California's Surface Water Ambient Monitoring Program

Summary of Toxicity in California Waters

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Assessment Questions

- Where has toxicity been observed in California waters?
- What is the magnitude of observed toxicity?
- How do the results of toxicity measurements compare among waters draining urban, agricultural, and other land cover areas?
- What chemicals have been implicated as causing toxicity?
- What are the ecological implications of aquatic toxicity?

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Assessment Questions (cont.)

- How are test results affected by the statistical methods applied, particularly with respect to use of the EPA Test of Significant Toxicity (TST)? (not today)
- What management initiatives have the potential to reduce toxicity associated with contaminants in surface waters? (not today)

Caveats

- Targeted sampling in downstream areas of watersheds (i.e., non-probabilistic sampling), data characterize sampled sites only and can't be extrapolated to unmonitored sites
- Results of standard laboratory toxicity tests can't be extrapolated to human health
- Grab samples may underestimate chronic ambient toxicity
- Acute toxicity tests may also underestimate chronic toxicity (e.g., 10d vs 28d sediment toxicity tests)
- Response of laboratory toxicity test organisms to contaminants might not be the same as resident organisms (except *Hyalella*)

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Methods Overview

- Time Period for Data Inclusion: *8/7/2001 - 3/31/2010*

  1047 sites, 3227 water samples, 1302 sediment samples; total tests = 8,542
- Data Sources: SWAMP (CEDEN) and partner programs – 9 Regions with different programs
- Thanks to the MPSL data team, Mark Pranger, Dave Paradies, Jeff Kapellas
- Toxicity Determinations
  - Water –freshwater tests *(P. promelas, C. dubia, S. capricornutum*) and some salt water tests
  - Sediment – freshwater tests primarily (H. azteca 10d) and marine tests

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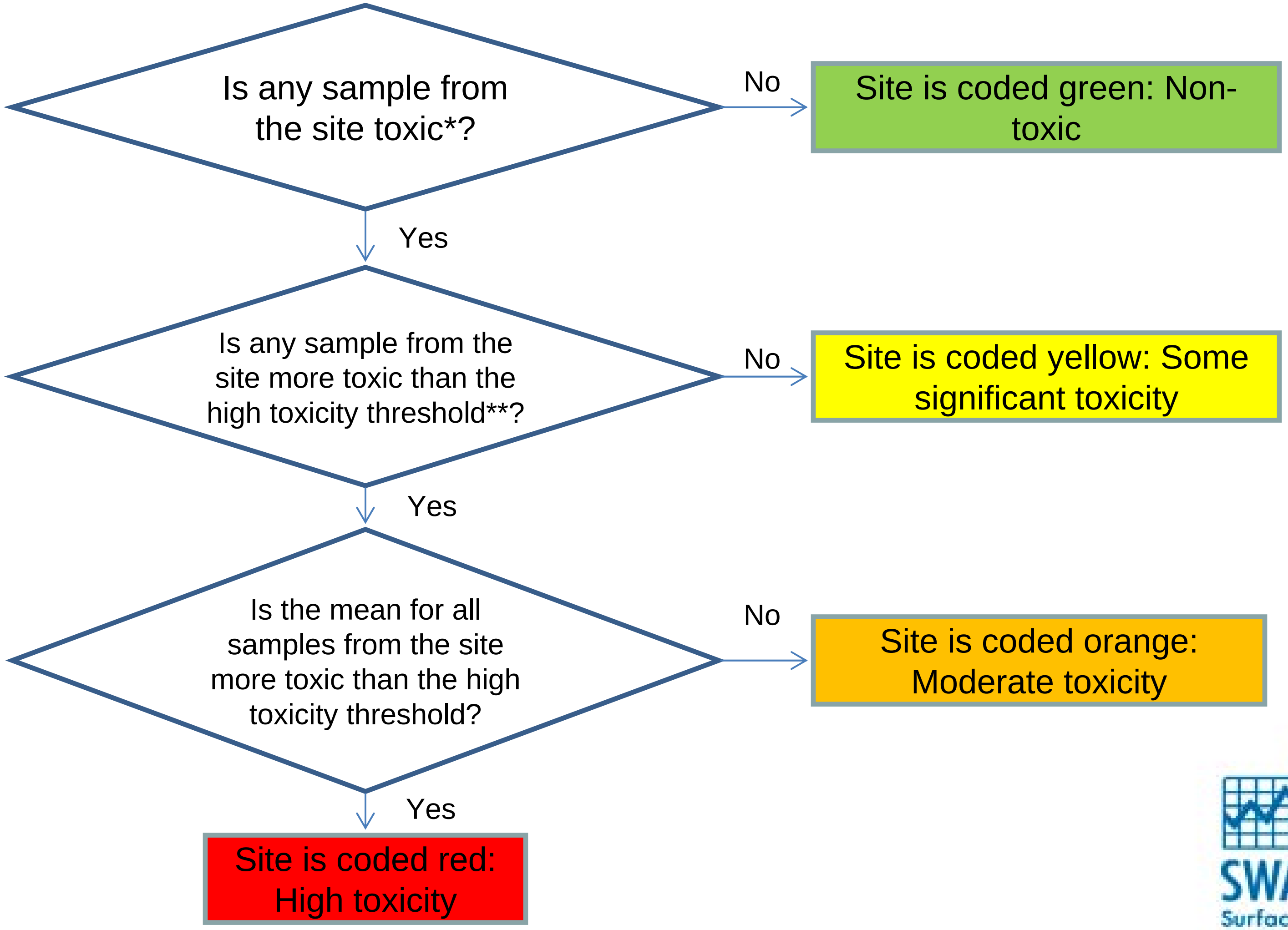
Site Characterization



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Key Findings – Assessment Qs 1 &2

- Where has toxicity been observed in California waters?

- What is the magnitude of observed toxicity?

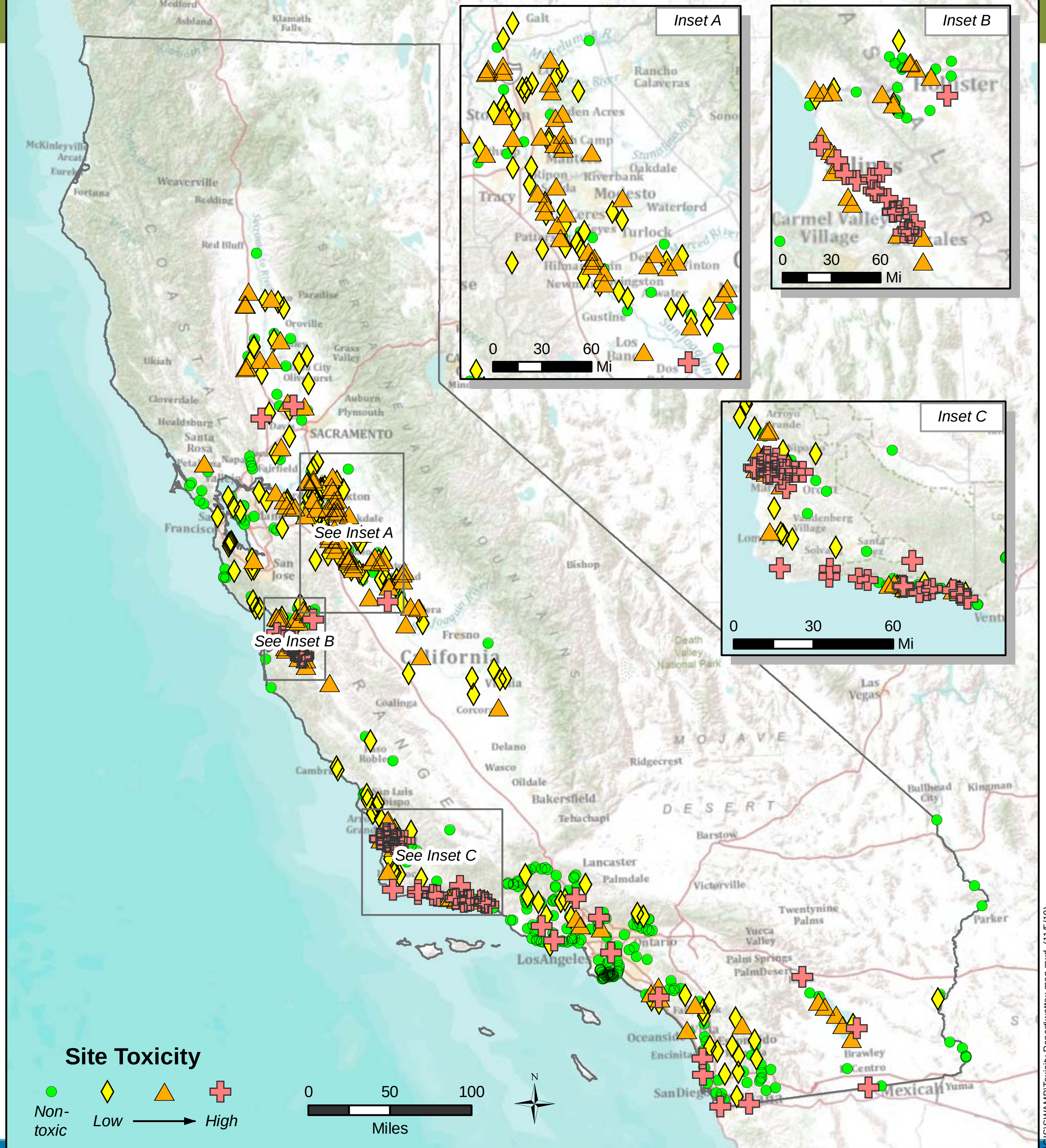

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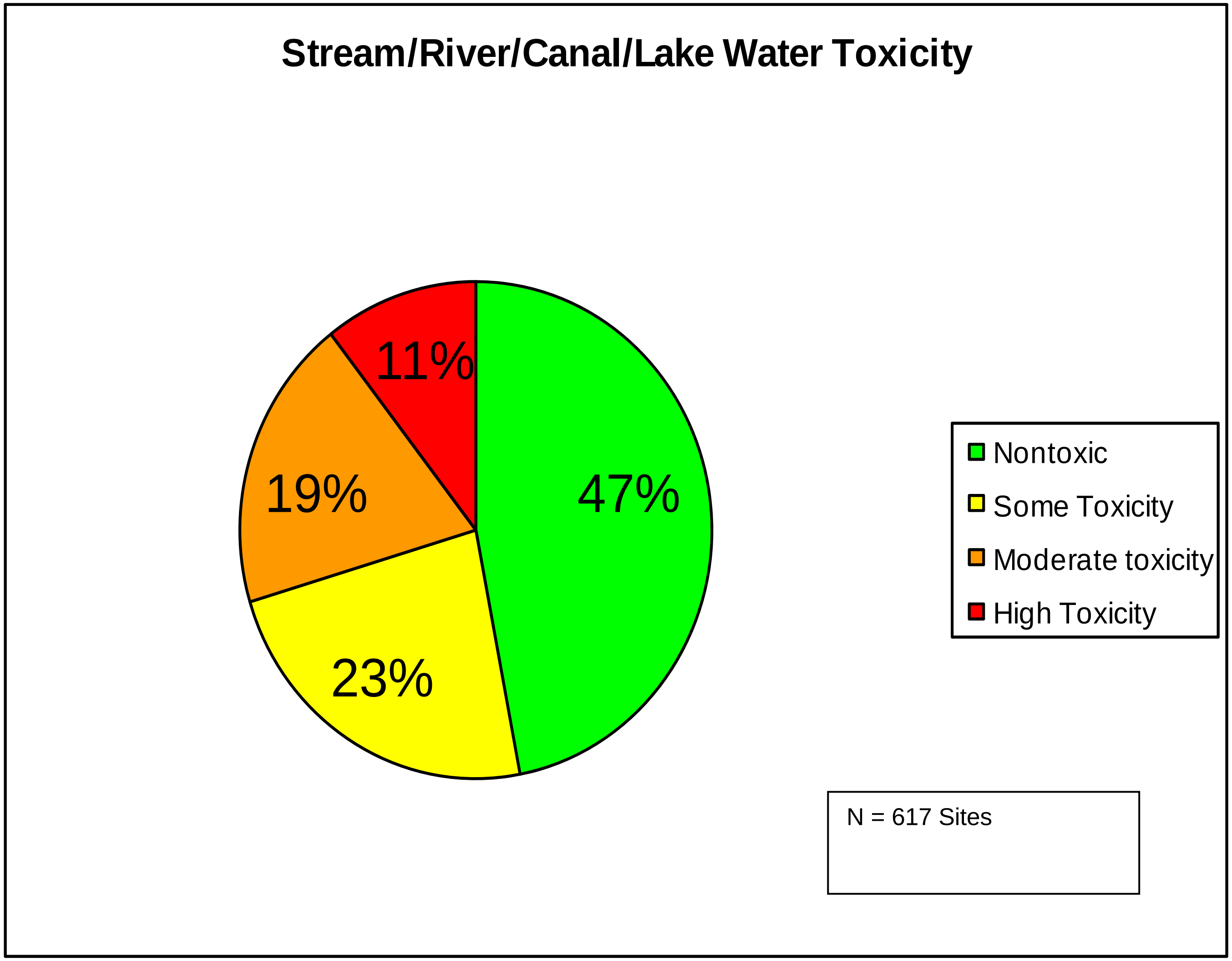
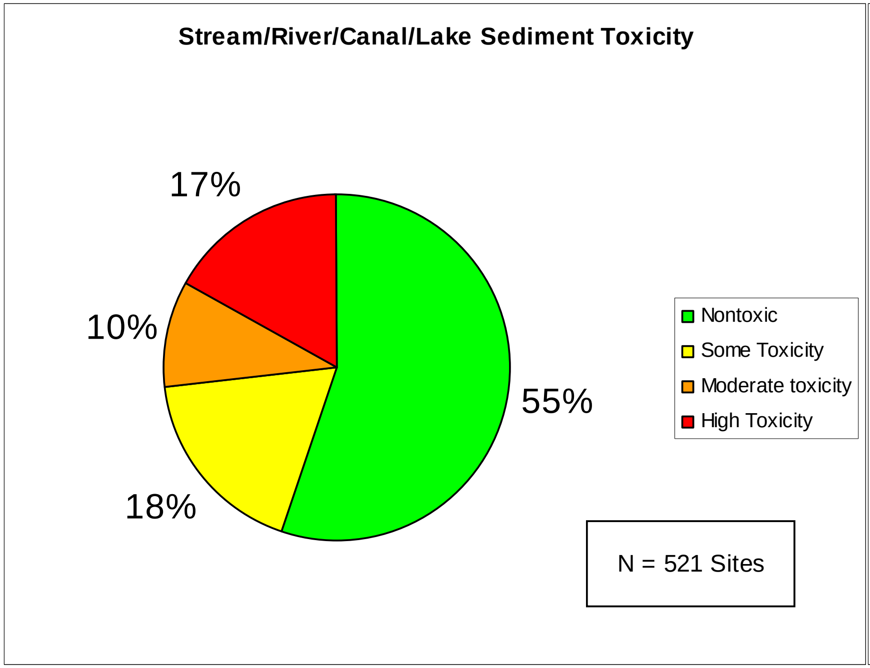
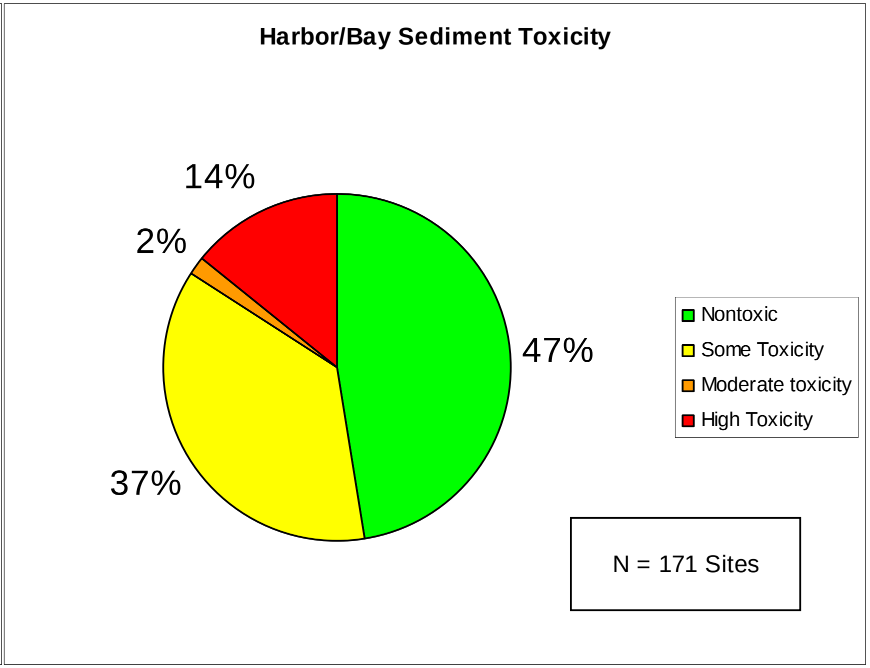
Figure 2. Magnitude of water column toxicity at all California sites assessed, based on the most

Percentage of Sites Demonstrating Water Toxicity



Percentage of Sites Demonstrating Sediment Toxicity





Freshwater sediment toxicity likely under-estimated: 10d test @ 23 °C

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Assessment Q3 - *How do the results of toxicity measurements compare among waters draining urban, agricultural, and other land cover areas?*

- Greater water and sediment toxicity was observed in agricultural and urban sites relative to undeveloped sites
- Greater water toxicity was observed in agricultural sites relative to urban sites
- There was no significant difference in sediment toxicity (as survival) between urban and agricultural sites.

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Assessment Q4 - What chemicals have been implicated as causing water toxicity?

- Using the SWAMP statewide database, there is a highly significant negative correlation between mixtures of pyrethroid pesticides, diazinon and chlorpyrifos in water and *C. dubia* survival (n = 465).
- TIEs have also shown the majority of water toxicity to *C. dubia* is due to diazinon and chlorpyrifos.
- There is also growing evidence that pyrethroids occur at concentrations toxic to *H. azteca* in water samples. This has implications for future monitoring.
- There is some TIE evidence of herbicides causing toxicity to algae (*S. capricornutum)*, and ammonia causing toxicity to fish larvae (*P. promelas*).
- There is also some TIE evidence of metals (copper and zinc) causing toxicity to fish and invertebrate larvae in stormwater entering marine waters.

Assessment Q4 (cont.) - What chemicals have been implicated as causing sediment toxicity?

- Using the SWAMP statewide database, there is a highly significant negative correlation between mixtures of pyrethroid pesticides and chlorpyrifos in sediment and *H. azteca* survival (n = 185).

- There is less statewide sediment TIE data but the data that are available demonstrate that sediment toxicity to amphipods is due to pyrethroid pesticides and chlorpyrifos.

- There is growing evidence of pyrethroid-associated toxicity to amphipods in harbors and estuaries.

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Assessment Q5 - *What are the ecological implications of aquatic toxicity?*

- The primary line of evidence used to link ambient water and sediment toxicity with ecological effects is macroinvertebrate bioassessments.
- Use of "Triad" studies that include toxicity tests, chemical analysis and bioassessments (with bioaccumulation) has been recommended by several national workshops as the primary ecological risk assessment approach.
- "Triad" studies in the Salinas River showed that stations with the greatest water and sediment toxicity also demonstrated degraded insect communities. Loss of mayflies and amphipods was linked to OPs and pyrethroids.
- Similar studies in the Santa Maria River have linked water and sediment toxicity with lower densities of insects, and reduced densities of *Hyalella*.

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Assessment Q5 (cont.) - *What are the ecological implications of aquatic toxicity?*

- Studies in the Central Valley have shown declines in amphipods(*Hyalella*) densities at sites where laboratory toxicity tests have been linked with pyrethroids

- Recent studies have shown similar linkages in several coastal estuaries and bays (San Diego Harbor, Newport Bay, Ballona Creek, the Santa Maria River estuary).

- We often lack information on sensitivity of resident species to specific contaminants of concern

- Other studies have suggested that habitat degradation plays a complicating role in macroinvertebrate community impacts

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Conclusions/Recommendations

- Toxicity in California surface waters is widespread and evidence suggests it's largely due to pesticides (based on non-probabilistic sampling)

- Increasing evidence of pyrethroid toxicity in water suggests need for more water testing with *Hyalella azteca.*

- Data from SWAMP regional and SPoT testing programs should be useful in detecting changes in toxicity patterns over larger spatial and temporal scales, there is a need for consistency

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Conclusions/Recommendations (cont.)

- Better linkage with "other" monitoring programs is needed (e.g., stormwater and other NPDES monitoring, ag waiver, DPR, NAWQA)
- Dedicated resources needed for inclusion of known and documented replicate-level toxicity data in centralized database(s)
- More TIEs with fish and algae would help explain toxicity to these indicators
- Linkage with bioassessment program(s) would help strengthen the in situ ecological context of toxicity and chemical monitoring data.

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SPoT Status Summary

- Sediment toxicity was observed at 23-35% of the statewide sites (at 23°C) over a three-year period.
  - 2008: 23% toxic (22 of 95 sites): All data complete and in SWAMP database, **Report almost complete!**
  - 2009: 35% toxic (8 of 23 sites): All data complete
  - and in SWAMP database
  - 2010: 28% toxic (27 of 95 sites): Chemistry incomplete
  - 2011: Sampling and testing has begun

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SPoT Summary (cont.)

- In 2008 and 2010, when the full set of sites were tested at 23°, toxicity occurred in all nine regions.
- In 2010, a subset of 24 sites were tested at 15 and 23 °C .

	15 degrees	23 degrees
Non-Toxic:	33%	67%
Significantly Toxic:	67%	33%
Highly Toxic:	42%	4%

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