Framework for Using Surface Water Monitoring Data Quantitatively in Pesticide Drinking Water Exposure Assessments

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Environmental Fate & Effects Division
Measure of Exposure: Goal

To derive reasonable upper bound pesticide concentrations

**Monitoring Data**
- Direct measure
- **Actual** pesticide use for specific site
- Often limited in time, and may be representative of many sites
- Tends to underestimate frequency of occurrence and peak exposure

**Modeling Data**
- Direct estimate
- **Maximum** or **typical** pesticide use
- Simulations over long time, based on a few standard vulnerable sites
- Daily concentrations and inputs can be adjusted to be more or less conservative
Current Tiered Process for Assessing Drinking Water Exposure – surface water

- Tiered approach is used to prioritize resources
  - Low tiers are easy to use, simple input and output
  - High tiers require more input, more complex and detailed output
- Upper bound estimate of exposure
  - If level of concern is not exceeded using screening exposure estimate, high confidence of low risk
  - If level of concern is exceeded, there could be risk, or it may be the result of overestimating exposure – refinements considered
Typical Characteristics of Tiered Process for Assessing Drinking Water Exposure – surface water

Tier 1
- Conservative screen
- National level analysis
- Chemical specific properties, label information
- Summary of monitoring data (descriptive statistics)

Tier 2
- Refined screen
- Regional or state level analysis
- Default chemical specific properties assumptions, label information, crop specific, agronomic practices, environmental conditions
- Summary of monitoring data (descriptive statistics)

Tier 3
- Refined
- Regional or state level analysis
- Sensitivity of chemical specific properties, typical use information, and alternative agronomic practices
- Summary of monitoring data including temporal and spatial components; descriptive statistics on a site specific (or local program) basis

Tier 4
- Highly refined
- Watershed level analysis
- SAM or other site specific approach
- Summary of monitoring data including temporal and spatial components; descriptive statistics on a site specific (or local program) basis
In the Current Drinking Water Exposure Assessment Process...

- Early tiers use conservative model inputs and scenarios
  - Less resource intensive
  - Confidence that if you’re below the level of concern, nation’s drinking water is safe

- But, when modeling results don’t pass, it’s very resource intensive to refine
  - More spatially and temporally defined inputs and outputs

- Monitoring data are rarely used quantitatively in drinking water exposure

**DESIRED STATE:** to begin to use surface water monitoring data quantitatively
Challenges with the Evaluation and Interpretation of Surface Water Monitoring Data

• Sources
  • Data sources include federal, state, academic, and other sources
  • Quality assurance/control in data reporting
  • Duplication

• Representation
  • Monitoring data reflect current but generally unknown use practices (e.g., rates) and under specific conditions (may not be predictive of concentrations in other areas)
    • Temporal and Spatial Considerations
      • Site vulnerability (soil/hydrologic vulnerabilities)
      • Program design
        • Infrequent sampling
      • Cropping patterns
      • Pesticide usage
      • Rainfall patterns
  • Often low or non-detectable levels
Sampling Frequency Implications

![Graph showing chlorine levels over time with daily and 7-day sampling points.](image)

- **Y-axis:** Chlorpyrifos (µg/L)
- **X-axis:** Date
- **Key:** Daily Sampling (solid line), 7-day Sampling (dots)

U.S. Environmental Protection Agency
# Sampling Frequency Implications

<table>
<thead>
<tr>
<th>Averaging Period</th>
<th>Concentration (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daily</td>
</tr>
<tr>
<td>1-day</td>
<td>0.916</td>
</tr>
<tr>
<td>4-day</td>
<td>0.640</td>
</tr>
<tr>
<td>21-day</td>
<td>0.265</td>
</tr>
<tr>
<td>60-day</td>
<td>0.155</td>
</tr>
<tr>
<td>90-day</td>
<td>0.105</td>
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</tbody>
</table>

- **Daily Sampling**: 0.916
- **14-day Sampling**: 0.184

- **~5x underestimation**
- **~4x underestimation**
SEAWAVE-QEX Model

• Regression model developed by USGS
  • Relates measured pesticide concentrations with daily streamflow (or other covariate) using a seasonal wave model to produce multiple, equally-probable simulations of daily concentration data
  • Developed to estimate “extreme” concentrations using stream flow (i.e., developed for flowing systems)

• Minimum requirements of the model
  • ≥ 12 samples/year with 3 years of data
  • ≤ 75% censoring rate

Sampling Bias Factors (SBF)

- SBF are derived from bootstrap sampling of daily monitoring data.

- SBF can be applied to summary statistics from less than daily monitoring data to ensure that at least 95 percent of the time, the SBF-adjusted monitoring concentration (i.e., measured concentration x SBF) is equal to or higher than the true concentration.

- Unitless value

- SBF addresses temporal sampling uncertainty
Consideration of Watershed Characterization on SBF

• Explore relationship of 40 watershed and catchment properties with the estimated SBFs

• Develop regression equations to adjust the SBF that will be used for application of the SBF to watersheds with minimal chemical monitoring data. This will permit extrapolation of summary statistics for monitoring data across sites.
Project Summary

**Develop a framework and overall process for using surface water monitoring data quantitatively in pesticide drinking water exposure assessments**

- Evaluate potential tools to account for temporal and spatial limitations in currently available surface water monitoring data to increase the utility of monitoring data in EPA drinking water assessments
  - SEAWAVE-QEX (seasonal wave with streamflow adjustment with extended capability)
  - sampling bias factors (SBFs)
  - regression using watershed characteristics to extrapolate data/SBF to non-monitored or less frequently monitored watersheds

- Create a comprehensive analysis plan that describes the tiered process of drinking water exposure assessment, culminating in the quantitative use of monitoring data
  - methods
  - inputs and outputs for each tier
  - strengths and weaknesses

Collaborating with the United States Geological Survey and the Washington State Department of Agriculture
Example SEAWAVE-QEX Evaluation Approach

**Measured Data**
- Concentration (ug/L) vs Date in 2005

**Concealed data to represent hypothetical 7-day stratified sampling strategy**

**Abbreviated Data**
- Concentration (ug/L) vs Date in 2005

**Input abbreviated data into SEAWAVE-QEX**

**1 of 50 SEAWAVE-QEX Chemographs**
- Concentration (ug/L) vs Date in 2005
Example SEAWAVE-QEX Evaluation Approach

Measured Data (µg/L)

<table>
<thead>
<tr>
<th>Date range</th>
<th>No. of observations</th>
<th>75th percentile</th>
<th>90th percentile</th>
<th>95th percentile</th>
<th>99th percentile</th>
<th>Maximum</th>
<th>%obs &gt; 10 µg/L</th>
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<tbody>
<tr>
<td>Annual</td>
<td>90</td>
<td>2.2</td>
<td>9.1</td>
<td>12.7</td>
<td>20.7</td>
<td>20.7</td>
<td>8.9</td>
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<tr>
<td>April-Aug</td>
<td>76</td>
<td>2.8</td>
<td>11.0</td>
<td>13.4</td>
<td>20.7</td>
<td>20.7</td>
<td>10.5</td>
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SEAWAVE-QEX 1 of 50 Chemograph (µg/L)

<table>
<thead>
<tr>
<th>Date range</th>
<th>No. of observations</th>
<th>75th percentile</th>
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<th>95th percentile</th>
<th>99th percentile</th>
<th>Maximum</th>
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<tr>
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<td>1.9</td>
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<td>2.2% (2obs)</td>
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<tr>
<td>April-Aug</td>
<td>153</td>
<td>2.0</td>
<td>5.5</td>
<td>7.1</td>
<td>14.8</td>
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<td>2.6% (2obs)</td>
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### Example SBF Evaluation Approach

#### Measured Data (µg/L)

<table>
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<tr>
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<th>1-day</th>
<th>4-day</th>
<th>21-day</th>
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<th>90-day</th>
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<td>3.4</td>
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<td>2.5</td>
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<tr>
<td>95th</td>
<td>10.8</td>
<td>6.7</td>
<td>3.6</td>
<td>2.8</td>
<td>2.6</td>
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#### SEAWAVE-QEX 1 of 50 Chemograph (µg/L)

<table>
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<tr>
<th>Percentile</th>
<th>1-day</th>
<th>4-day</th>
<th>21-day</th>
<th>60-day</th>
<th>90-day</th>
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<tbody>
<tr>
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<td>7.5</td>
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<td>2.9</td>
<td>2.3</td>
<td>2.2</td>
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<tr>
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<td>9.1</td>
<td>6.0</td>
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<table>
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<th>4-day</th>
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<tbody>
<tr>
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<td>39.8</td>
<td>25.2</td>
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<tr>
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<td>30.6</td>
<td>12.8</td>
<td>8.3</td>
<td>7.0</td>
<td></td>
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Method Evaluation

SEAWAVE-QEX is a suitable method of imputing monitoring data for monitoring programs with less than daily sampling frequencies.

SBF may be a useful approach for determining confidence bounds on water monitoring data when data are not suitable for SEAWAVE-QEX analysis.

preliminary results
**Next Steps**

- **Drinking Water Assessment Case Study** – taking a chemical from Tier 1 through Tier 4 to demonstrate proof of concept

- **Continue work on evaluating tools** – SEAWAVE-QEX and SBF

- **Develop framework for tiered process for evaluating pesticide concentrations in drinking water, including quantitative use of surface water monitoring data**

- **Environmental Modeling Public Meeting (May 23, 2018; Arlington, VA) and the American Chemical Society National Fall Meeting (August 21-23, 2018; Boston, MA)**

- **Scientific Advisory Panel - TBD**