Methods for Incorporating Aquatic Plant Effects into Community Level Benchmarks

EPA Development Team

Regional Stakeholder Meetings
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Outline

- Purpose and Scope
- Existing data requirements and approaches for estimating aquatic plant effects
- Key research questions/issues
- Evaluation of approaches

Purpose and Scope

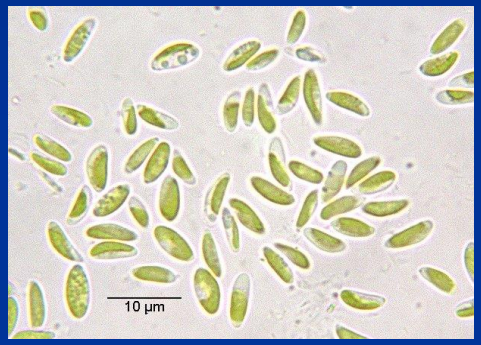
- Consider existing approaches used by OW and OPP for characterizing plant aquatic ecological effects
- Describe the best integrated use of existing tools for incorporating plant effects into aquatic community-level benchmarks.
- Characterize the uncertainty and robustness of current data for aquatic plants

OPP's Approach to Evaluate Aquatic Plant Effects

- Tier I (Limit test)
  - Needed for all pesticides with outdoor uses
  - 4 microalgae + *Lemna:* laboratory tests with Technical Grade Active Ingredient (TGAI)
  - If >50% effect, Tier II testing required
- Tier II (Dose-response test)
  - Pesticides that are known phytotoxins also tested at Tier II
  - 4 microalgae + *Lemna:* laboratory tests with TGAI
  - If >50% effect, Tier III testing may be required
- Tier III (Field test)
  - 4 vascular plant families, 3 seedless vascular plant families, 10+ families of algae, 1 bryophyte family tested with typical end-use product to determine detrimental effects at critical growth stages
  - Rarely required by the Agency

Typical Aquatic Plant Surrogates Used in US Regulatory Testing

Non-vascular plants



Pseudokirchneriella subcapitata

Anabaena flos-aquae

Navicula pelliculosa

Skeletonema costatum

Lemna gibba,
a free-floating vascular macrophyte

OW's Approach to Evaluate Aquatic Plant Effects

- Minimal plant data are required for the derivation of Water Quality Criteria (typically not used since less sensitive)
- "Results of tests with plants usually indicate that criteria which adequately protect aquatic animals and their uses will probably also protect aquatic plants and their uses."
  - May not be supported when addressing certain chemical classes (e.g., herbicides)
- Plant value based on a 96-hr test conducted with an alga or a chronic test conducted with an aquatic vascular plant
- Final Plant Value: lowest value from a test with an "important" plant species where test concentrations are measured, and endpoint is biologically "important".

Approaches Used Internationally

- Canada
  - At least one vascular plant or alga to derive guidelines (if the compound is highly phytotoxic, 4 species are required)
  - Safety factors
    - 10 applied for LOEC
    - 100 for acute data on persistent chemicals
    - 20 for acute data on non-persistent chemicals
- European Union
  - Requires a green algae test (for herbicides, tests on an alga and a vascular plant)
  - Safety factor of 10 to the lowest plant test value

State Approach (MN)

- Protect overall integrity of plant community from significant impacts; protect the most sensitive species
- For 2 herbicides: target 20th percentile level of protection
- Acute criterion derived using Great Lakes Initiative Tier II methodology with standard animal data
- Chronic criterion derived using distribution of plant data only
- Both EC_{50} values and/or maximum acceptable toxic concentration (MATCs) were collected and put in separate distributions; distributions with most robust data set were used to derive criteria
  - 5th percentile of EC_{50} distribution
  - 20th percentile of MATC distribution

Key Issues

- Minimum/type of data requirements to document aquatic plant sensitivity
  - aquatic plant grouping into subsets to draw better surrogates
  - representativeness of current microalgal species for non-vascular plants
  - representativeness of *Lemna* for aquatic macrophytes
- Endpoint selection
  - The appropriateness of the current plant measurement end points (ECx versus NOAEC)
  - Specific measurement endpoint-related questions
- Miscellaneous

Key Issues

1. **Types/Minimum Data to Document Sensitivity**

- Do we need to group aquatic plants into new subsets to draw better surrogates
  - Non-vascular vs. vascular (currently used)
  - Habitat
  - Life history patterns
  - Physiology

Key Issues

- Are the sensitivities of current microalgal species representative of non-vascular plant sensitivities?
  - Limited information available for comparison of sensitivities of standard algal species to other non-vascular families such as mosses and liverworts
  - Many tests compared sensitivities of various freshwater microalgal species - great variation (2 to 10 orders of magnitude) between species for same toxicant
  - Sensitivities of freshwater vs. saltwater algae are not well understood

Key Issues

- Is the sensitivity of *Lemna* representative of vascular plants sensitivity?
  - *Lemna*, a free floater, may not be a suitable surrogate to represent the diversity of types of aquatic vascular plants (emergent, submerged, rooted floating, and free floating)
  - Many vascular plants are rooted in the sediment, which could provide another route of exposure

Key Issues

2. Endpoint Selection

- Appropriateness of ECx vs. point estimates such as NOEC/MATC
- Are plant endpoints acute or chronic?
- Use of plant and animal data in the same SSD
- Use of non-traditional endpoints
- Inclusion of reproduction-based endpoints
- Can endpoints from different test methods, test durations, and light intensities be combined? If so how?

Key Issues

3. Miscellaneous

- How should plant recovery be incorporated?
  - Exponential growth over short periods vs. aquatic animal life cycle and reproductive strategies
    - Current frequency and duration for acute and chronic effects to aquatic animals is once in 3 years – appropriate for plants?
- How to address community level impacts
  - Community shifts?
  - Other measures?

Strategy for Addressing Key Issues

- Toxicity data of at least 2 herbicides with "large" data sets will be utilized
- What approaches to take when only OPP data are available?
- What approaches to take when more data are available?
- Application of safety factors? (as used by Canada, EU/Denmark etc.) – are there other factors that are more scientifically defensible?

Summary

- Aquatic plant testing needs are becoming more apparent.
- Key issues
  - Representativeness of current tested species
  - Determining minimum data set
  - Potential use of safety factors
  - Use of non-traditional or reproductive endpoints
- Issues discussed in white paper will need to be readdressed in the future.