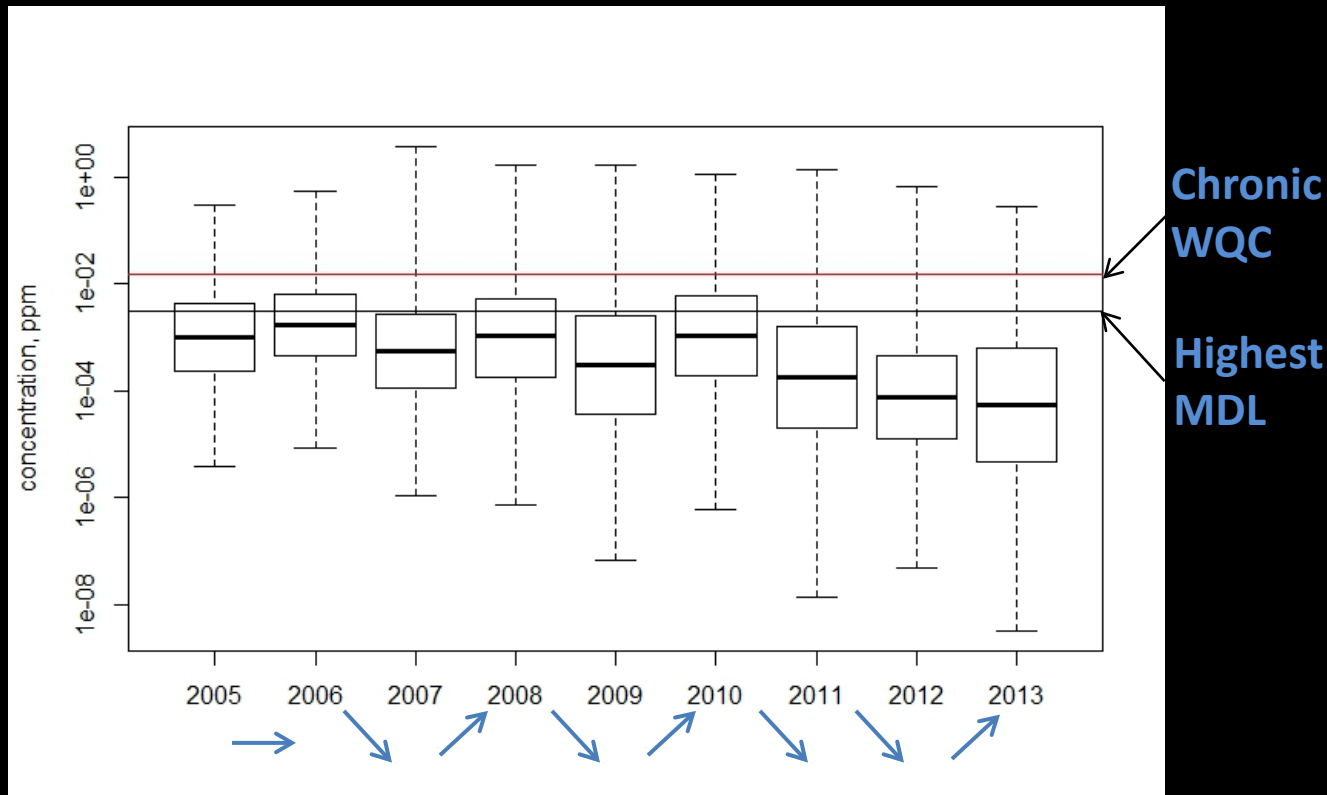
- Thresholds: acute and chronic WQC, NOAEC, all higher than MDL
- Trend varies with different threshold



Trend Analysis

Two R program packages:

- NADA: make an educated guess of the non-detects, trend analysis
- COIN: permutation comparison of concentrations in adjacent years



Trend Analysis

NADA: fit linear regression of all data (detects and non-detects) and calculate annual change

Bootstrap: evaluate the impact of limited spatial/temporal sampling coverage

	Annual change		
	Simple linear regression <u>with detects only</u>	Non-parametric Mann-Kendall trend test	Parametric MLE regression (bootstrap 95% CI)
2005-2013 data	3.6%	-38.7%	-26.4% (-32.2~-19.8%)
2008-2013 data	1.0%	-63.6%	-56.5% (-62.8~-49.3%)
2010-2013 data	-12.4%	-81.0%	-73.6% (-81.7~-62.1%)

p-value > 0.05,
misleading if
only detects
are considered

Results from two NADA
methods are comparable and
statistically significant

Ecological Risk Assessment

Deterministic approach:

$$\text{Risk Quotient} = \frac{\text{estimated environmental concentration}}{\text{toxicity threshold}}$$

Challenges:

- estimate environmental concentration when %non-detects so high!
- select toxicity threshold: varying sensitivity of different indicator groups

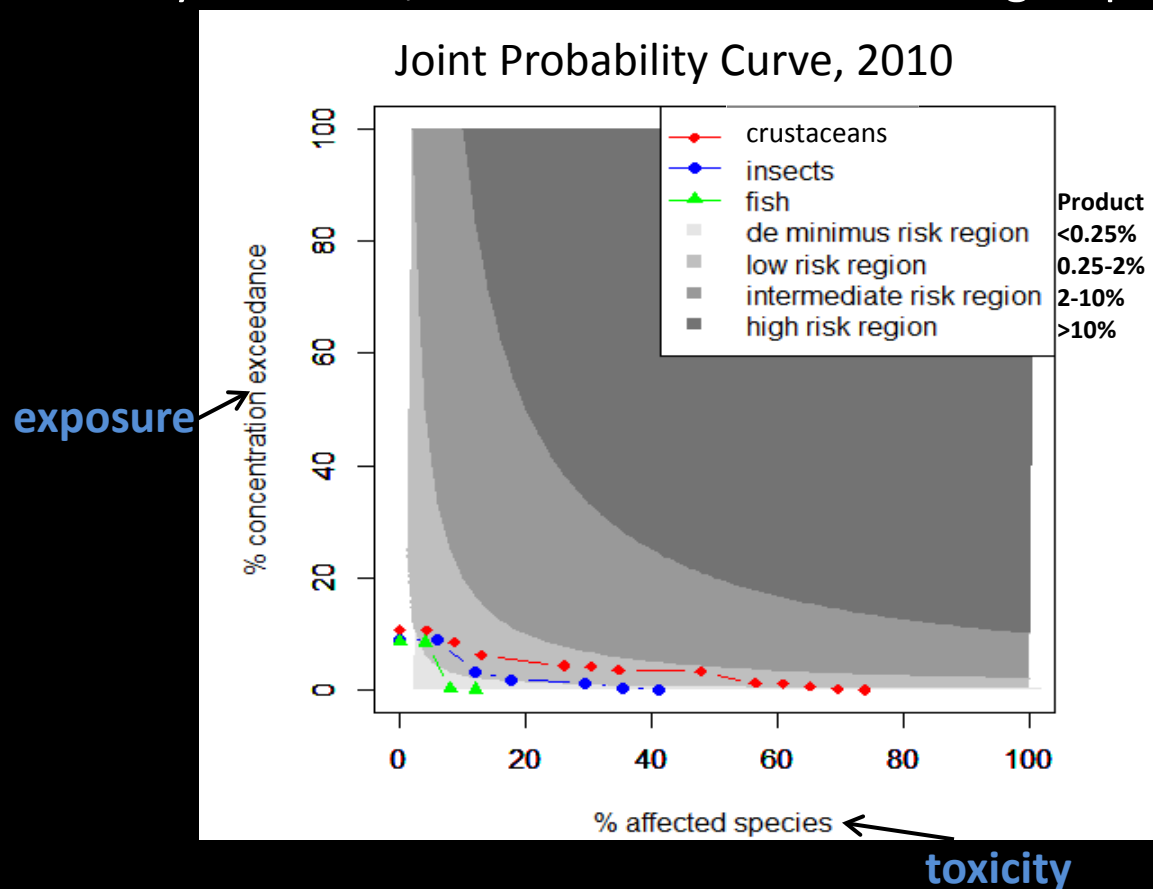
LC ₅₀ , ppb			
Range	Crustaceans	Insects	Fish
0.01-0.09	0.035, 0.054, 0.07	0.05	
0.1-0.9	0.1, 0.1, 0.11, 0.12, 0.15, 0.16, 0.19, 0.19, 0.3, 0.3, 0.33, 0.5, 0.82	0.17, 0.24, 0.28, 0.3, 0.62	0.53
1-9	1.47, 1.55, 2.9, 6, 8.58	1.98, 1.98, 2, 2.16, 4.48, 6.6, 7.97, 8.44	1.1, 1.3, 4.2, 4.65, 4.7, 4.97, 7.2, 8, 8.49, 8.5
10-99	30.5, 457	27.2, >34	10, 10, 11, 18, 18,
100-999		>300	122, 207, 244, 250, 250, 298, 520, 806, >806

Ecological Risk Assessment

Probabilistic approach:

-Joint Probability Curve, risk = exposure × toxicity

-Work for any %detects, can differentiate indicator groups with varying sensitivity



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Thank you!

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