

Evaluation of Lake-wide, Early-season Herbicide Treatments for Controlling Invasive Curlyleaf Pondweed in Minnesota Lakes

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Water Resources Science Graduate Program



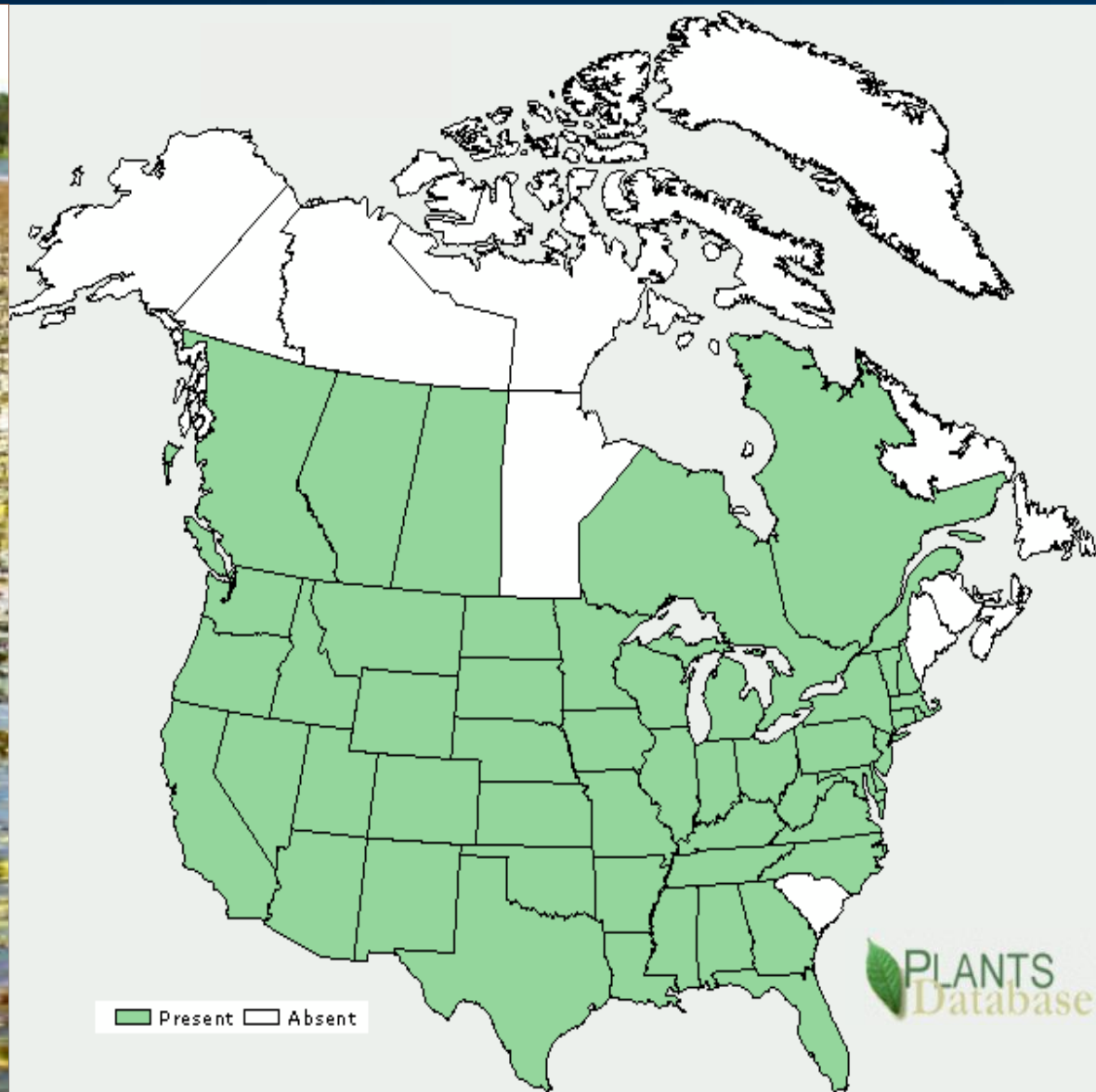
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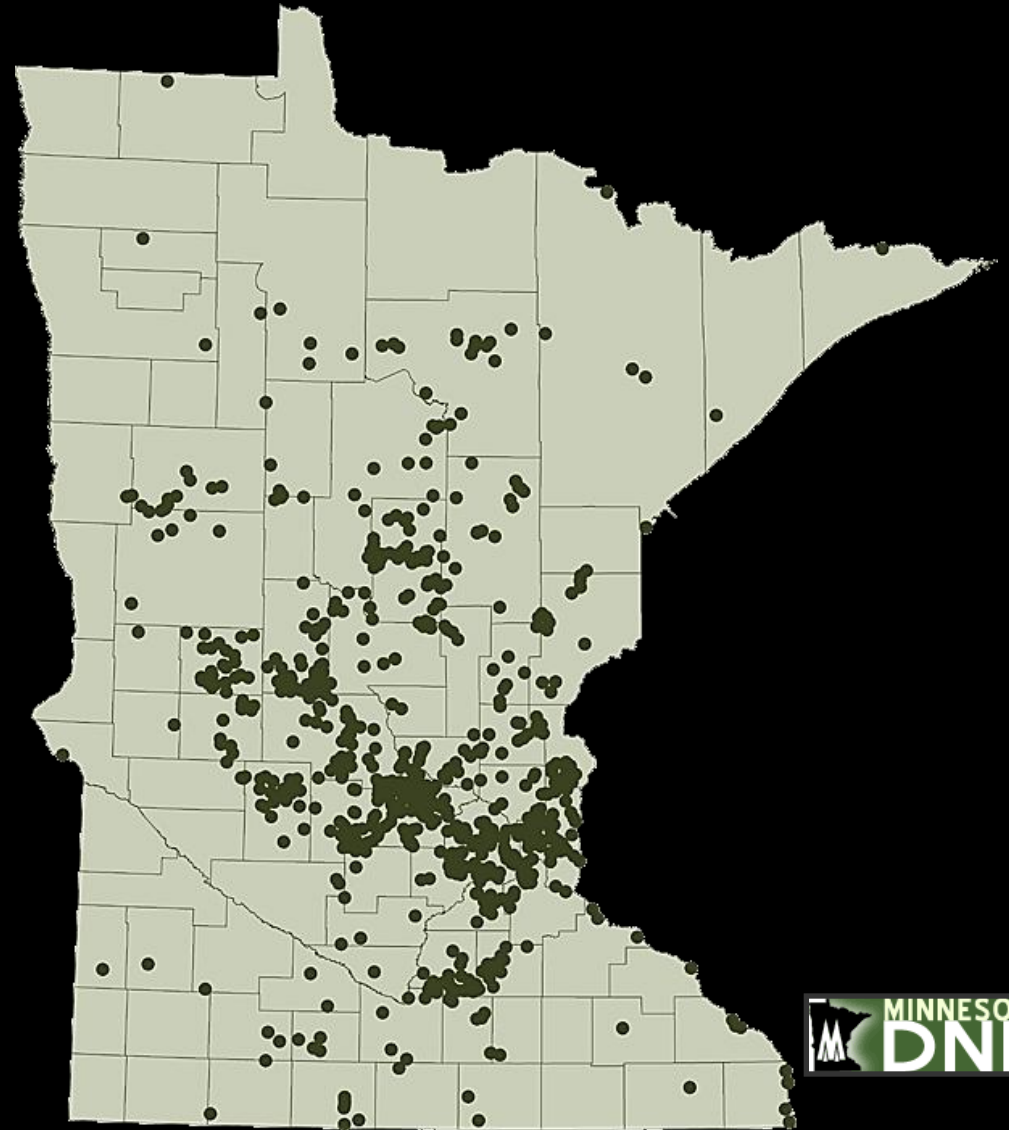
Funding and additional support provided by



Curlyleaf Pondweed



Curlyleaf Pondweed



Curlyleaf Life-Cycle in MN



Why manage curlyleaf?

Recreational & Ecological Impairment

Management Goals

- 1 - Reduce nuisance growth
- 2 - Promote native plants
- 3 - Long-term control
- 4 - Improve Water Quality



FALL

WINTER

SPRING

SUMMER

FALL

ICE

Herbicide Application

What herbicides were tested?

Endothall

Short Contact Time

Selective: 10 to 15 °C

Treat areas of Curlyleaf



Fluridone

Long Contact Time

Selective: 2 to 4 µg/L

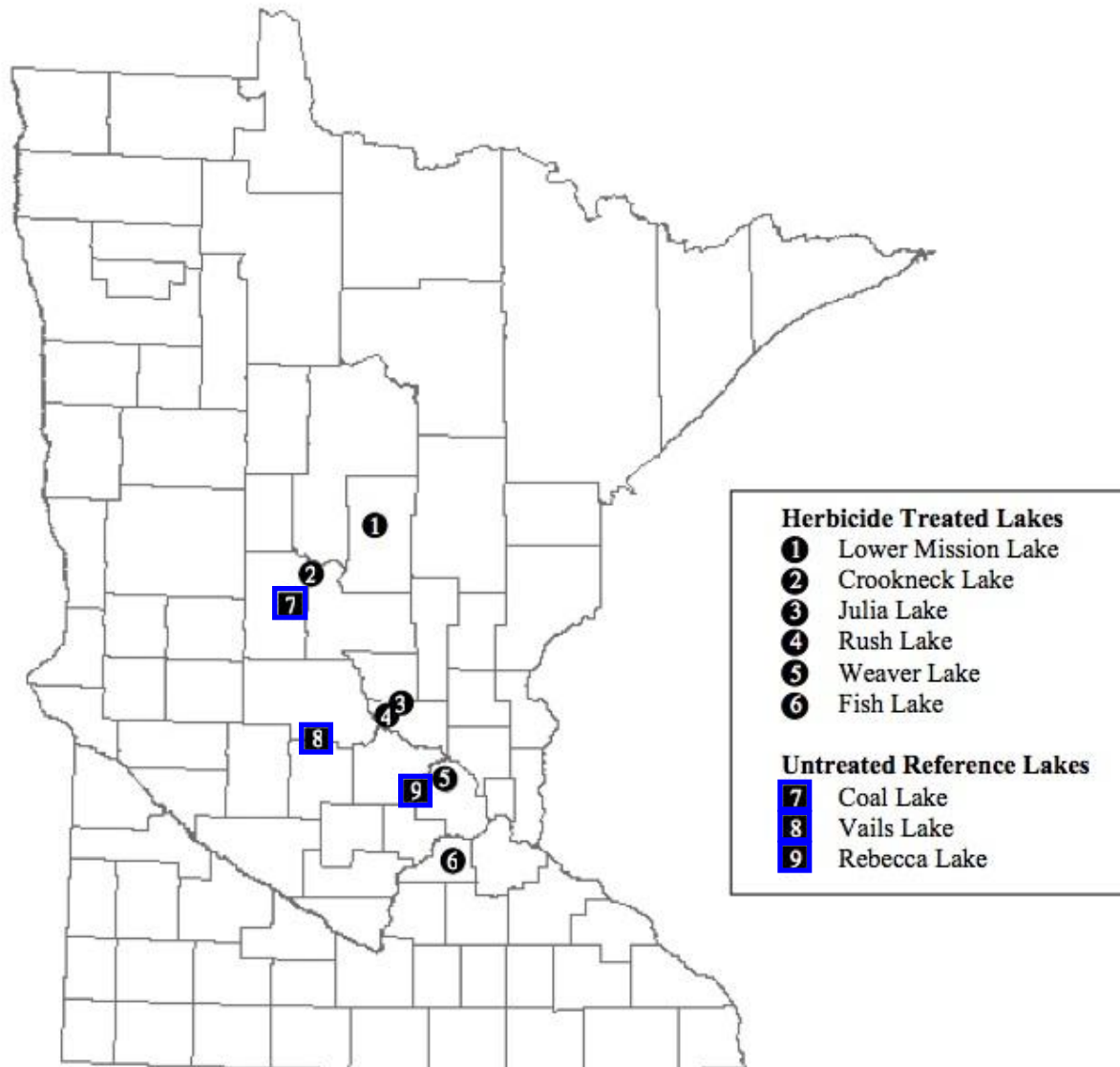
Treat entire lake



Study Objectives

- Did herbicides control curlyleaf?
 - Frequency of occurrence
 - Abundance (biomass)
 - Turion production, abundance and viability
- Did herbicides affect native plants?

Study Lakes



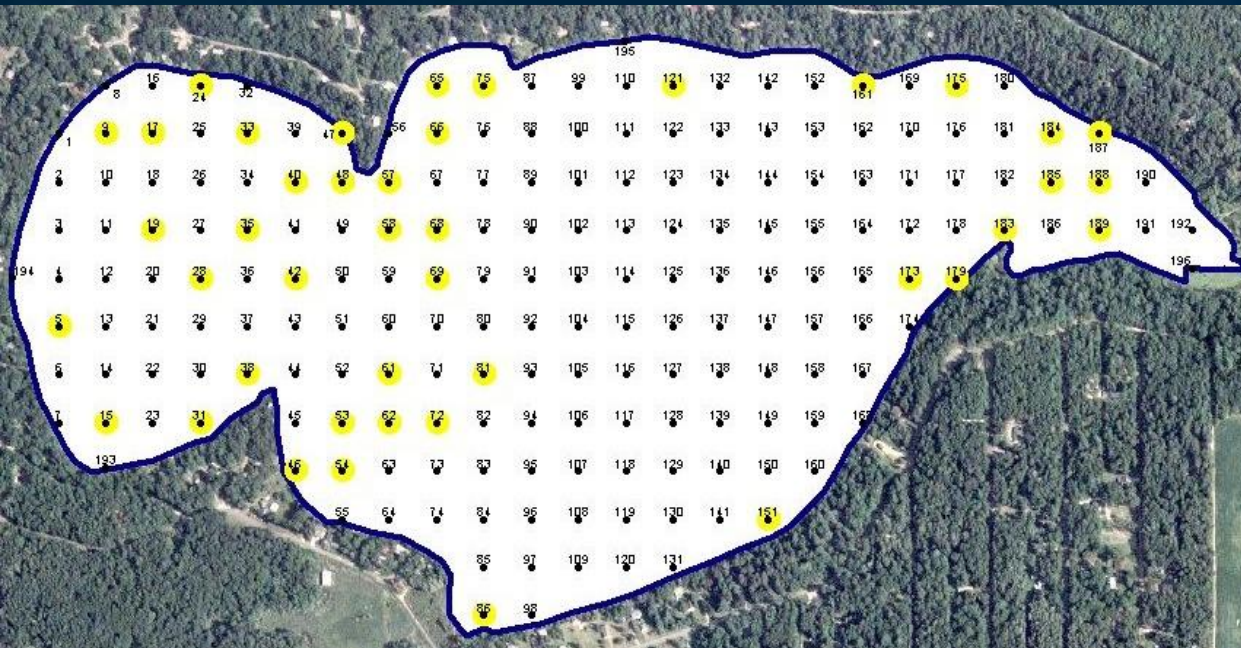
Study Lakes

	Lake	Herbicide	Avg. Secchi (<i>m</i>)	Area (<i>ha</i>)	% Littoral (<i><4.6 m</i>)	% Littoral Infested
REFERENCE	Coal	None	2.4	69	40	45
	Rebecca	None	1.9	105	50	95
	Vails	None	1.6	64	80	75
TREATED	Crookneck	Endothall	2.9	74	80	40
	Fish	Endothall	1.6	70	40	60
	Julia	Endothall	0.6	62	100	50
	Lower Mission	Endothall	3.8	292	60	60
	Rush	Endothall	0.6	65	100	80
	Weaver	Fluridone & Endothall	2.3	62	50	80

Monitoring 2006-2009

Vegetation Surveys

May, June, August



Monitoring 2006-2009

Turion Production



Monitoring 2006-2009

Turion Abundance



Monitoring 2006-2009

Turion Viability



Effects of Herbicide Treatment

Curlyleaf Frequency

Curlyleaf Biomass

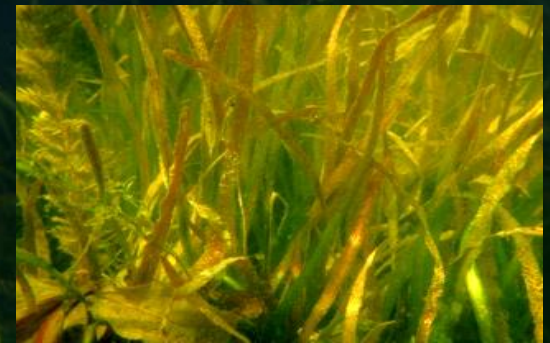
Turion Production

Turion Abundance

Turion Viability

Native Plants

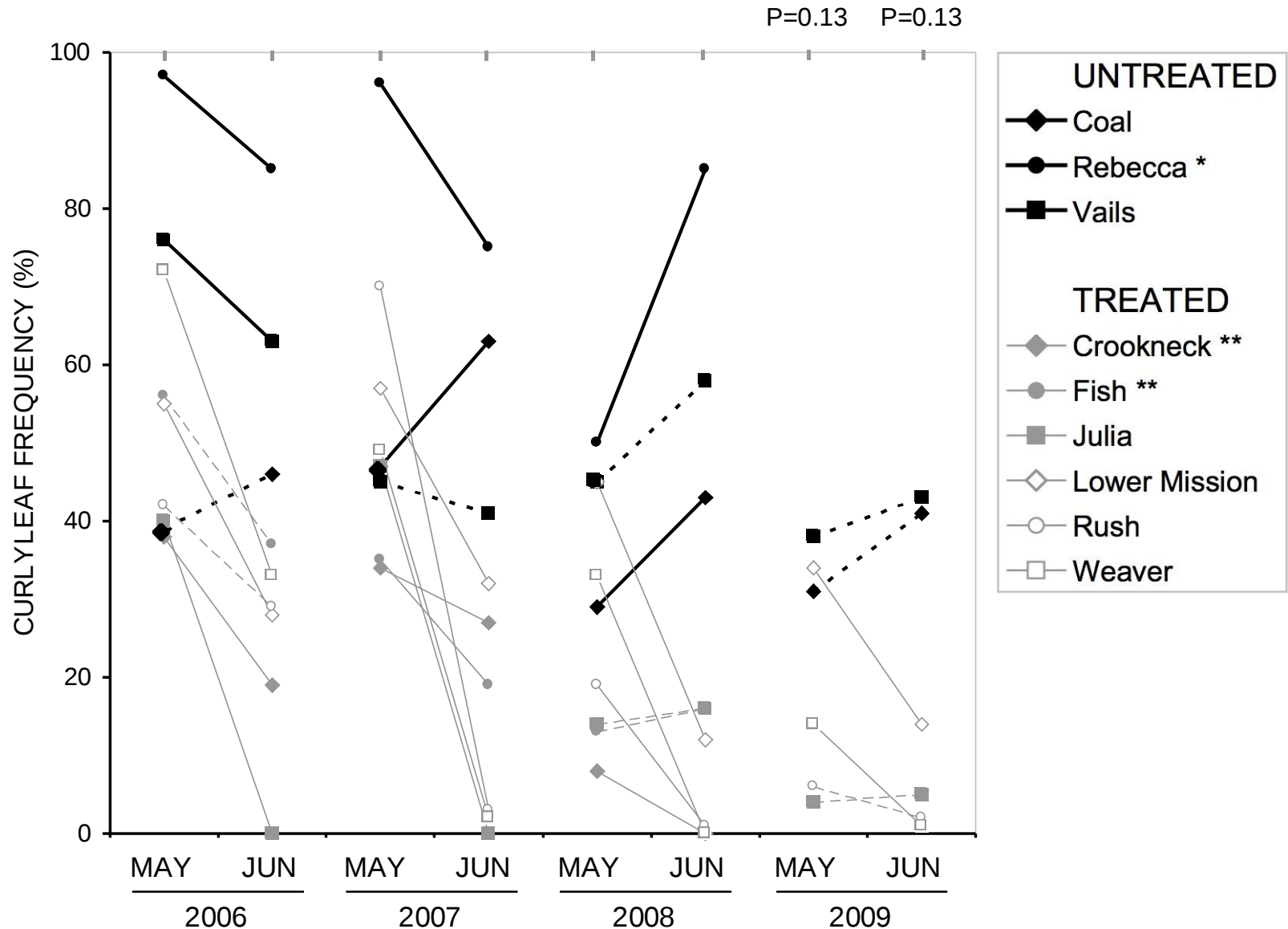
Water Clarity



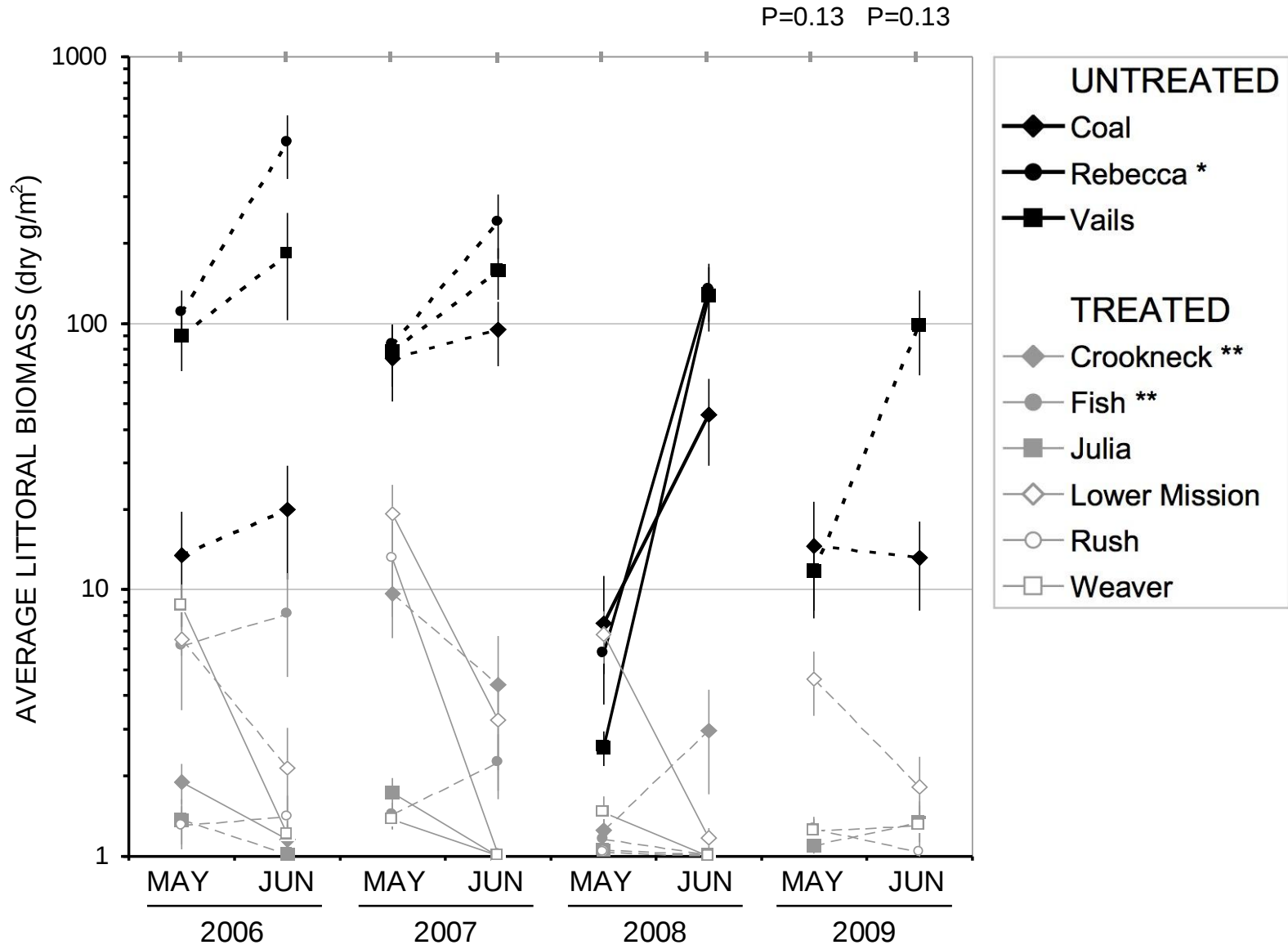
Curlyleaf Frequency & Biomass



Curlyleaf Frequency



Curlyleaf Biomass



Curlyleaf Turions

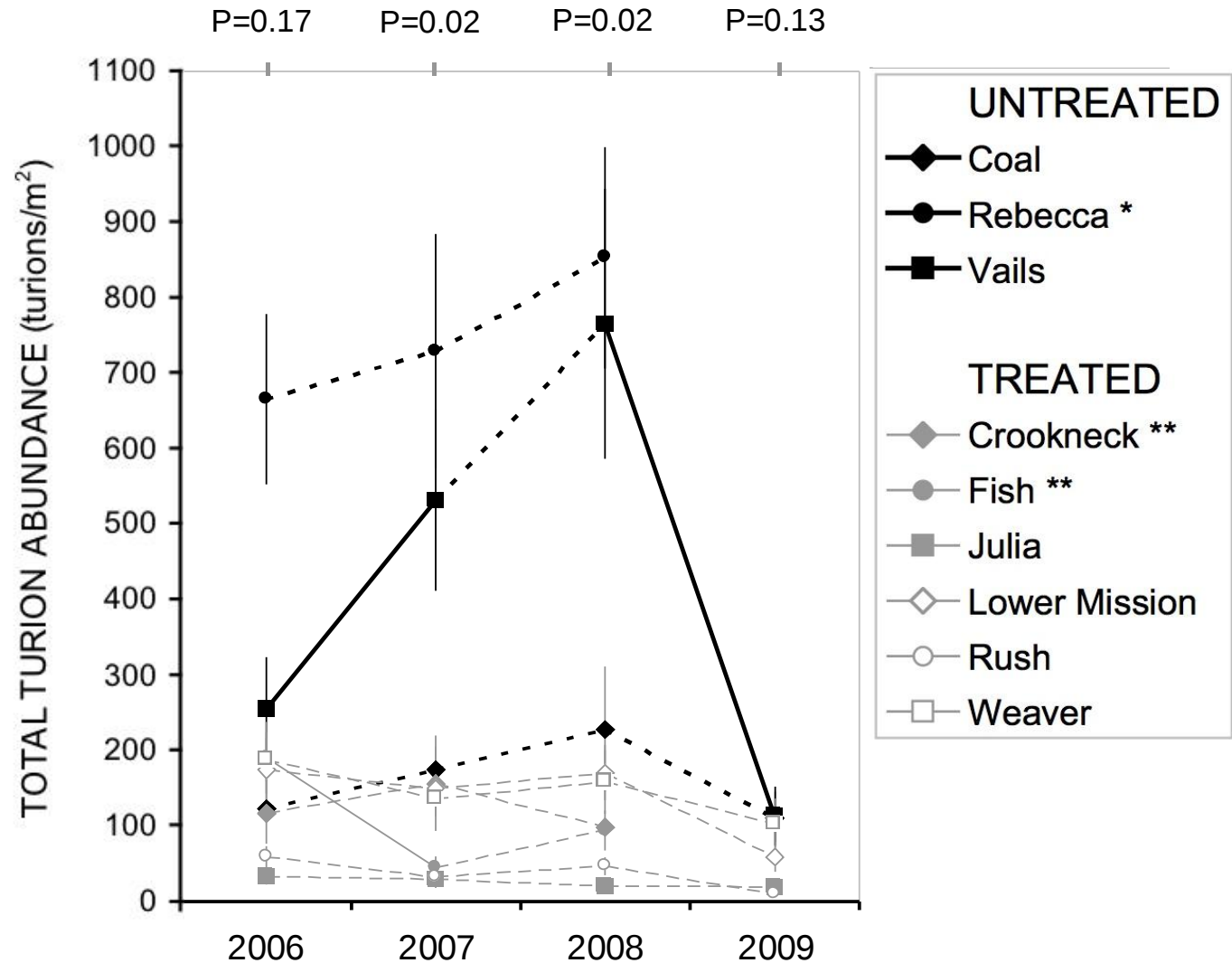


Did treatments stop turion production?

Turions / m² (on standing plants)

		HERBICIDE-TREATED LAKES						UNTREATED REFERENCE		
		Crookneck	Fish	Julia	L. Mission	Rush	Weaver	Coal	Rebecca	Vails
2006	$\bar{x}$									
2007		<1 (<1)	<1 (<1)	0 -	<1 (<1)	0 -	0 -	312 (93)	778 (210)	509 (124)
2008		2 (2)	<1 (<1)	0 -	0 -	0 -	0 -	87 (46)	313 (93)	379 (124)
2009		8 (5)	10 (8)	0 -	<1 (<1)	0 -	0 -	52 (23)	11 (4)	206 (83)

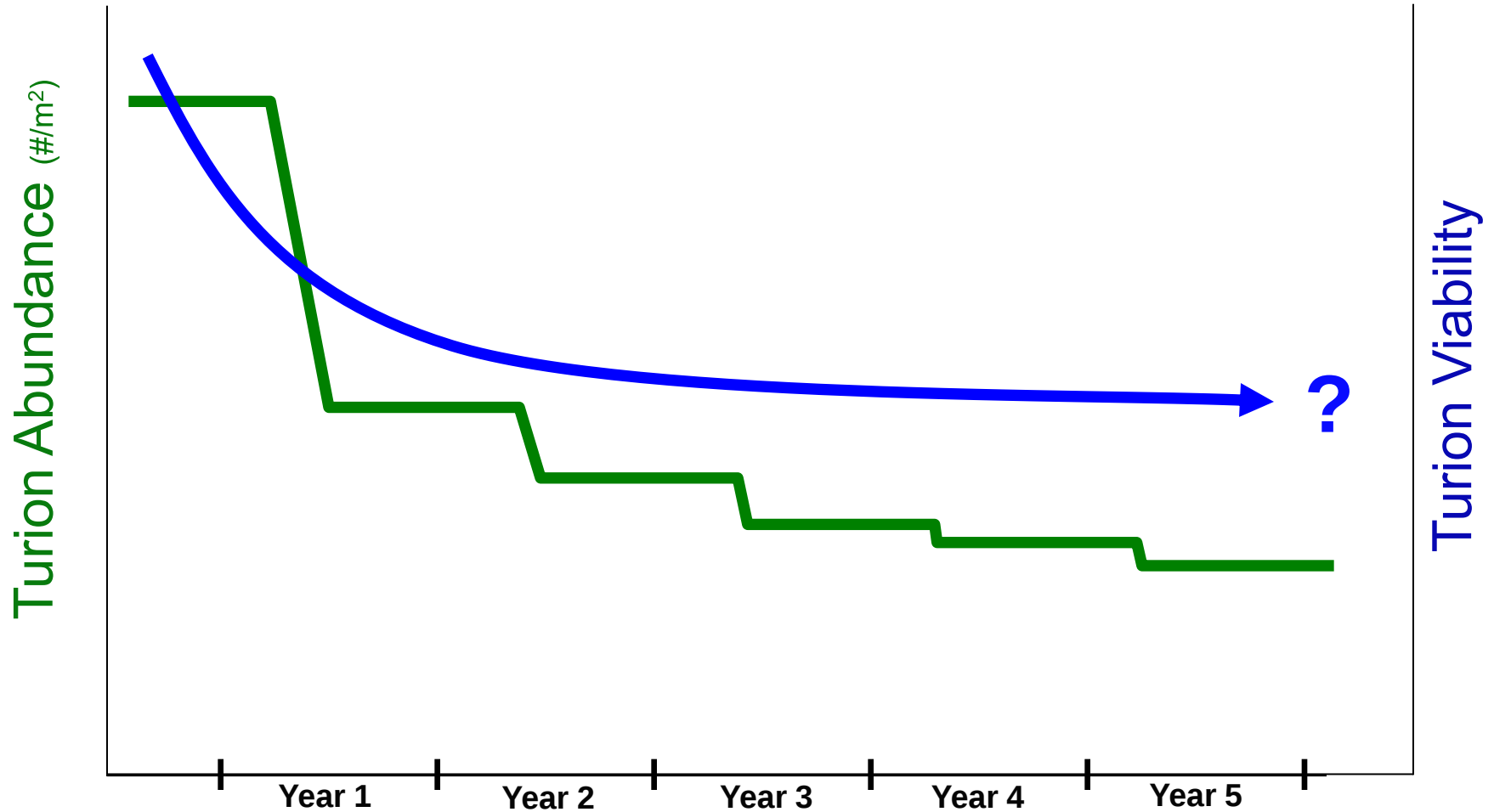
Did treatments reduce turion abundance?



Did treatments reduce turion viability?

	HERBICIDE-TREATED LAKES						UNTREATED REFERENCE		
	Crookneck	Fish	Julia	L. Mission	Rush	Weaver	Coal	Rebecca	Vails
% VIABLE									
2006	73	29	81	59	43	42	91	76	82
2007	74	50	77	45	62	40	76	85	85
2008	76	40	83	52	63	45	71	85	89
2009	69	40	76	21	67	48	79	76	83
ABUNDANCE OF VIABLE TURIONS (N/m ²)									
2006	85	55	27	103	25	79	111	505	208
2007	115	22	22	67	20	54	132	620	451
2008	75	38	17	88	30	71	161	725	681
2009	30	27	14	12	7	49	86	330	94

Turion Depletion



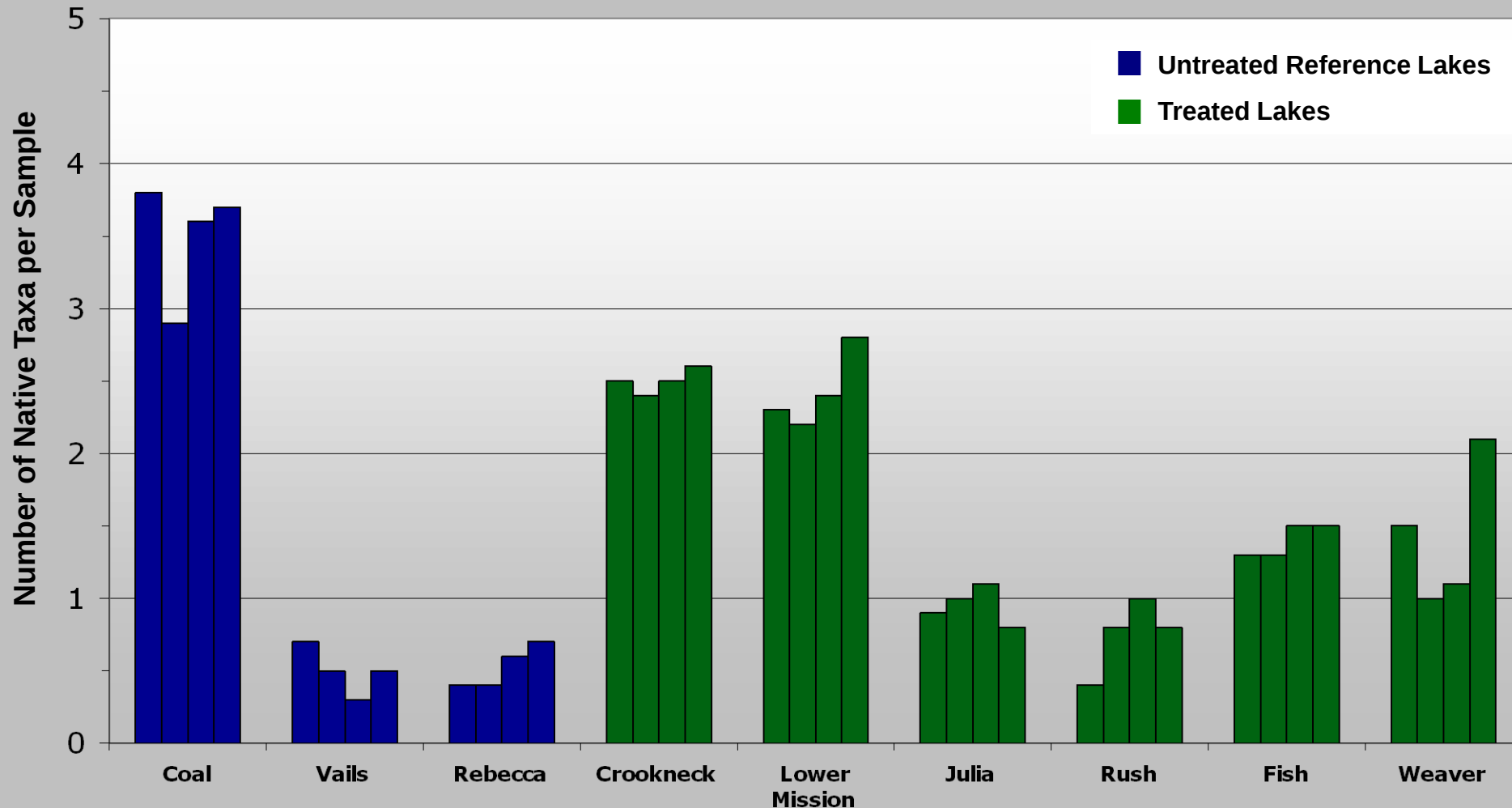
Native Plants



Did treatments harm native plants?

Average Native Taxa per Sample

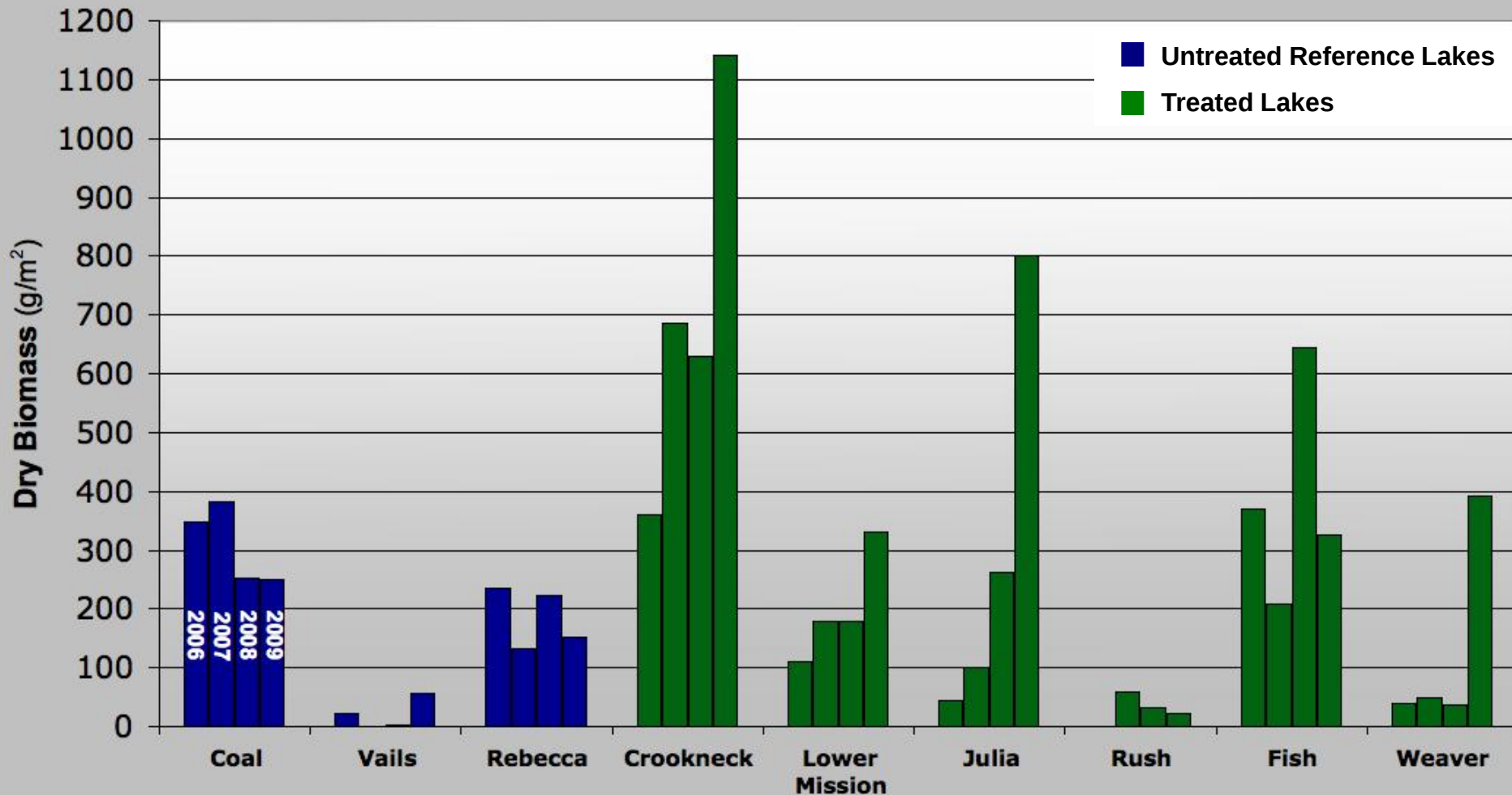
August 2006-2009



Did treatments harm native plants?

Native Plant Biomass: Littoral Area

August 2006-2009

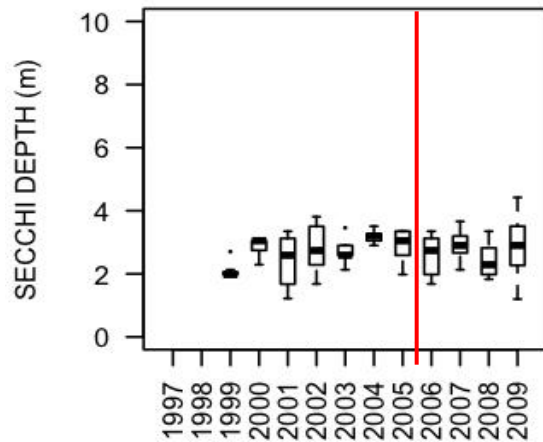


Water Clarity

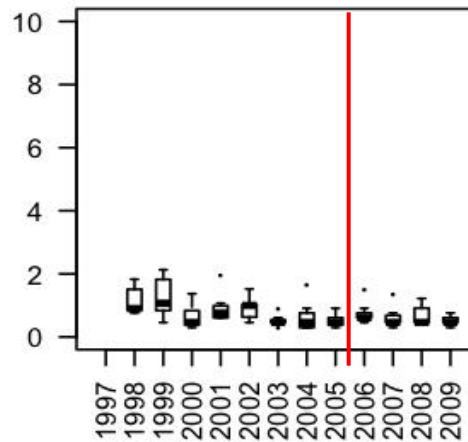


Did treatments increase water clarity?

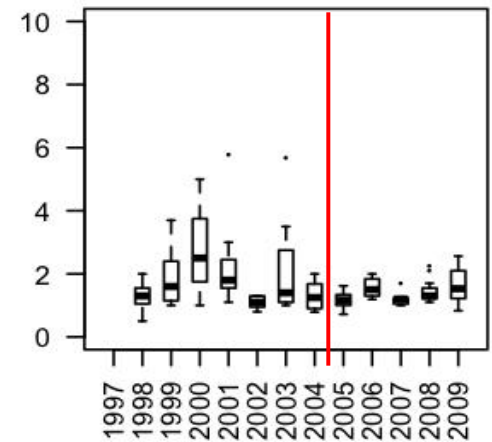
CROOKNECK



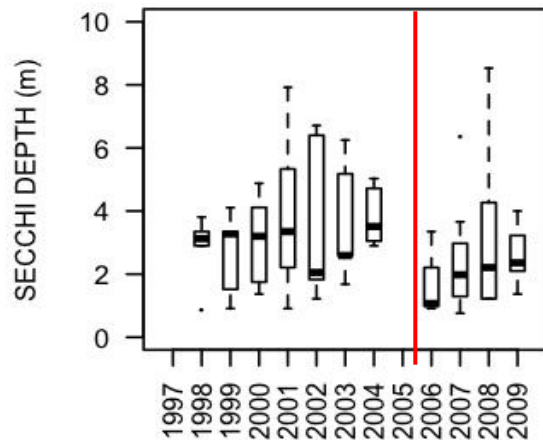
JULIA



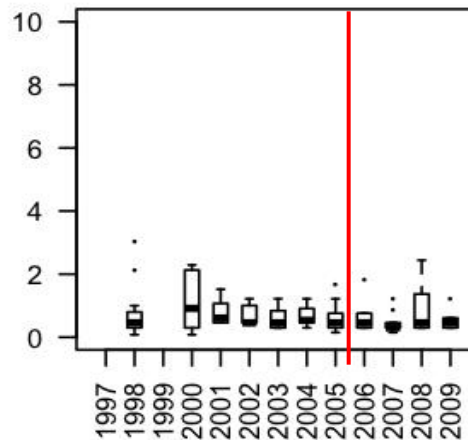
FISH



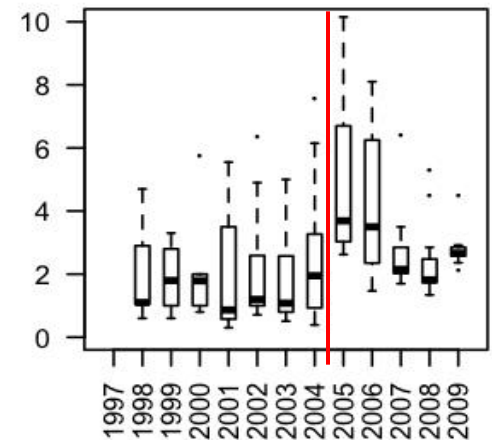
LOWER MISSION



RUSH



WEAVER

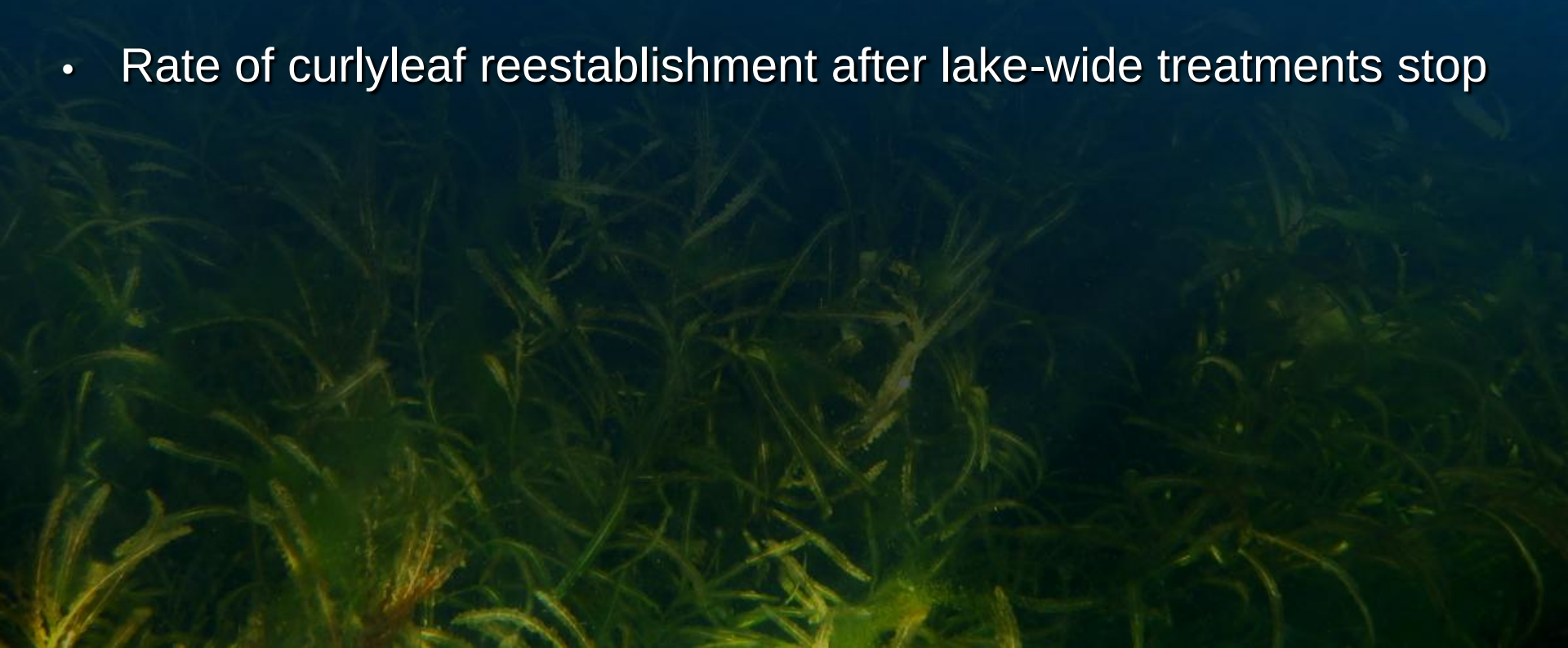


Conclusions

- Large within-year effects on curlyleaf frequency and biomass
- Near elimination of turion production
- Majority of turion depletion appears to occur in first year of treatment
- No clear indication of cumulative carry-over effects due to high variability in reference lakes
- Turions remain viable in sediment for more than 4 years
- Some shifts in native plant community, but generally maintained diversity and abundance
- Lake-wide treatments do not eradicate curlyleaf, but may reduce curlyleaf to levels where other less intensive measures may be able to maintain control

Future Research

- How does viable turion abundance relate to curlyleaf sprouting?
- Determine how long buried turions remain viable
- Rate of curlyleaf reestablishment after lake-wide treatments stop



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