

# Relative Sensitivity of Macrophyte & Algal Species to Herbicides & Fungicides using Species Sensitivity Distributions

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*Myriophyllum spicatum*  
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# Outline

- Project background & objectives
- Database compilation & SSD approach
- Results & conclusion
- Uncertainties & limitations



*Egeria densa*  
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*Lemna gibba*  
(Dana Moore, U. Manitoba)



*Myriophyllum spicatum*  
(Chris Banman, Bayer CropScience)

# Project background & objectives

## SETAC AMRAP Workshop (2008)

Uncertainty was expressed over use of macrophyte endpoints in SSD analysis:

- the relative sensitivity of regulatory test species (*Lemna* and algae) to other macrophyte species
- the selection of macrophyte endpoints for inclusion in SSD analysis

## Workgroup Objectives

- To compile & analyse a database of macrophyte & algae endpoints to address these uncertainties
- To provide recommendations for the use of macrophyte data in SSD analyses

# SSD Database Compilation

- macrophyte and algal endpoints ( $EC_{50}$ ) were collated for 60 compounds (herbicides & fungicides) from published papers & unpublished reports
- as far as possible, datasets included the standard regulatory test species (*Lemna* species & 4 algal species) as well as *Myriophyllum*
- each study and endpoint was evaluated according to quality criteria
- minimum number of macrophyte species considered necessary for SSD analysis was 6
- suitable macrophyte data were available for 13 out of 60 compounds
- compounds represent 6 modes of action

# SSD Methods (1)

## Selection of the toxicity endpoint (EC<sub>50</sub> value) for each species

- Dataset contains multiple endpoints based on a wide range of measurement parameters for each species, eg growth rate, shoot fresh weight as well as non-standard biochemical & physiological parameters
- earlier analyses suggest that choice of endpoint can significantly alter analyses but has less influence on the position of *Lemna* species in SSD
- insufficient data to allow selection of consistent endpoints across all species
- lowest endpoints used in this analysis

**but**

➤ *lowest EC50 is not suggested as a regulatory endpoint*

# SSD Methods (2)

## Combination of algal & macrophyte endpoints

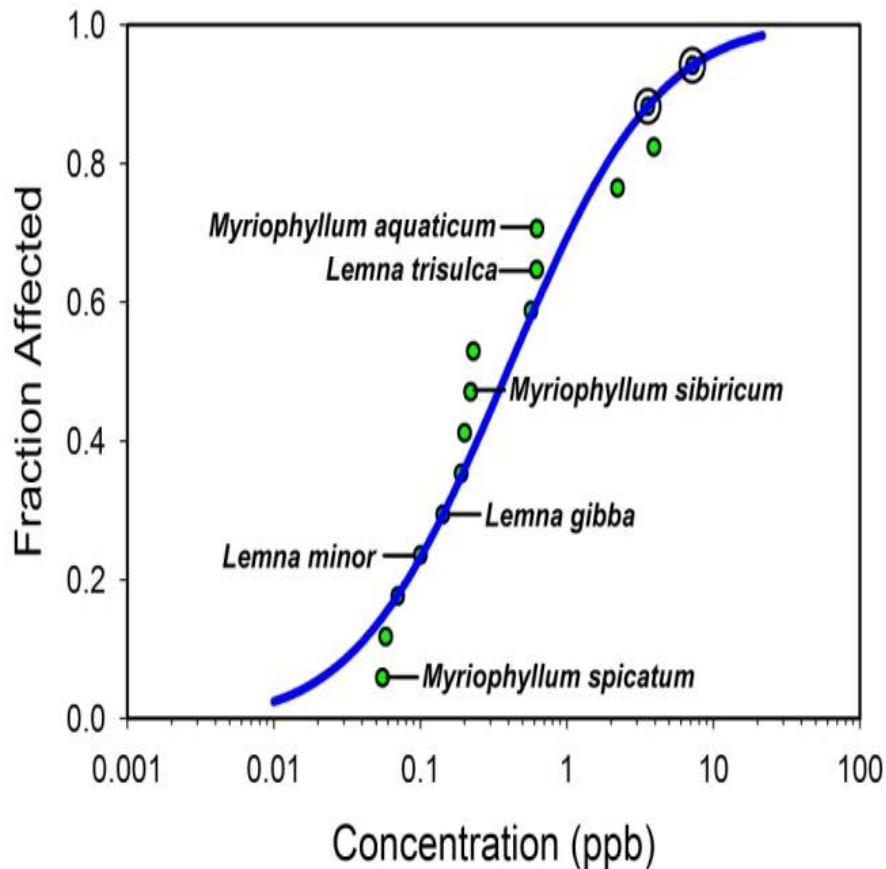
- due to volume of published algal data, algal data limited to standard regulatory test species only
  - inappropriate to estimate SSDs using partial algal dataset
  - uncertainty over incorporation of both data types in single SSD
- 
- only macrophyte endpoints were used to derive SSDs
  - algal endpoints overlaid on macrophyte SSD in order to estimate position of algal species in macrophyte SSD

# SSD Outputs

## Indicators of the position of species of interest in SSD

- percentile
- percentiles do not take account of spread of SSD (slope of regression curve)
- $HC_5$  (concentration at which 5% of species are affected by 50%)
- ratio of  $EC_{50}$  to macrophyte  $HC_5$  is also used as an indicator of the position of species of interest in the SSD

# SSD Analysis Example: Compound A



- EC<sub>50</sub> values available for 16 macrophyte species
- 2 “greater-than” values were included in the value of  $N$  in the Weibull percentiles BUT excluded from regression analysis
- HC<sub>5</sub> of 0.018 (0.0056-0.060  $\mu\text{g/L}$  confidence limits)
- EC<sub>50</sub> concentrations for *Lemna minor* & *L. gibba* are 4 & 6 –fold higher than HC<sub>5</sub>, respectively



# Results: Position in SSD (Percentile)

Compound	<i>Lemna</i>
A	29.4
B	<b>81.3</b>
C	9.1
D	<b>70.0</b>
E	45.5
F	7.7
G	11.1
H	No data
I	40.0
J	<b>77.8</b>
K	<b>85.7</b>
L	9.1
M	No data

- Lower percentile = greater sensitivity relative to other species in SSD
- Above or below 50<sup>th</sup> percentile
- *Lemna* is in lower half of SSD for 7 out of 11 compounds
- *Lemna* is towards less sensitive end of SSD for 4 compounds (B, D, J & K)

# Results: Position in SSD (Percentile)

Compound	<i>Lemna</i>	Algae
A	29.4	<b>99.8</b>
B	<b>81.3</b>	<b>90.0</b>
C	9.1	5.3
D	<b>70.0</b>	1.0
E	45.5	18.3
F	7.7	5.4
G	11.1	7.3
H	No data	0.52
I	40.0	26.6
J	<b>77.8</b>	47.9
K	<b>85.7</b>	25.4
L	9.1	0.43
M	No data	0.55

- Most sensitive algal species is in lower half of SSD for 11 out of 13 compounds
- For 2 compounds (A & B) algae are relatively less sensitive
- In a standard regulatory dataset, one test species is always in lower half of SSD for 12 out of 13 compounds
- Exception is compound B, where standard test species lie at top end of SSD

# Results: Position in SSD (Percentile)

Compound	<i>Lemna</i>	Algae	<i>Myriophyllum</i>
A	29.4	<b>99.8</b>	5.9
B	<b>81.3</b>	<b>90.0</b>	<b>12.5</b>
C	9.1	5.3	<b>72.7</b>
D	<b>70.0</b>	1.0	30.0
E	45.5	18.3	36.4
F	7.7	5.4	23.1
G	11.1	7.3	No data
H	No data	0.52	<b>66.7</b>
I	40.0	26.6	<b>90.0</b>
J	<b>77.8</b>	47.9	33.3
K	<b>85.7</b>	25.4	No data
L	9.1	0.43	36.4
M	No data	0.55	<b>77.8</b>

- *Myriophyllum* is in lower half of SSD for 7 out of 11 compounds
- but is relatively less sensitive to remaining 4 compounds (C, H, I & M)
- For compound B, *Myriophyllum* is significantly more sensitive than *Lemna* & algae

# SSD Summary & Conclusion

## Summary

For 11 out of 13 compounds:

- one of the standard algal species is most sensitive species in standard regulatory dataset

For remaining 2 compounds:

- *Lemna* is the most sensitive species for compound A
- *Myriophyllum* is the most sensitive species for compound B

## Draft Conclusion

- no single species consistently represents the most sensitive macrophyte species
- but**
- For 12 out of 13 compounds, data for *Lemna* and the 4 standard algae include an endpoint that is near or below the macrophyte HC5
  - For the remaining compound, *Myriophyllum* is most sensitive species

# Uncertainties & Limitations

Relative sensitivity of macrophyte species & their position in SSD is dependent upon many factors

- **Mode of action**

- Dataset represents a limited number of modes of action
- Some modes of action are represented only by a single compound

- **Endpoint selection**

- many endpoints available for a single species
- insufficient data/resource to allow selection or derivation of consistent endpoints across all species

➤ Uncertainties remain over the use of macrophyte endpoints in SSDs that warrant further investigation

Draft report is currently under review within workgroup & will be finalised shortly

Work Group is considering options for further work

# Acknowledgments

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