Regression models for explaining and predicting concentrations of organochlorine pesticides in whole fish from United States streams

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Today’s talk

• Organochlorine pesticides and the NAWQA program

• Regression models

• Model applications: dieldrin as example
OC pesticides in NAWQA

- Organochlorine (OC) pesticides
  - Most uses cancelled during 1972-1988

- NAWQA sampling for OC pesticides
  - Targeted studies in relation to land use
  - Whole fish and bed sediment
Occurrence in whole fish

**Agricultural**
- $p,p'$-DDE
- $p,p'$-DDD
- $p,p'$-DDT
- $o,o'$-DDE
- $o,o'$-DDD
- $o,o'$-DDT

**Urban**
- cis-Chlordane
- trans-Chlordane
- cis-Nonachlor
- trans-Nonachlor
- Oxychlordane
- Dieldrin
- Heptachlor epoxide
- Pentachloroanisole
- Hexachlorobenzene

**Undeveloped**

Percentage of samples with detections
Declining DDT in whole fish

Concentration (µg/kg)


Median DDT

Wildlife Benchmark
Potential effects on wildlife

One or more benchmarks exceeded
No benchmarks exceeded
Summary
• OCs in whole fish have declined nationally
• Low levels are still prevalent in streams
• Potential for adverse effects

Implications
• Need for national assessment
• Predictive models may be an alternative to widespread direct monitoring
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Objectives
• Extend targeted NAWQA studies into a comprehensive national assessment
  – Explain the distribution of OCs in whole fish
  – Predict OC concentrations in whole fish in unmonitored streams

Approach
• Develop statistical regression models
  – p,p’-DDX, p,p’-DDE, p,p’-DDT
  – cis-chlordane, trans-nonachlor
  – dieldrin
Model development data: dieldrin

- 650 streams in 43 Study Units
- Whole fish
- Multiple taxa
Explanatory variables

- Elapsed time since 1966
- Fish lipid content
- Fish taxon
- Source variables **
- Watershed variables **
  - Physical
  - Hydrologic
  - Soil
  - Climate
  - Agricultural management practices
- Regional variables **

** Nationwide data sources
Past agricultural use intensity: aldrin + dieldrin

EXPLANATION
Pounds of active ingredient per square mile

- none
- 0.001 – 0.337
- 0.338 – 0.951
- 0.952 – 2.705
- 2.706 – 6.261
- ≥ 6.262
<table>
<thead>
<tr>
<th>Pesticide compound</th>
<th>Variability explained</th>
<th>Most important variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>p,p'-DDX</td>
<td>47%</td>
<td>Lipid, agricultural use, population density</td>
</tr>
<tr>
<td>p,p'-DDE</td>
<td>51%</td>
<td>Lipid, termite-urban, population density</td>
</tr>
<tr>
<td>p,p'-DDT</td>
<td>41%</td>
<td>Lipid, agricultural use, forested land</td>
</tr>
<tr>
<td>cis-Chlordane</td>
<td>64%</td>
<td>Lipid, termite-urban, population density</td>
</tr>
<tr>
<td>trans-Nonachlor</td>
<td>64%</td>
<td>Lipid, population density</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>64%</td>
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</tr>
</tbody>
</table>
Effect of lipid content on predictions

6.2% lipid

4.2% lipid
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Dieldrin in whole fish at 6.2% lipid: probability of exceeding 120 µg/kg
Dieldrin in whole fish at 4.2% lipid: probability of exceeding 25 µg/kg
Conclusions

• Most models explain 50-65% of variability

• Explanatory variables include lipid, past agricultural use, urban use surrogates

• Limitations of the models

• Predictive regression models may be a useful tool in planning future monitoring
For more information:

- NAWQA pesticide national synthesis project:  
  http://ca.water.usgs.gov/pnsp/

- Dieldrin fish model:  

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