Sloped mesocosms: a new design to evaluate macrophyte community effects

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Cambridge Environmental Assessments

Introduction

- Increasing complexity of exposure calculation and risk assessment
- Mesocosm studies must increase design complexity to stay relevant
- Here we show progress in this area of mesocosm study design using examples from recent state of the art regulatory tests with herbicides

Experimental design for herbicides

- Does the test system represent a realistic freshwater community?
- Are the investigated endpoints sensitive?

Macrophyte species

Species	Family	Embryonic class	Morphological characteristics
Callitriche stagnalis (Water starwort)	Plantaginaceae	Dicot	Rooted, floating leaved
Elodea canadensis (Canadian pondweed)	Hydrocharitaceae	Monocot	Rooted, submerged
Glyceria maxima (Reed sweet grass)	Poaceae	Monocot	Rooted, emergent
Hippuris vulgaris (Common mare's tail)	Plantaginaceae	Dicot	Rooted, emergent
Myriophyllum spicatum (Eurasian watermilfoil)	Haloragaceae	Dicot	Rooted, submerged
Potamogeton natans (Broad leaved pondweed)	Potamogetonaceae	Monocot	Rooted, floating leaved
Veronica beccabunga (Brooklime)	Scrophulariaceae	Dicot	Rooted, emergent

Meeting functional group requirements

- Planting depths need to accurately reflect macrophyte assemblages in natural edge of field water-bodies
- Previously done through raised baskets/steps
- Creates discrete populations not true communities

Sloped mesocosms

Suggested planting depths

Species	Planting depth (cm)
Veronica beccabunga (Brooklime)	0 - 10
Callitriche stagnalis (Water starwort)	10 - 20
Glyceria maxima (Reed sweet grass)	20 - 30
Hippuris vulgaris (Common mare's tail)	20 - 30
Myriophyllum spicatum (Eurasian watermilfoil)	30 - 40
Potamogeton natans (Broad leaved pondweed)	50
Elodea canadensis (Canadian pondweed)	50

Macrophyte health assessments

- Measurement endpoints selected to provide both qualitative and quantitative data
- Essential for a robust assessment

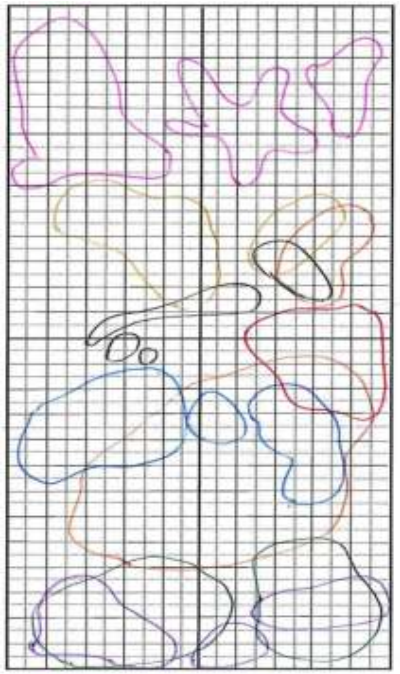
Recommended health assessments

Species	Appearance		Structure				
	% chlorosis	% necrosis	Number stems	Stem length	Nodes per cm	Number leaves	Number flower spikes
Callitriche stagnalis	✓	✓					
Elodea canadensis	✓	✓			✓		
Glyceria maxima	✓**	✓**	✓*	✓*			
Hippuris vulgaris	✓**	✓**	✓	✓			
Myriophyllum spicatum	✓	✓			✓		
Potamogeton natans	✓	✓				✓	✓
Veronica beccabunga	✓	✓			✓		✓

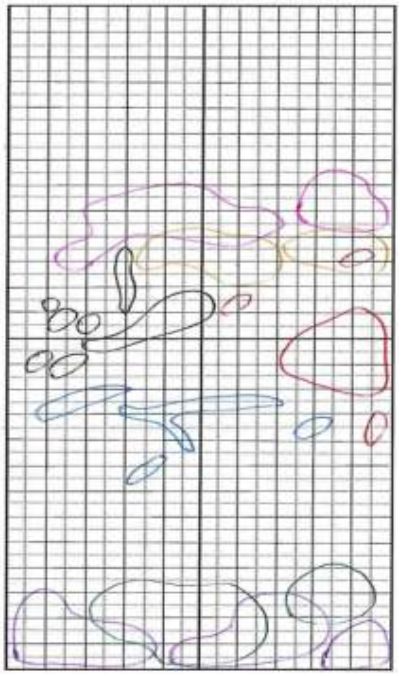
* Main stem only, **emergent leaves only

Growth assessment

Control



Treatment



Potamogeton natans	
Elodea canadensis	
Myriophyllum spicatum	
Glyceria maxima	
Hippuris vulgaris	
Callitriche stagnalis	
Veronica beccabunga	
Filamentous algae	

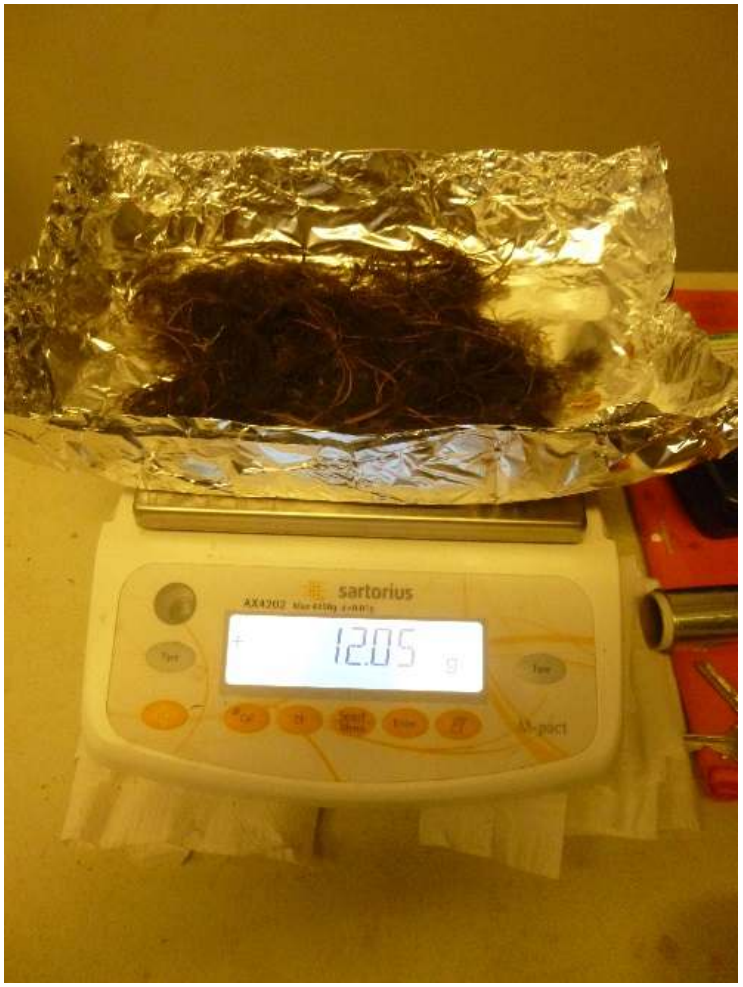
MSD/MDDs

- MSD analysis helps to determine the robustness of the endpoints
- Indicates the smallest treatment effect that can be identified
- Higher abundance and lower variation between replicates = lower MSD and a more reliable study

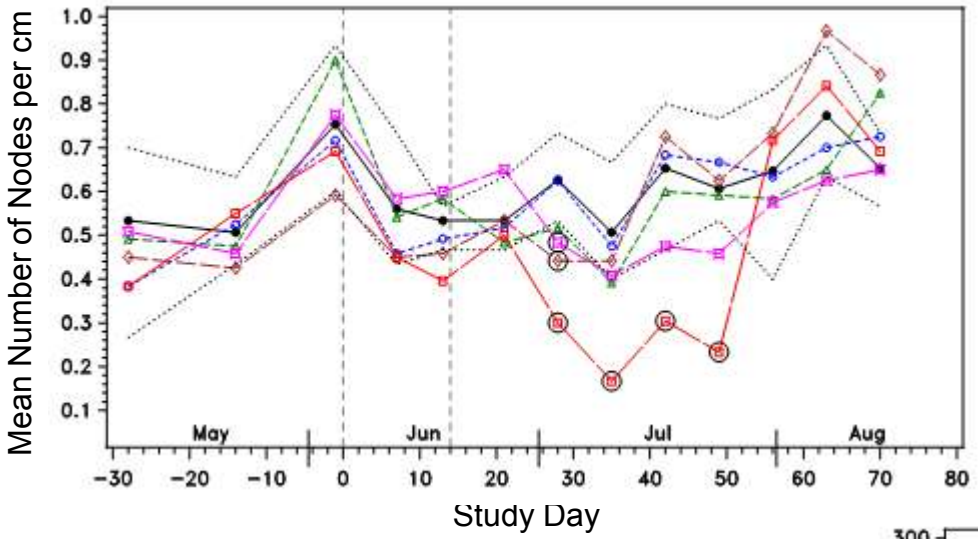
MSD value classes

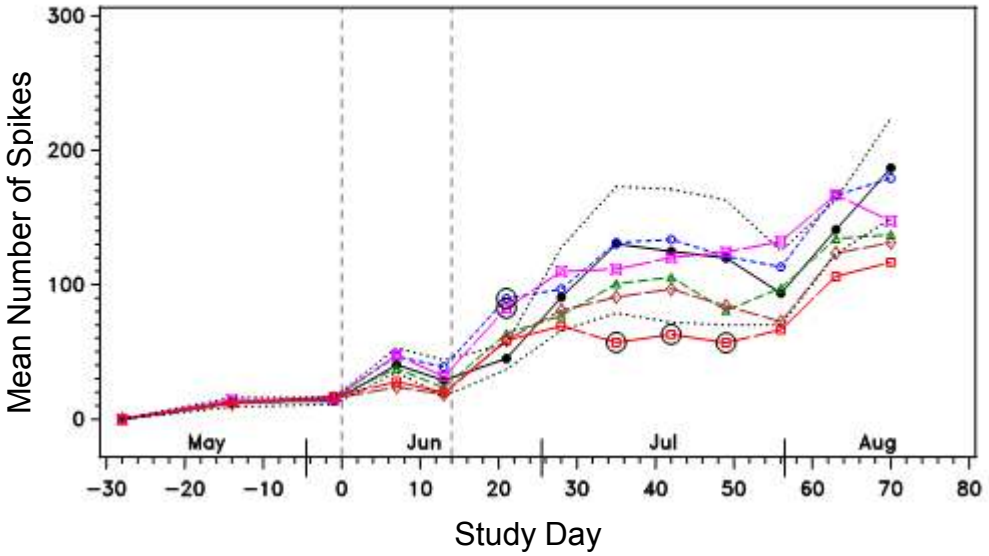
MSD Class	MSD %	Comment
0	>100%	No effects can be determined statistically
1	90-100%	Only large effects can be determined statistically
2	70-90%	Large to medium effects can be determined statistically
3	50-70%	Medium effects can be determined statistically
4	<50%	Small effects can be determined statistically

Results



Nodes and flower spikes

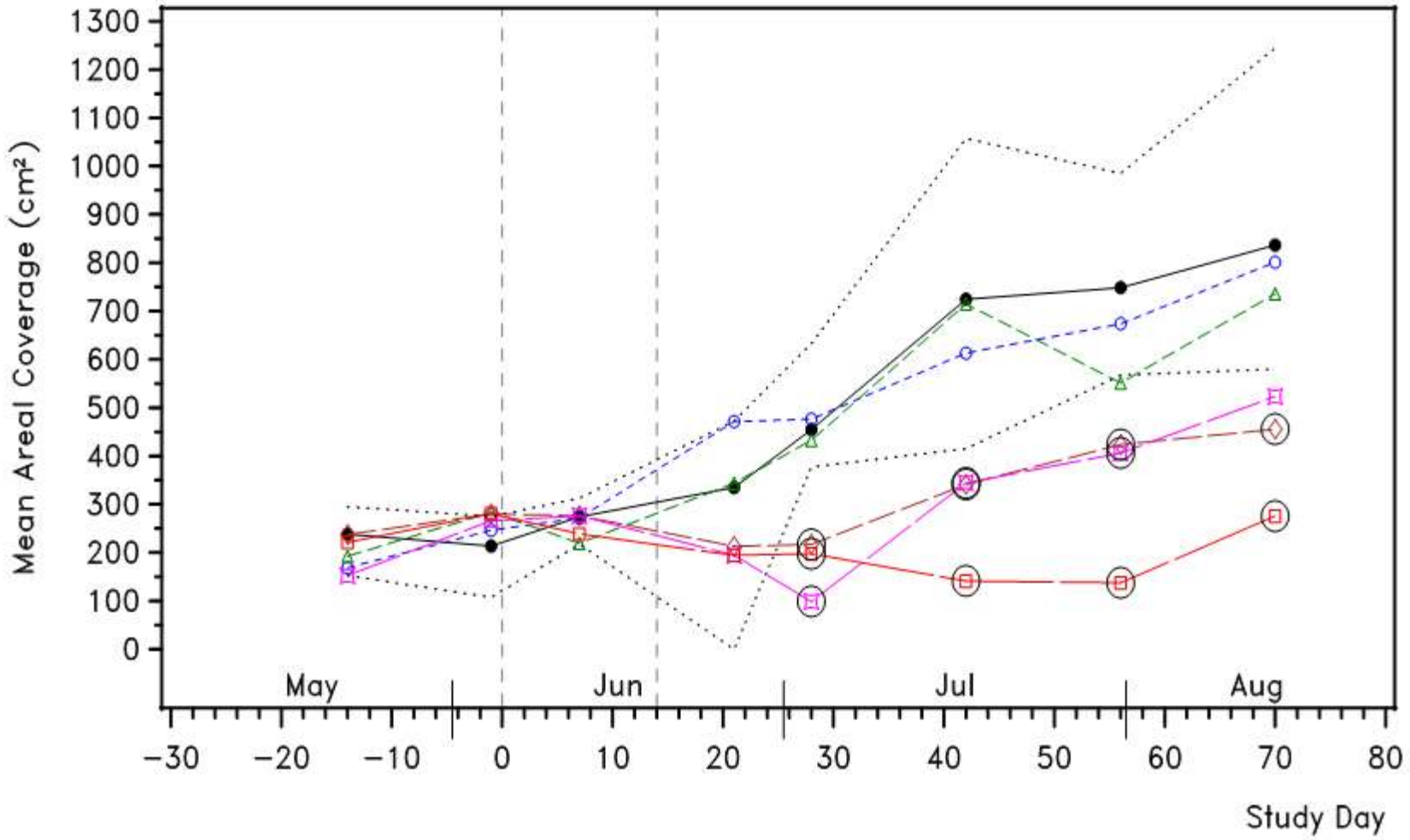




Macrophyte assessment MSDs

Day No.	Taxon/parameter									
	Elodea	*Glyceria*		*Hippuris*		*Myriophyllum*	*Potamogeton*		*Veronica*	
	Nodes/ cm	No. stems	Stem length	No. stems	Stem length	Nodes/ cm	No. leaves	Flower spikes	Nodes/ cm	Flower spikes
-28	54	17	28	NC	30	53	69	NC	38	NC
-14	30	23	24	40	39	47	55	NC	28	28
-1	80	12	22	41	47	27	57	197	32	62
7	38	40	33	48	45	35	48	189	19	52
13	65	49	45	41	46	47	53	176	26	69
21	47	51	51	57	53	30	70	159	25	72
28	63	55	61	48	52	19	75	106	28	51
35	38	31	41	45	54	38	67	99	24	44
42	24	34	40	51	65	49	60	111	18	49
49	53	45	51	58	65	53	55	113	18	44
56	49	42	51	76	93	42	66	159	26	69
63	42	41	51	89	105	31	60	217	26	57
70	47	49	56	96	121	34	73	130	33	47

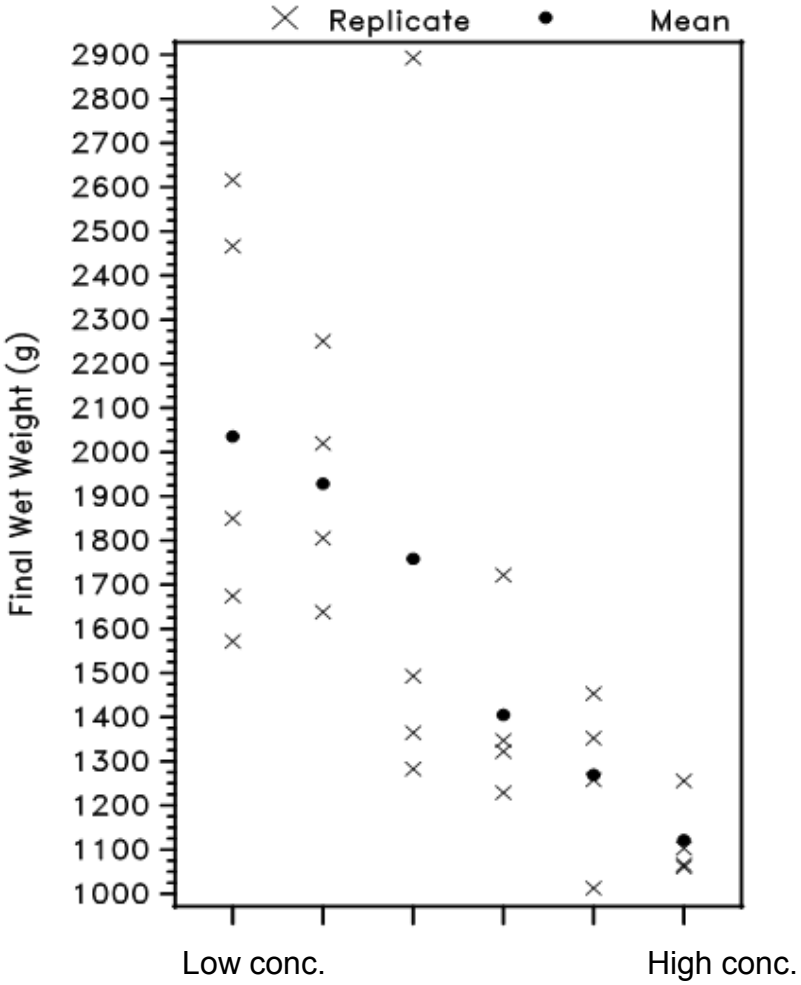
Elodea areal coverage

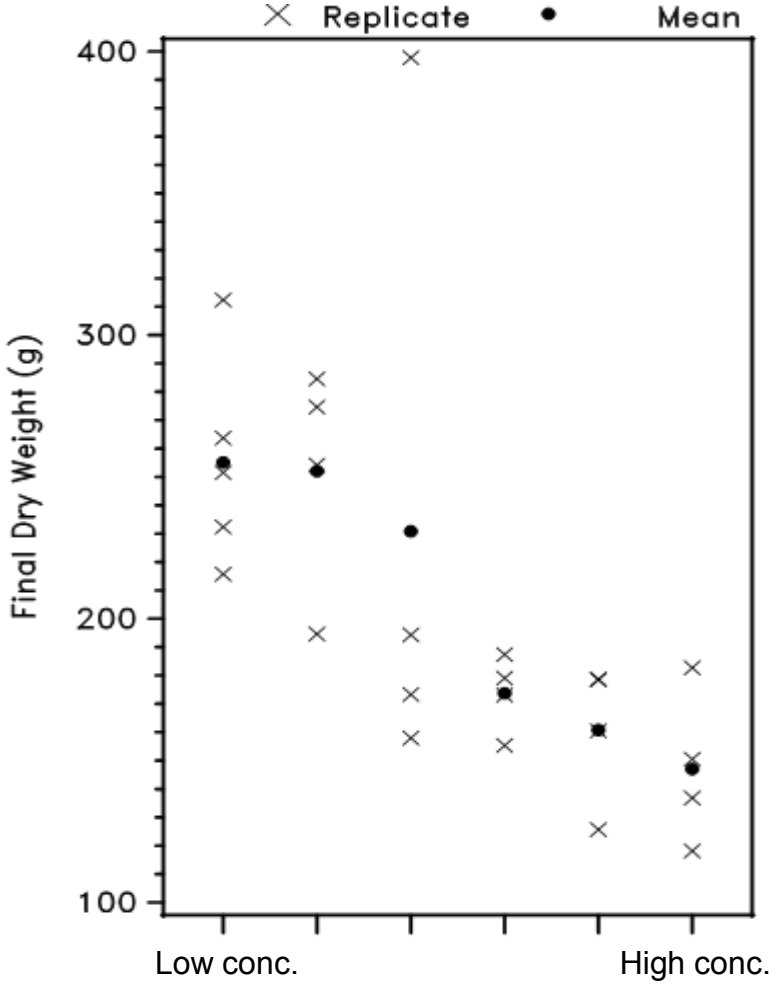


Areal coverage MSDs

Day No.	Taxon/Parameter								
	Callitriche	*Elodea*	*Filamentous*	*Glyceria*	*Hippuris*	*Myriophyllum*	*Potamogeton*	*Veronica*	Total
-14	49	45	415	37	32	57	36	79	71
-1	42	64	148	47	81	46	44	35	43
7	46	47	153	40	96	48	55	23	37
21	51	70	88	55	79	47	42	29	20
28	50	42	140	57	55	38	50	39	23
42	72	47	229	54	65	33	31	30	25
56	161	35	244	51	126	59	46	31	23
70	349	39	202	83	134	42	45	25	26

Total wet and dry weights





Wet and dry weight MSDs

Parameter	Taxon						
	Elodea	*Glyceria*	*Hippuris*	*Myriophyllum*	*Potomogeton*	*Veronica*	Total
Wet weight	45	72	155	45	66	58	37
Dry Weight	47	83	129	44	71	55	38

Discussion

- Communities considered representative of naturally occurring freshwater ecosystems
- Statistically significant effects determined for health assessments, areal coverage and wet and dry weights
- Effects followed by recovery also demonstrated for phytoplankton and zooplankton

Conclusions

- MSD classes for macrophyte assessments, generally 3 or 4 with some occasional higher values; medium and small effects could be determined for most parameters
- The mesocosm design and endpoints used are considered to be robust and reliable for evaluating the effects of a comprehensive and diverse macrophyte community

Summary

To ensure mesocosms accurately represent natural water-bodies and provide robust community endpoints we recommend:

- Macrophyte species cover a range morphological traits and embryonic classes
- Mesocosm design allows different planting depths without stopping community interactions
- Assessments provide quantitative and qualitative data