Prioritizing Contaminants of Emerging Concern for Aquatic Ecological Applications
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ET&C FOCUS

In honor of ET&C's anniversary, we are pleased to present the third in a regular series of succinct and timely articles to sharpen our understanding of current and emerging topics of interest to the scientific community at large.

Prioritizing Contaminants of Emerging Concern for Ecological Screening Assessments


WERF Project CEC5R08

Development of Diagnostic Tools for Trace Organic Compounds and Multiple Stressors
Research Objectives

- Develop and apply a procedure to prioritize CECs
- Develop and test diagnostic tools to identify whether CECs are a cause of biological impairment
- Develop a relational database of CEC exposure data
- Develop a Collaboration Plan for fostering partnerships among stakeholders in Phase 2
Which CECs should I monitor?
CEC Prioritization Issues

- Often based on production data, chemical use, fate, and predicted toxicity (e.g., HPV chemical prioritizations)
- Thousands of chemicals could be considered.
- Many uncertainties as to whether certain predicted CECs of high importance actually occur (could occur) in surface waters
- Toxicity of many CECs unknown
- Local water agencies need a way to tailor the process for their sites, their constituencies, their particular sources
Regulated Entities Need to Know:

- Which chemicals should they monitor
  - Which CECs present the most risk to biota

- How to interpret the chemical results
  - What levels could potentially pose a risk

- How to screen their site to determine the need for further evaluation
The approach we took:

Start with the CECs that have been monitored and that people are finding in surface waters
What are people monitoring?
CEC Prioritization Approach

Compiled:
- CEC occurrence data
- CEC fate information (ECOSAR, PBT Profiler)
- Predicted toxicity and endocrine activity thresholds (ECOSAR, PBT Profiler, EU, FDA)
Occurrence Data

- Over 100 studies examined; 70 studies used
- Information from > 700 sites
- Over 500 CECs, including 48 high risk, high production volume CECs with no occurrence information (Howard and Muir 2010)
- Over 30 monitoring organizations represented
- Information included as supplemental information
Prioritized CECs Based on:

1) Maximum observed concentration vs. conservative effect thresholds (Hazard-based)
2) Hazard-based + persistence and bioaccumulation scores (Hazard + PB)
3) Persistence, Bioaccumulation, Toxicity (PBT)
Screening Calculation of Hazard

Hazard Value (HV) – based on “traditional” toxicological endpoints.

Value ≥ 0.10 used to identify higher risk CECs

\[
\text{Hazard Value} = \frac{\text{Max Occurrence Concentration}}{\text{Lowest Chronic Toxicity Threshold}}
\]
Also Calculated Endocrine Activity-Based Hazard

Endocrine activity for each CEC normalized to EE2 using predicted no effect and probable effect concentration

Calculated both a No Effect Endocrine Risk Value and a Probable Effect Endocrine Risk Value for each CEC
\[\text{No Effect EARV} = \frac{\text{Max Occurrence Concentration}}{\text{Normalized PNEC}}\]

- No Effect \(< 1.0 = \text{likely no effect}\)

\[\text{Probable Effect EARV} = \frac{\text{Max Occurrence Concentration}}{\text{Normalized PEC}}\]

- Probable Effect \(\geq 1.0 = \text{likely effect}\)
Hazard-based Approach

Relatively few pharmaceuticals ranked as high priority as compared to the number monitored

– Exceptions are synthetic steroids and hormones
Hazard-based Approach

- Most sensitive endpoint was predicted chronic toxicity rather than estrogenic activity for most high priority CECs
  - **Exceptions are the few hormones**
Hazard-based Approach

- Shortest CEC list of all 3 approaches (41)
- Most pharmaceuticals monitored may not present a hazard to aquatic life.
- **HOWEVER**, many unknowns in terms of estrogenic and other endocrine activity effects of many of these chemicals
Uncertainties using Occurrence Data

Occurrence data should be treated with some caution because:

- Many questions regarding analytical methods, quantification of CECs
- Not a complete compilation of all data collected in the U.S.
Hazard + PB Approach

- Hormones, steroids, pharmaceuticals, and surfactants still important

- Half of the CECs are persistent or bioaccumulative chemicals: pesticides and fragrances.
PBT Approach

- Most are pesticides, PAHs, and industrial chemicals

- This is the longest list of high priority CECs (108).
Some Common CECs May Be Low Risk

- Caffeine is almost always measured but was low hazard using all 3 approaches.

- But some CECs that are low hazard may be useful surrogates for co-occurring high hazard CECs that are more difficult to measure.

- Not enough information to determine which CECs tend to co-occur in surface waters and probably is site-specific (depending on sources present).
CEC Lists Should Serve as a Tool!

- Lists of high priority CECs should **not** be taken as monitoring requirements or chemicals for regulation.
- High priority CECs might vary with site factors, treatment available, etc.
- Prioritization approaches should help utilities and others organize and manage screening of CECs.
- A chemical by chemical approach may be okay for prioritizing CECs, but need to consider the cumulative risk of CECs at a site.
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Visit WERF’s Trace Organic Web Site:

www.werf.org/traceorganics

Final report is under project CEC5R08 at:

www.werf.org/diagnostictools

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