Eurasian watermilfoil management in Wisconsin

Joint Meeting of the Great Lakes
& Mississippi River Basin ANS Panels
Madison, WI
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Macrophyte Research

Standard protocol development

To support future good data collection

To support scientific evaluation of management decisions

Baseline Data

Eurasian Watermilfoil

Herbicide Monitoring

http://dnr.wi.gov/lakes/plants/research/

Eurasian Watermilfoil

What:

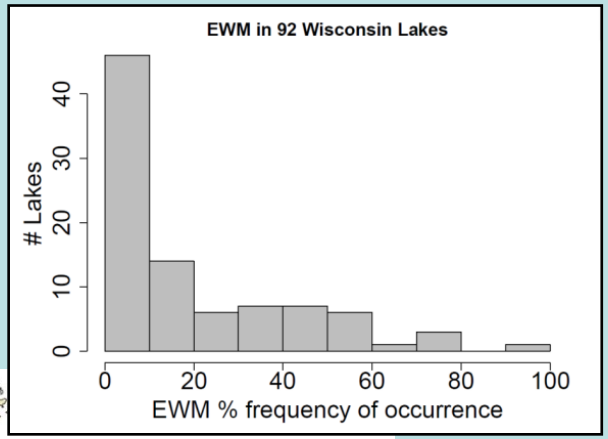
Collect standardized data on the distribution, ecology, and management of EWM

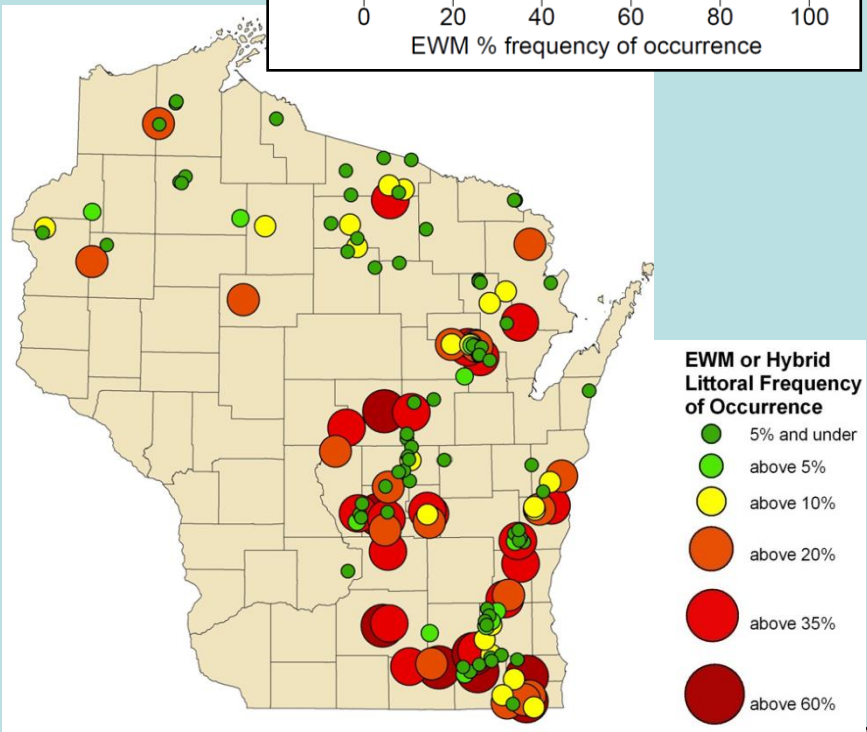
Purpose:

Create a baseline statewide dataset on EWM populations

Output:

EWM Factsheet (PUB-SS-1074 2011)





Eurasian Watermilfoil Study

What:

Collect long-term data on the distribution, ecology, and management of EWM

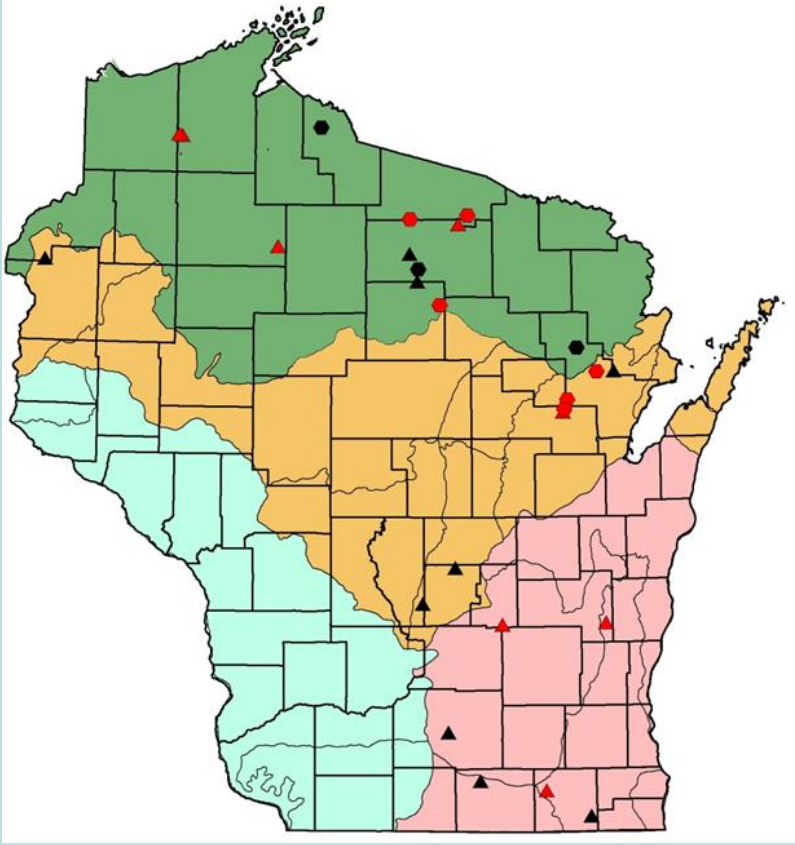
Purpose:

Create a baseline long-term dataset on EWM populations over time

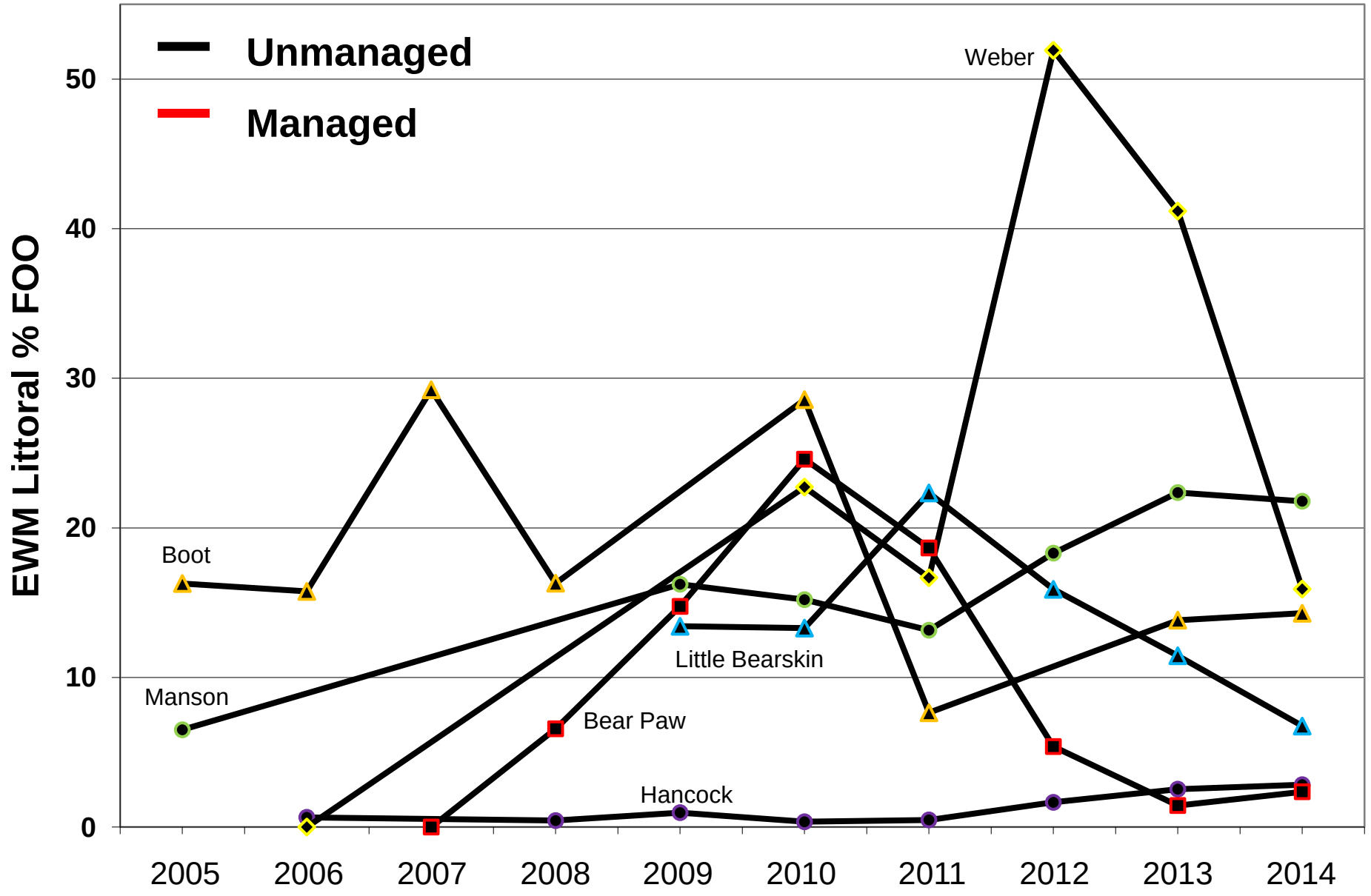
Output:

Long-term temporal and spatial EWM & natives trends

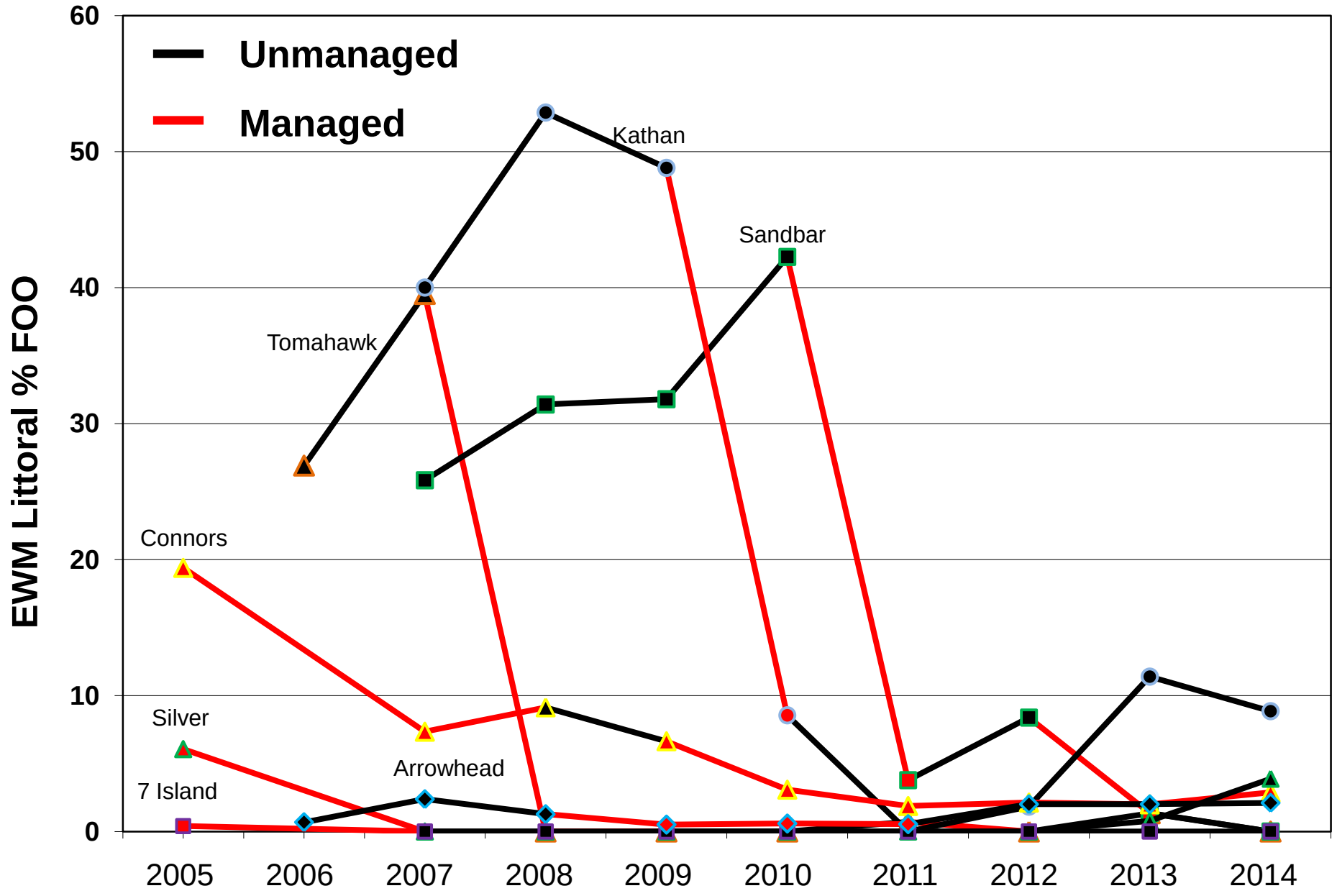
- Annual aquatic plant survey & biomass collection on 24 lakes over time
- 3 ecoregions, established and new populations, managed and unmanaged



Northern Lakes & Forests



Northern Lakes & Forests



Herbicide Monitoring

What:

Collect data on herbicide concentration and exposure times under varying operational conditions

Purpose:

To provide recommendations for improving control of invasive aquatic plants and reducing damage to native plants

Output:

Scientific evaluation of herbicide treatments

Nault et al. 2012. NALMS LakeLine 32(1):19-24

Nault et al. 2014. Whole-lake 2,4-D for EWM Control. Lake & Res. 30(1):1-10.

Large Scale Treatment Factsheet (PUB-SS-1077 2011)

Small Scale Treatment Factsheet (PUB-SS-1143 2014)

Barton et al. 2013. Turville Bay Report. (PUB-SS-1120 2013)

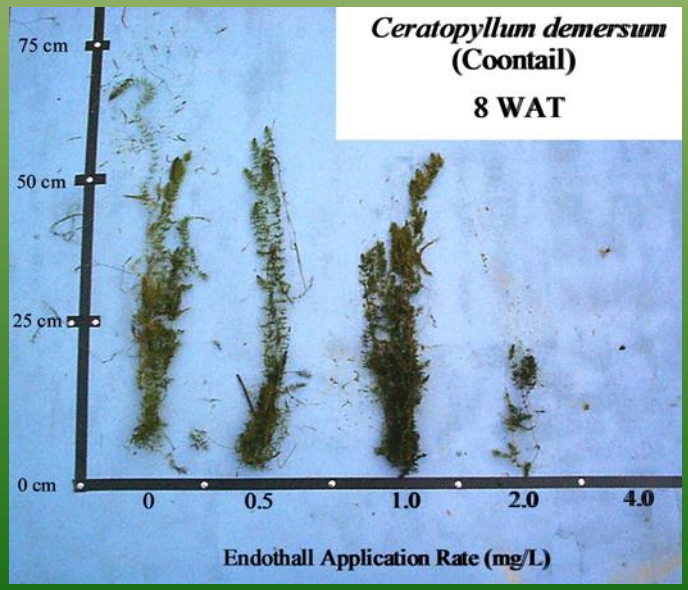
Nault et al. 2015. NALMS LakeLine. *In press*.

CET Experiments

Indoor Growth Chambers

Outdoor Mesocosm Tanks

- Wide range of herbicide concentrations and exposure times (CET)
- Replicated studies
- Species sensitivity



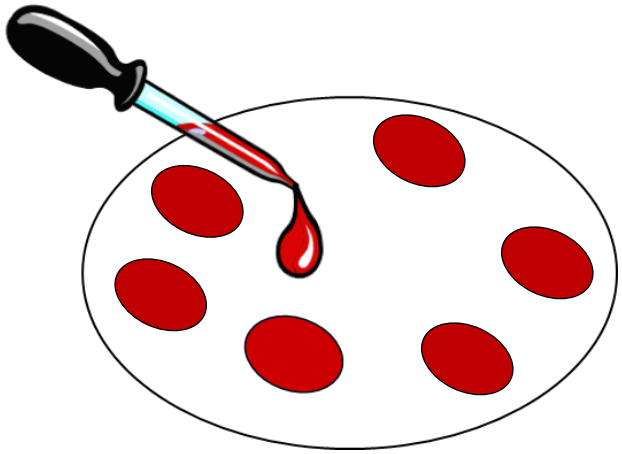
Implementation Considerations

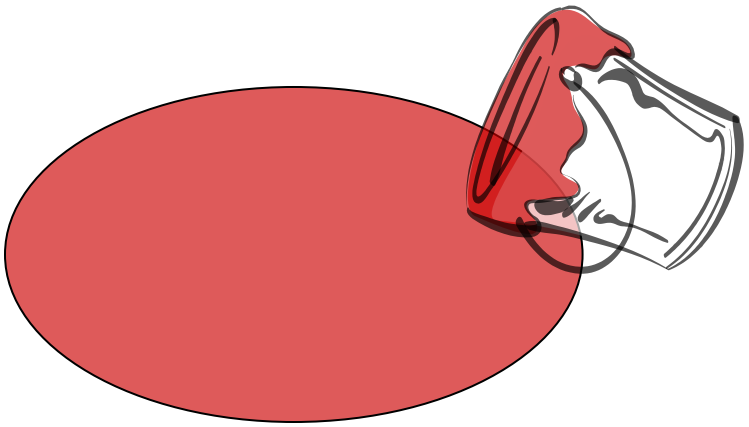
- Management goal(s)
- Management scale(s)
- Timing (seasonality, weather, water temps)
- Herbicide products and formulations
- Application rates
- Flowing water, water level management
- Lake type, size, bathymetry, water chemistry
- Target and non-target plant species
- Integrated management techniques

Large-Scale Definitions

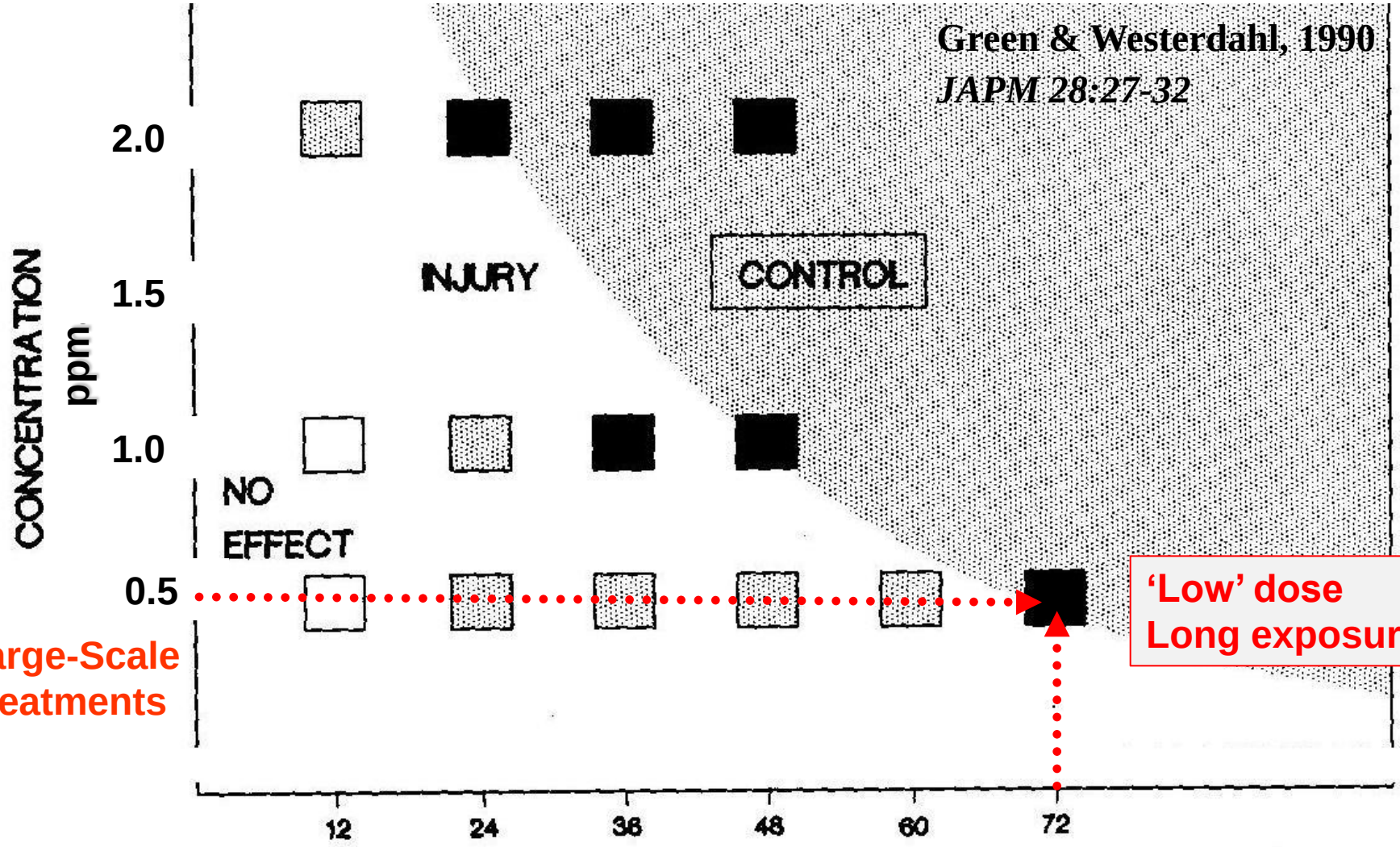
- *WI Admin. Code*: >10 acres or >10% of littoral zone

- *Ecological:* Herbicide will be applied at a scale where dissipation will result in significant lakewide concentrations and effects are anticipated on a lakewide scale





2,4-D Concentration/Exposure Time



Large-Scale Treatments

'Low' dose
Long exposure

Recommended label rate:
2.0 – 4.0 ppm

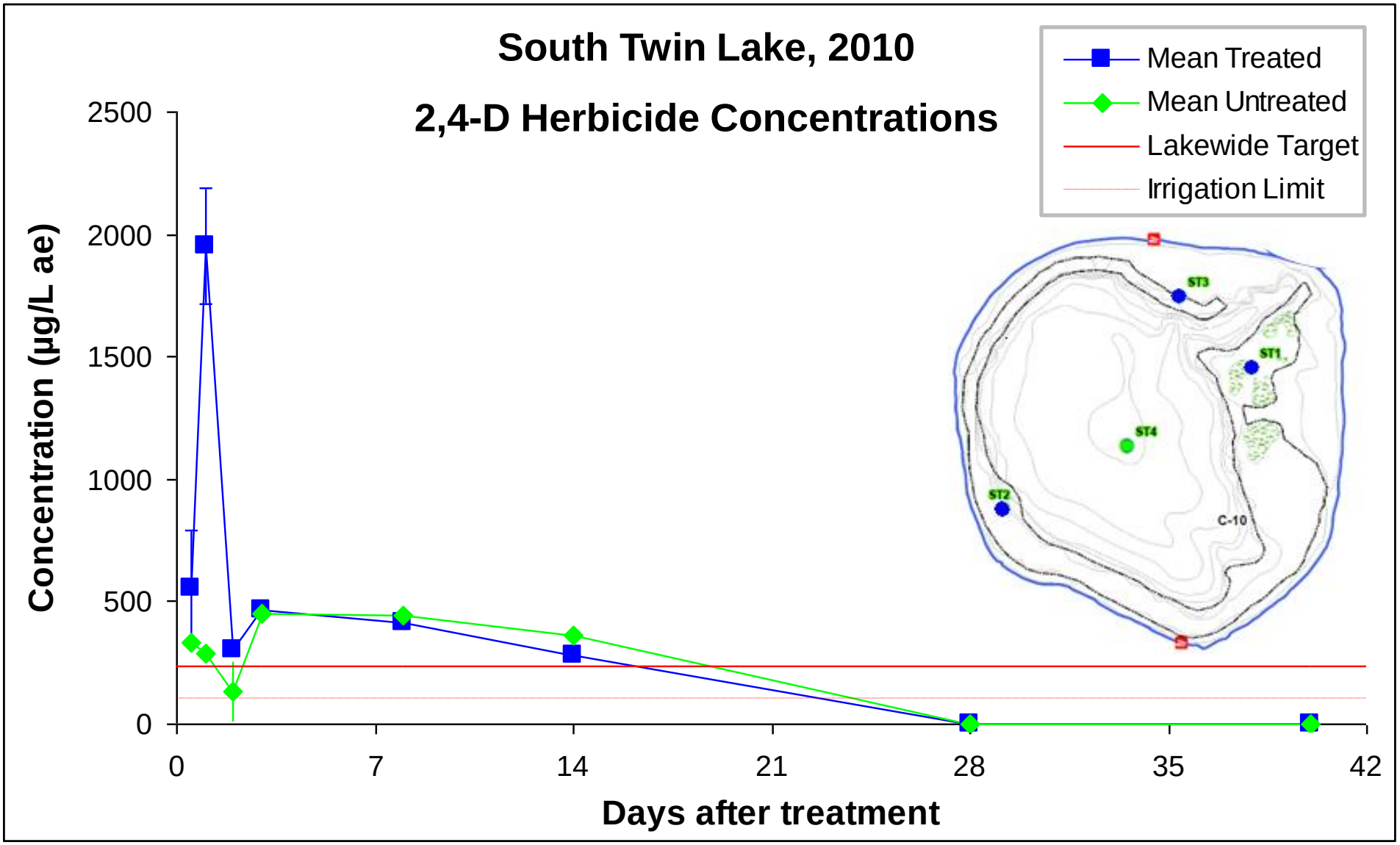
1.0 ppm = 1.0 mg/L = 1000 ppb

Herbicide Exposure Time

- **Dissipation:** horizontal and vertical movement of herbicide within the water column
  - Treatment area relative to lake
  - Wind
  - Water flow
  - Water depth
- **Degradation:** physical breakdown of herbicide into inert components
  - Microbial
  - Photolytic

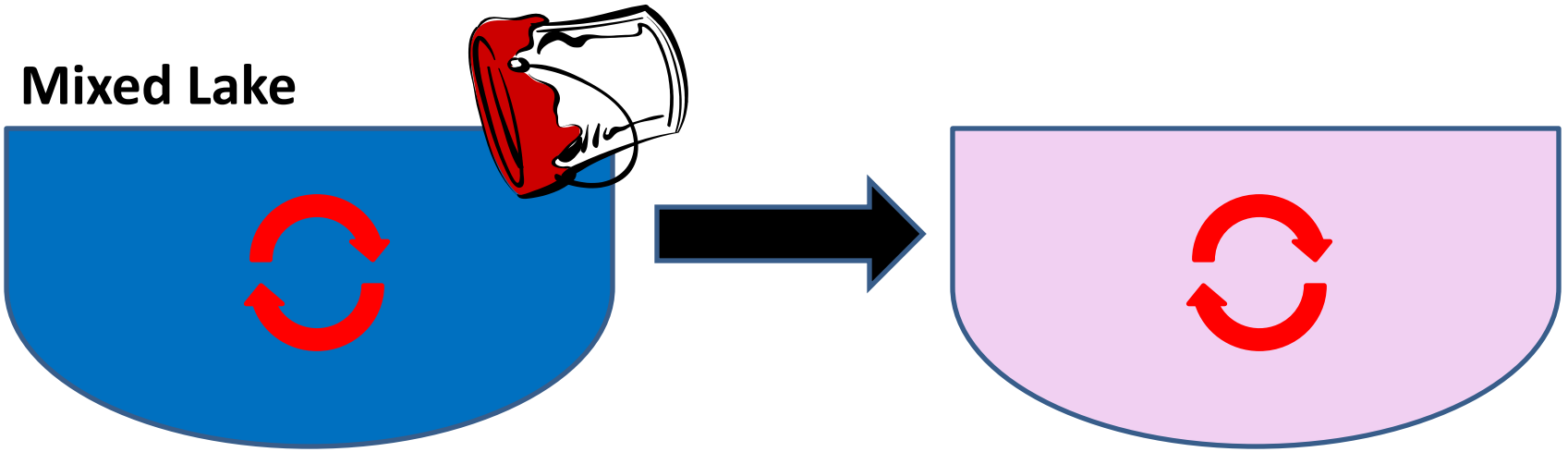
Lakewide Dissipation

26% of lake treated

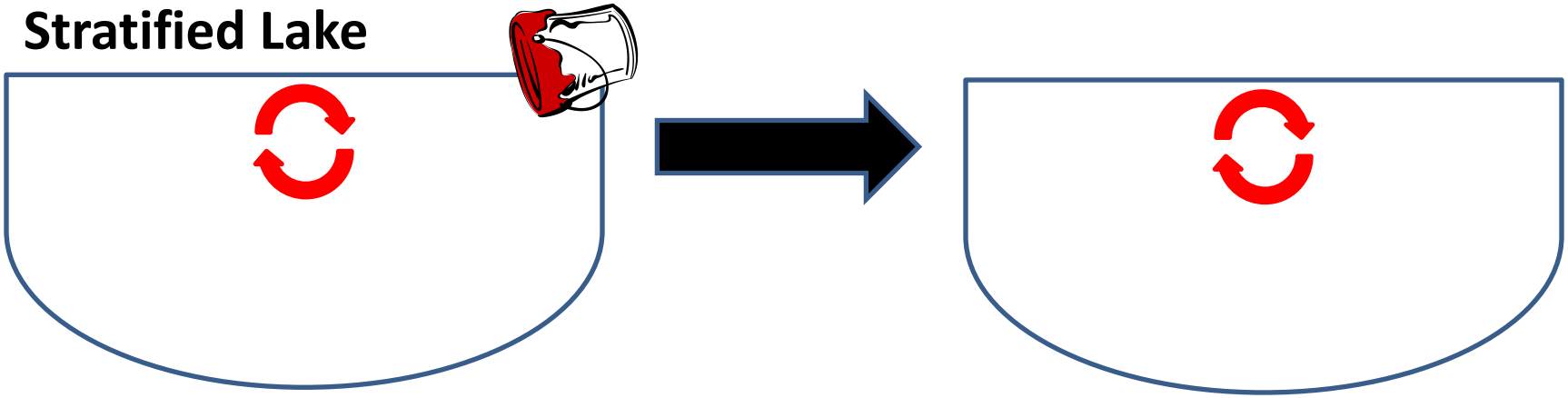


Lakewide Dissipation

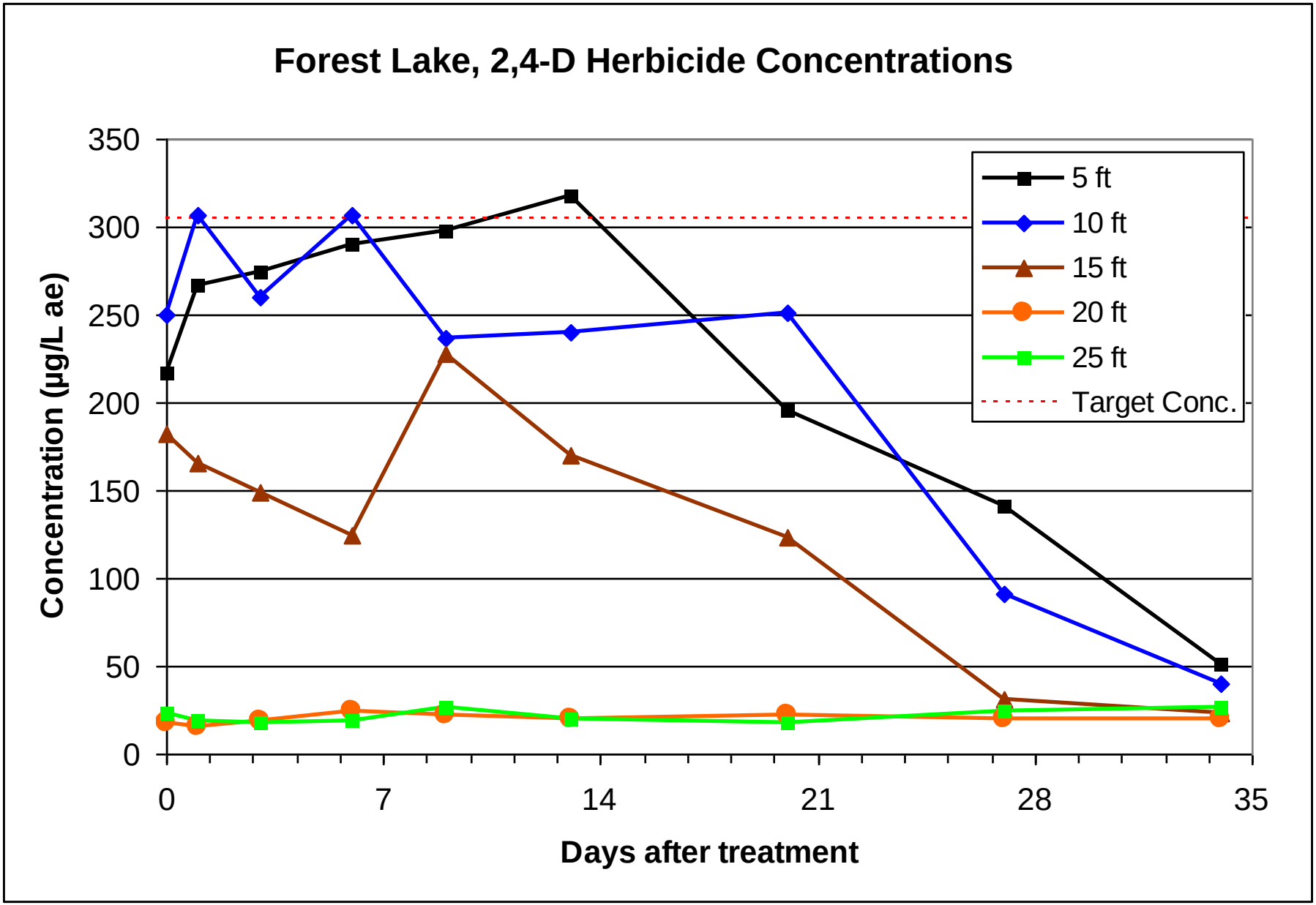
Mixed Lake



Stratified Lake



Lakewide Dissipation



Study Lakes

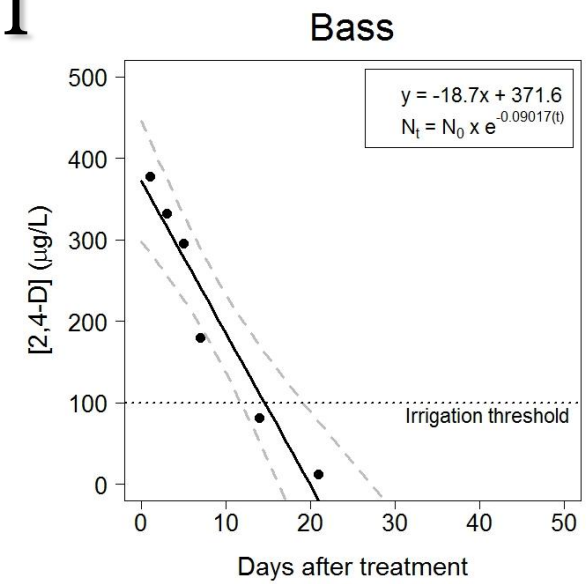
- *20 lakes*
- *Variety of lake types*
- *Range of sizes and depths*
- *Range of trophic status*

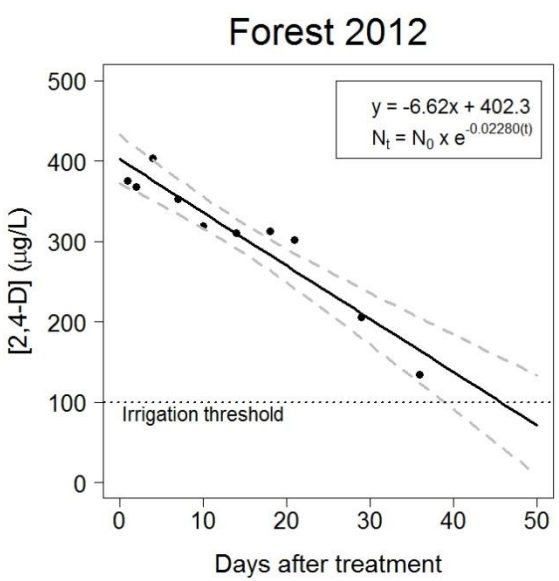
Treatments

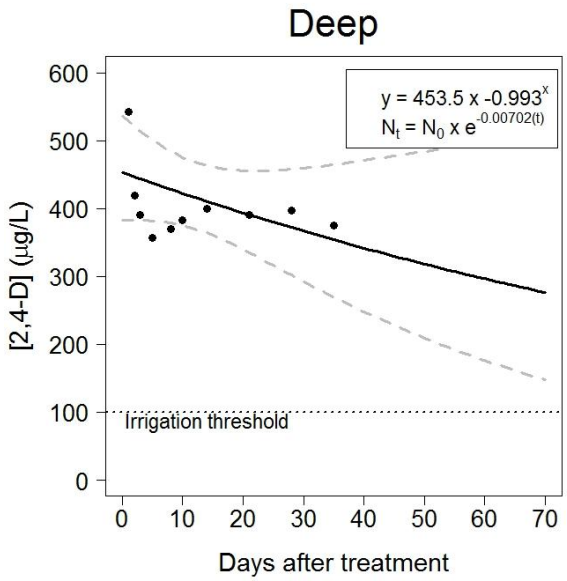
- *Lakewide liquid 2,4-D targets of 0.073 - 0.5 ppm (epilimnetic)*
- *Application rates of 0.25 - 4.0 ppm*
- *8-100% of lake surface area treated*
- *Early season (spring) treatments*
- *Monitored from 2008-2014*

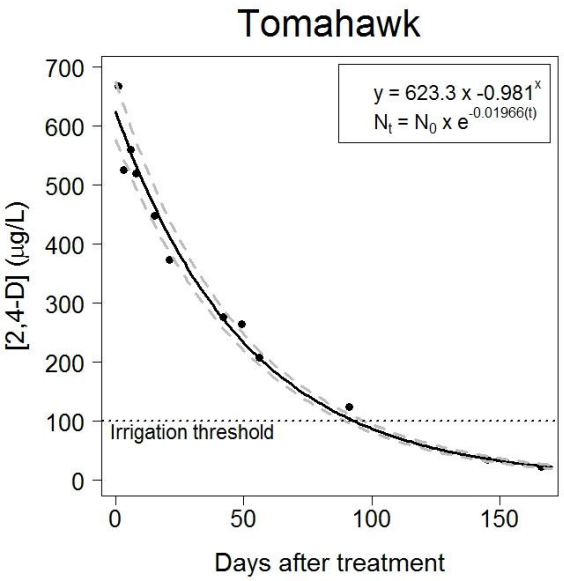
Degradation Models

- *Majority of models highly significant ($p < 0.001$)*
- *Mean 1-7 DAT ranged from 0.127-0.584 ppm*
- *Calculated 2,4-D half-lives ranged from 4-57 days*
- *Irrigation restriction (<0.1 ppm by 21 DAT) exceeded in over half the treatments*

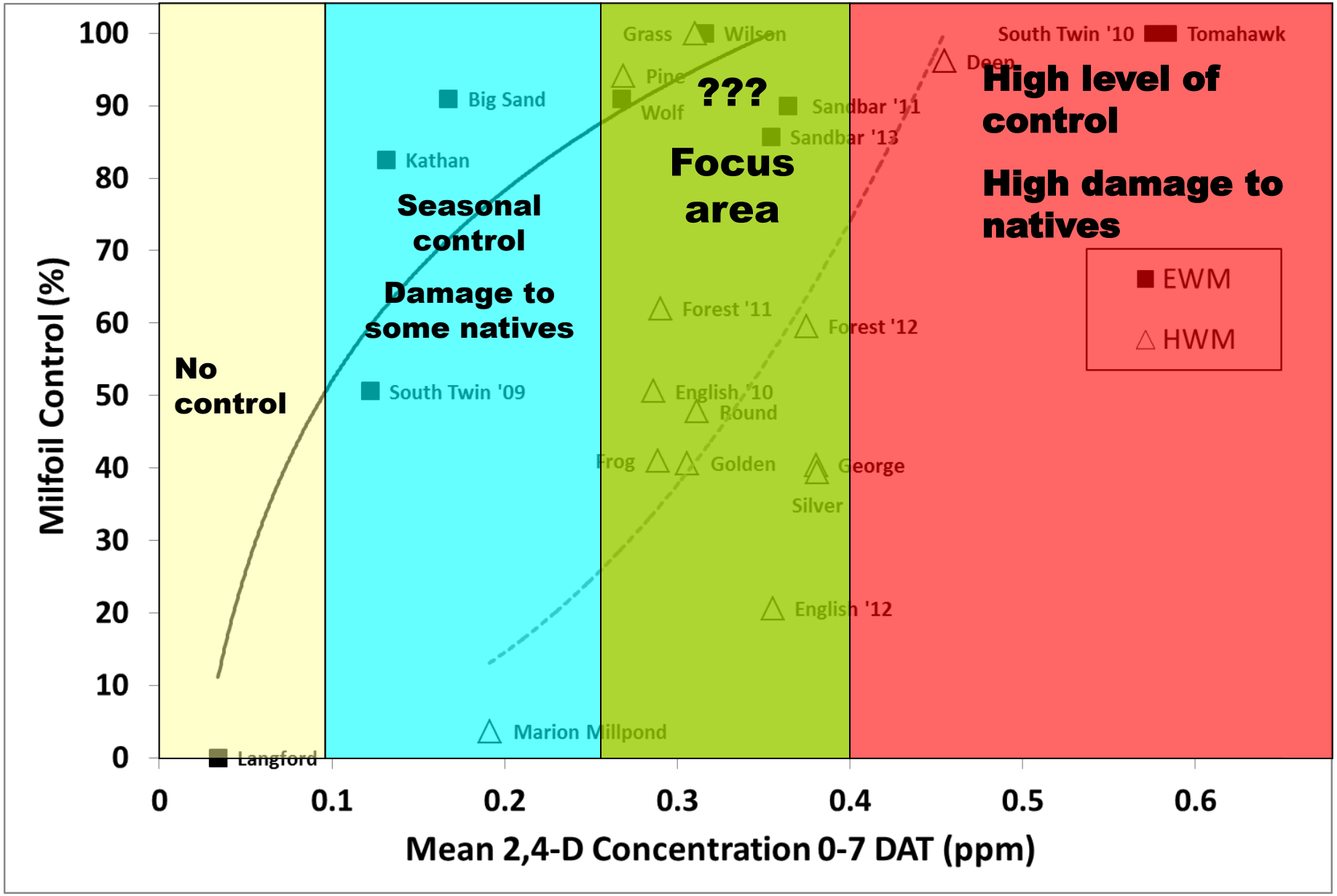




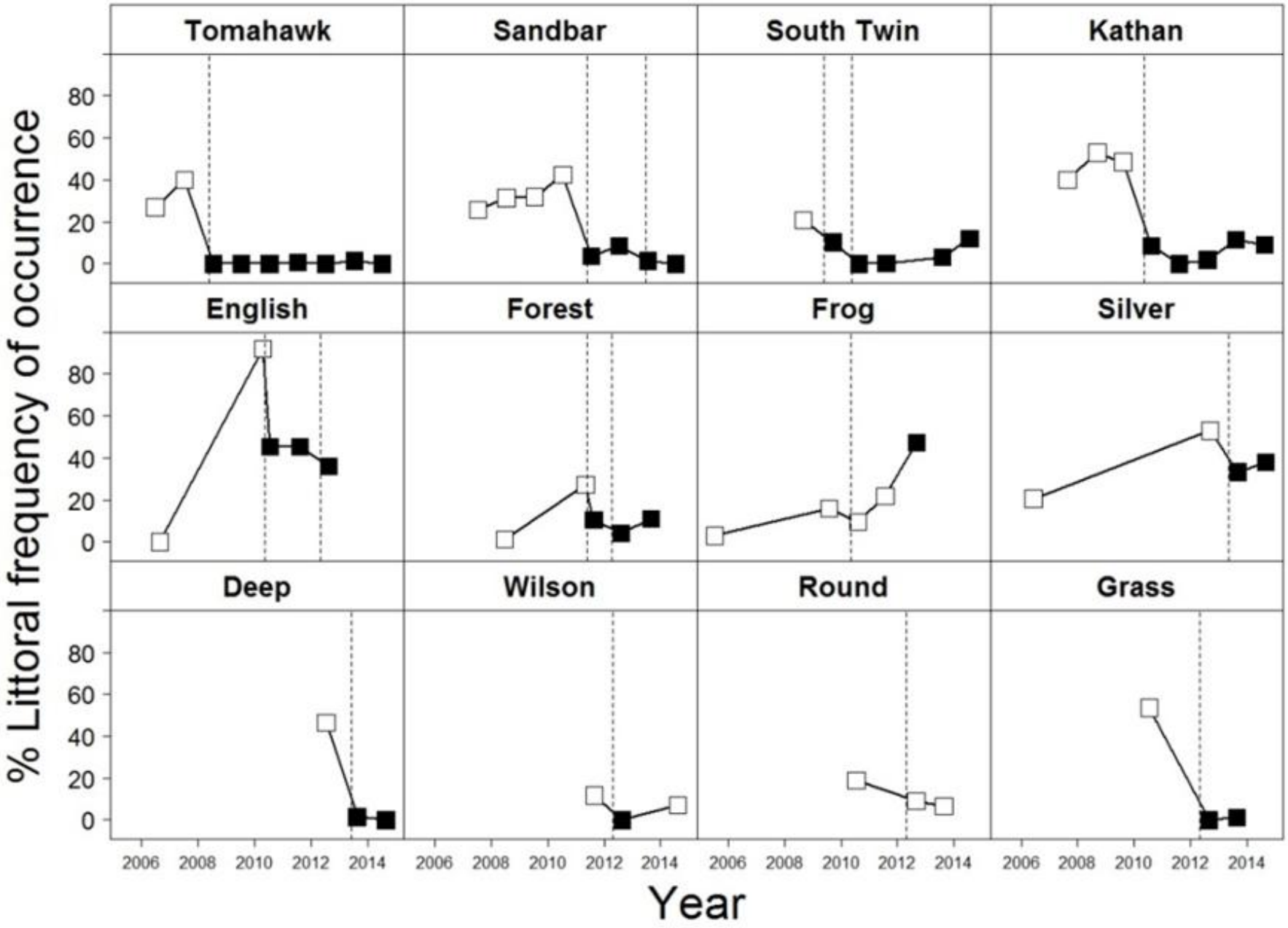




Milfoil Control



Long-Term Milfoil Control



Pre/Post Native Species
2,4-D Whole Lake Treatments

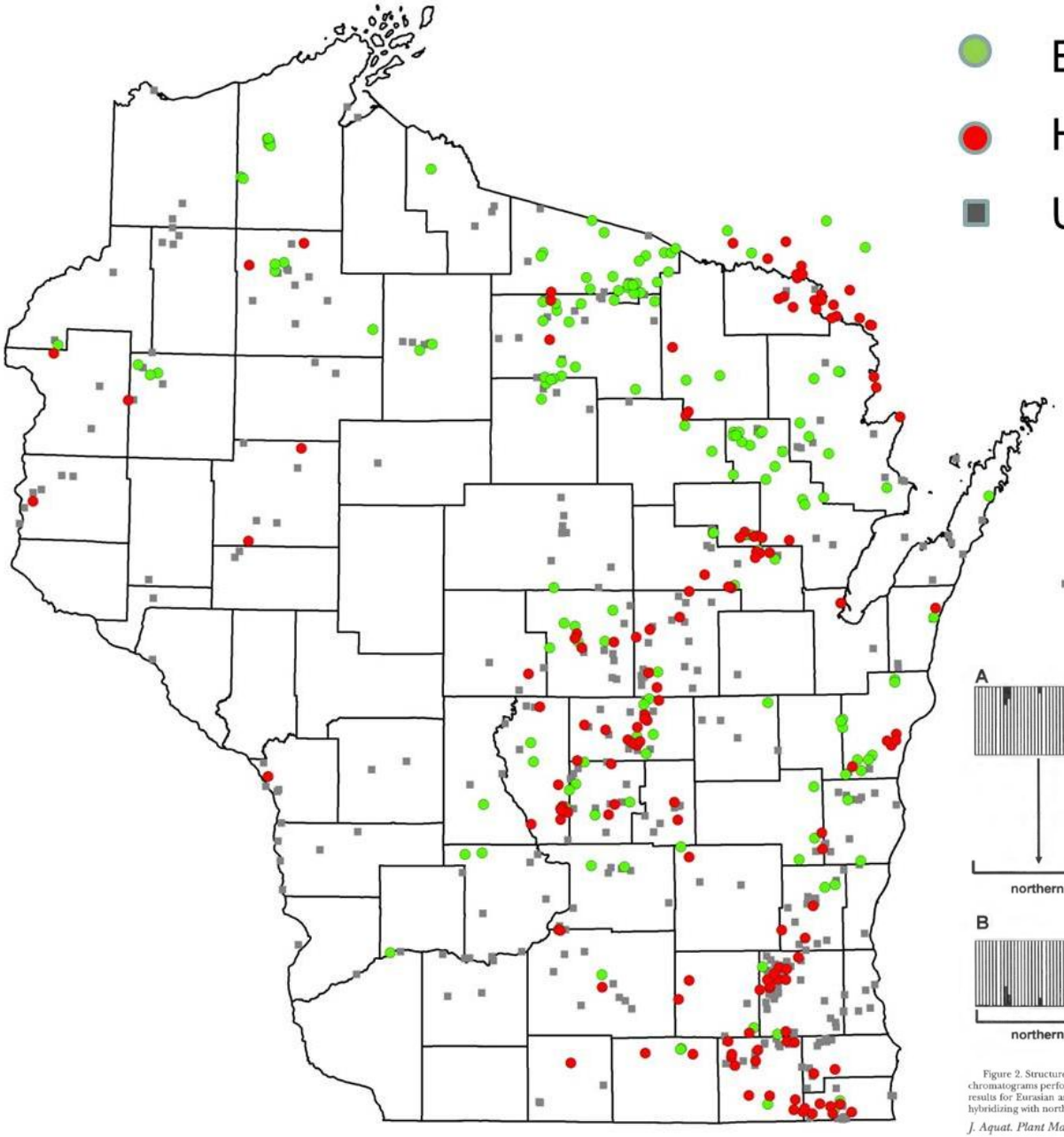
* = negative
+ = positive

Scientific Name, Common Name	Group	Sandbar	Tomahawk	Frog	Kathan	S. Twin '09	S. Twin '10	Berry	Wilson
Myriophyllum spicatum , Eurasian water milfoil	Dicot	***	***	n.s.	***	***	***	***	***
Bidens beckii , Water marigold	Dicot	-	<5%	-	-	***	***	-	-
Brasenia scherberi , Watershield	Dicot	-	<5%	-	n.s.	-	-	n.s.	<5%
Ceratophyllum demersum , Coontail	Dicot	<5%	<5%	-	n.s.	n.s.	n.s.	<5%	***
Chara spp., Muskgrasses	Macroalgae	n.s.	n.s.	n.s.	n.s.	***	n.s.	n.s.	*
Eleocharis acicularis , Needle spikerush	Monocot	n.s.	<5%	-	<5%	n.s.	n.s.	<5%	<5%
Elodea canadensis , Common waterweed	Monocot	n.s.	***	-	n.s.	n.s.	***	<5%	n.s.
Heteranthera dubia , Water star grass	Monocot	-	<5%	-	-	***	*	-	-
Myriophyllum tenellum , Dwarf watermilfoil	Dicot	n.s.	<5%	-	-	<5%	-	<5%	-
Myriophyllum sibiricum, Northern watermilfoil	Dicot	-	<5%	-	<5%	***	***	**	<5%
Najas flexilis , Bushy pondweed	Monocot	**	***	***	***	n.s.	***	*	*
Nitella spp., Stoneworts	Macroalgae	n.s.	***	-	***	<5%	<5%	<5%	n.s.
Nymphaea odorata , White water lily	Dicot	-	<5%	<5%	n.s.	-	-	<5%	n.s.
Potamogeton amplifolius , Large-leaf pondweed	Monocot	n.s.	***	n.s.	n.s.	<5%	<5%	n.s.	n.s.
Potamogeton epihydrus , Ribbon-leaf pondweed	Monocot	-	-	-	***	-	-	-	<5%
Potamogeton foliosus , Leafy pondweed	Monocot	-	-	*	-	-	-	-	-
Potamogeton friesii, Fries' pondweed	Monocot	-	-	-	-	**	<5%	-	-
Potamogeton gramineus , Variable leaf pondweed	Monocot	*	n.s.	<5%	<5%	n.s.	*	n.s.	-
Potamogeton pusillus , Small pondweed	Monocot	***	***	n.s.	***	*	***	<5%	**
Potamogeton richardsonii, Clasping-leaf pondweed	Monocot	<5%	-	-	<5%	+	n.s.	-	-
Potamogeton robbinsii , Robbins pondweed	Monocot	n.s.	*	-	-	n.s.	n.s.	n.s.	***
Potamogeton strictifolius , Stiff pondweed	Monocot	-	-	***	***	<5%	<5%	<5%	-
Potamogeton zosteriformis , Flat-stem pondweed	Monocot	-	-	n.s.	+	n.s.	***	<5%	***
Stuckenia pectinata , Sago pondweed	Monocot	-	-	n.s.	-	-	-	<5%	-
Utricularia minor , Small bladderwort	Dicot	-	-	-	*	-	-	-	-
Vallisneria americana , Wild celery	Monocot	***	***	<5%	+	***	+	+	*
Native spp. Significant Decrease (FOO > 5%)		4	7	3	6	7	8	2	7
Native spp. Significant Increase (FOO > 5%)		0	0	0	2	1	1	1	0
Net Native spp. Loss/Gain		-4	-7	-3	-4	-6	-7	-1	-7

Hybrid Watermilfoil

- Many misconceptions and misinformation regarding hybrid watermilfoils (*M. spicatum* X *sibiricum*)
- Statewide analysis of confirmed or suspected milfoil populations tested through ITS sequencing for hybridity
- ~130 lakes in WI have HWM confirmed
- There is not one 'single' hybrid watermilfoil, but it is rather a genetically diverse group that reflects recurrent hybridization (Zuelling & Thum 2012, JAPM)
- Further exploration of hybrid water milfoils and effectiveness of various herbicide treatments
- Collaboration with GVSU on variation in lakewide milfoil populations and selection pre vs post treatment
- Not <u>all</u> HWM appear to be tolerant to herbicides, but majority show statistically significant differences in % control when compared to pure EWM

Confirmed Hybrid Watermilfoil



- EWM
- HWM (or both)
- Unknown

Zuelling & Thum, 2012

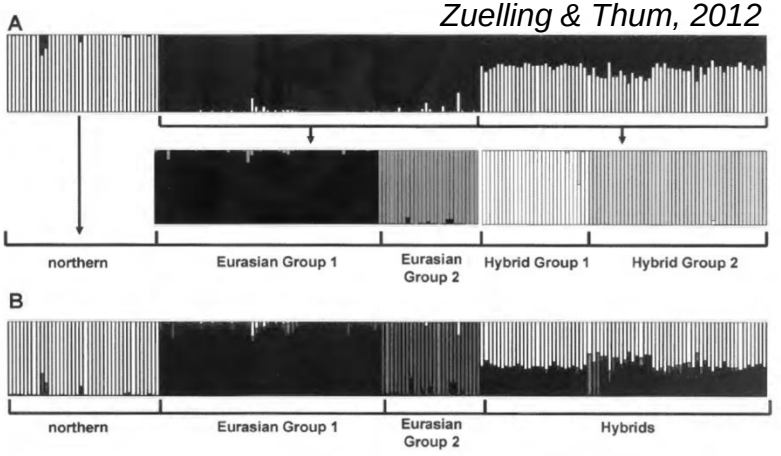


Figure 2. Structure results for our AFLP dataset. Vertical bars represent unique clones from each population identified with a visual inspection of AFLP chromatograms performed during scoring of AFLP chromatograms. A. (top): Structure results for the full dataset at K = 2; (bottom): Hierarchical Structure results for Eurasian and hybrid watermilfoils. Note that both contain two additional groups. B. Entire AFLP dataset at K = 3, shows both Eurasian groups hybridizing with northern watermilfoil.

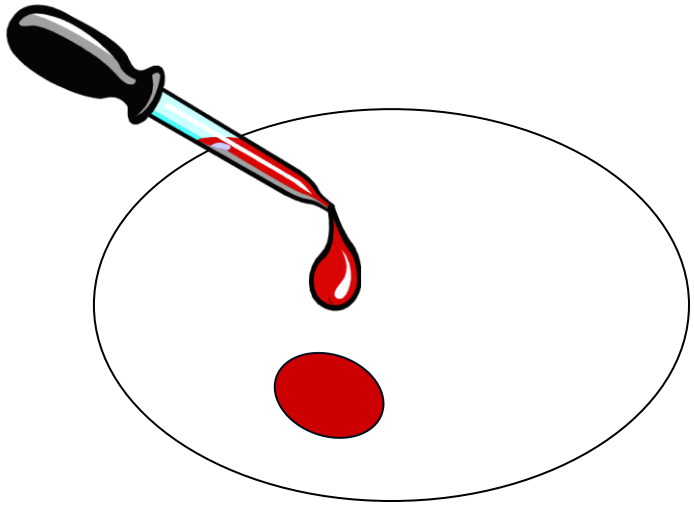
Preliminary Findings

- Herbicide dissipation is rapid and large scale treatments can result in a whole-lake treatment if the scale of the treatment area is large compared to the overall lake epilimnetic volume
- 2,4-D degradation rates and half-lives are variable across different lakes; analysis currently in progress…
- Early spring, large scale 2,4-D treatments may result in longer persistence of herbicides than expected; may exceed 0.1 ppm for >21 days
- EWM control looks promising, however short-term damage to certain native species may occur and long term effects on biotic and abiotic parameters is uncertain
- Hybrid watermilfoils need to be better documented and studied in both field and laboratory
- Future research into other herbicides (combos, triclopyr, fluridone)
- Herbicide monitoring is important, both to understand treatment efficacy, as well as ecological risks

Small-Scale Definitions

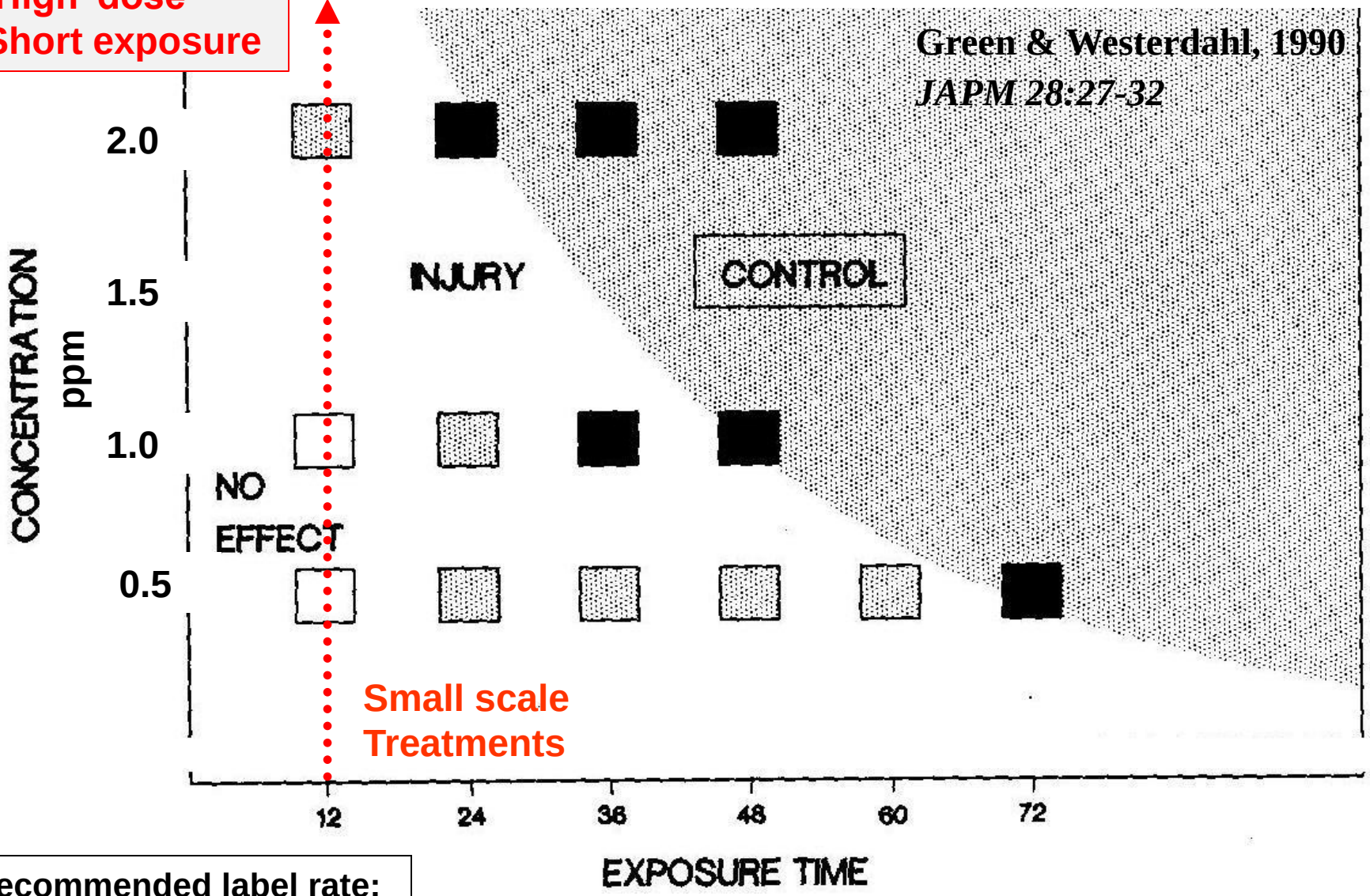
- *WI Admin. Code*: <10 acres or <10% of littoral zone

- *Ecological:* Herbicide will be applied at a scale where dissipation will not result in significant lakewide concentrations and effects are anticipated on a localized scale



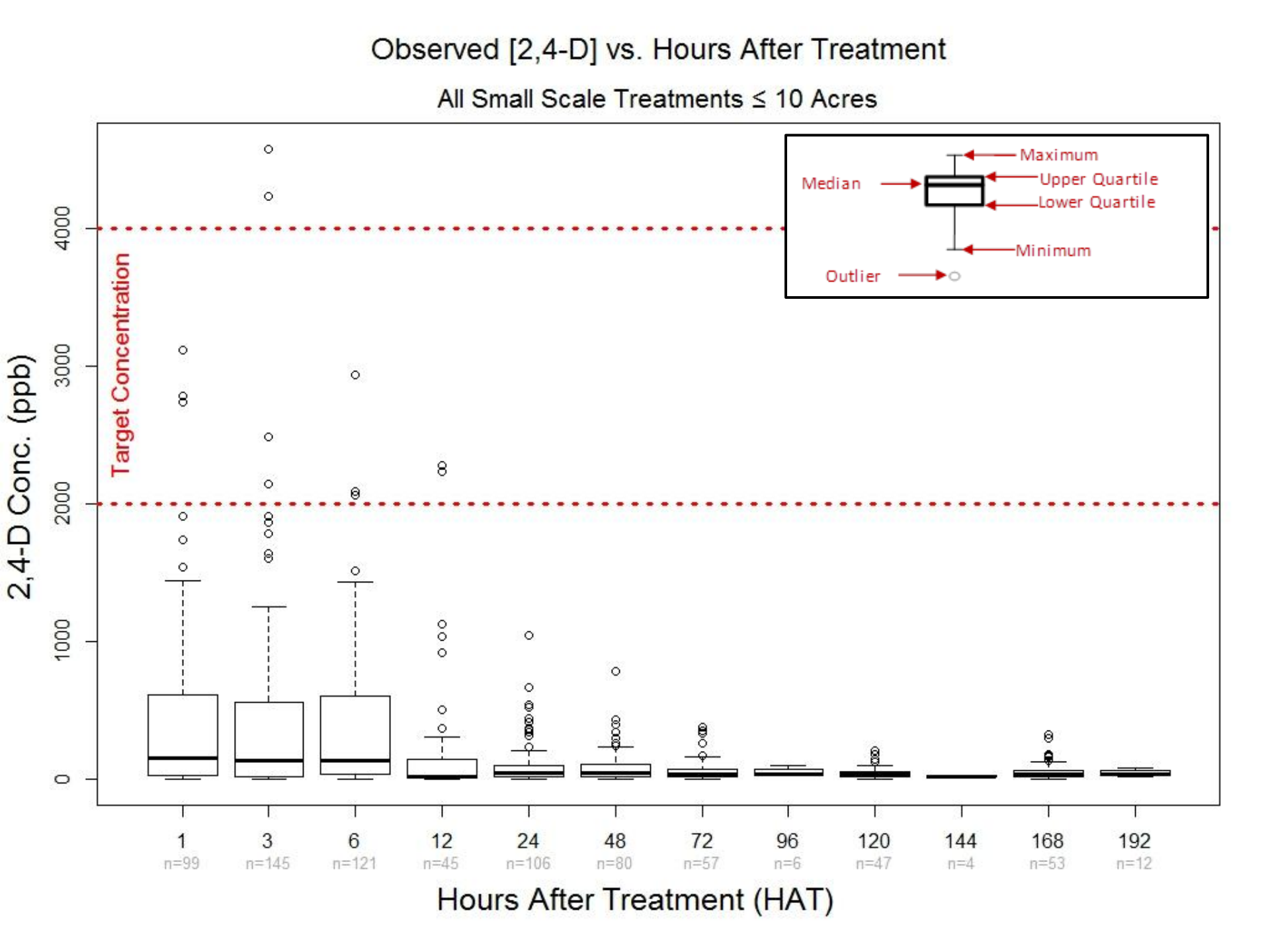
2,4-D Concentration/Exposure Time

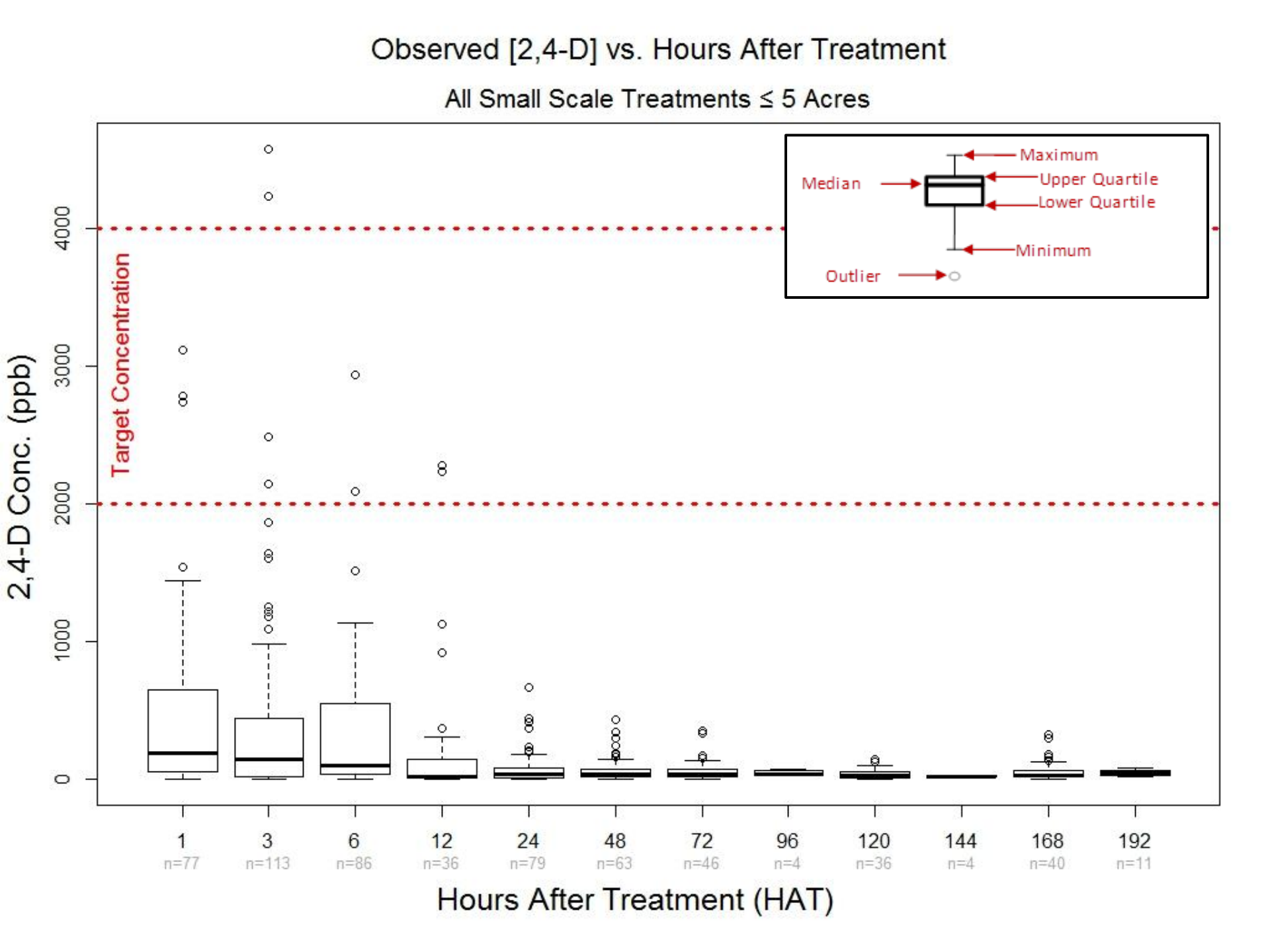
'High' dose
Short exposure

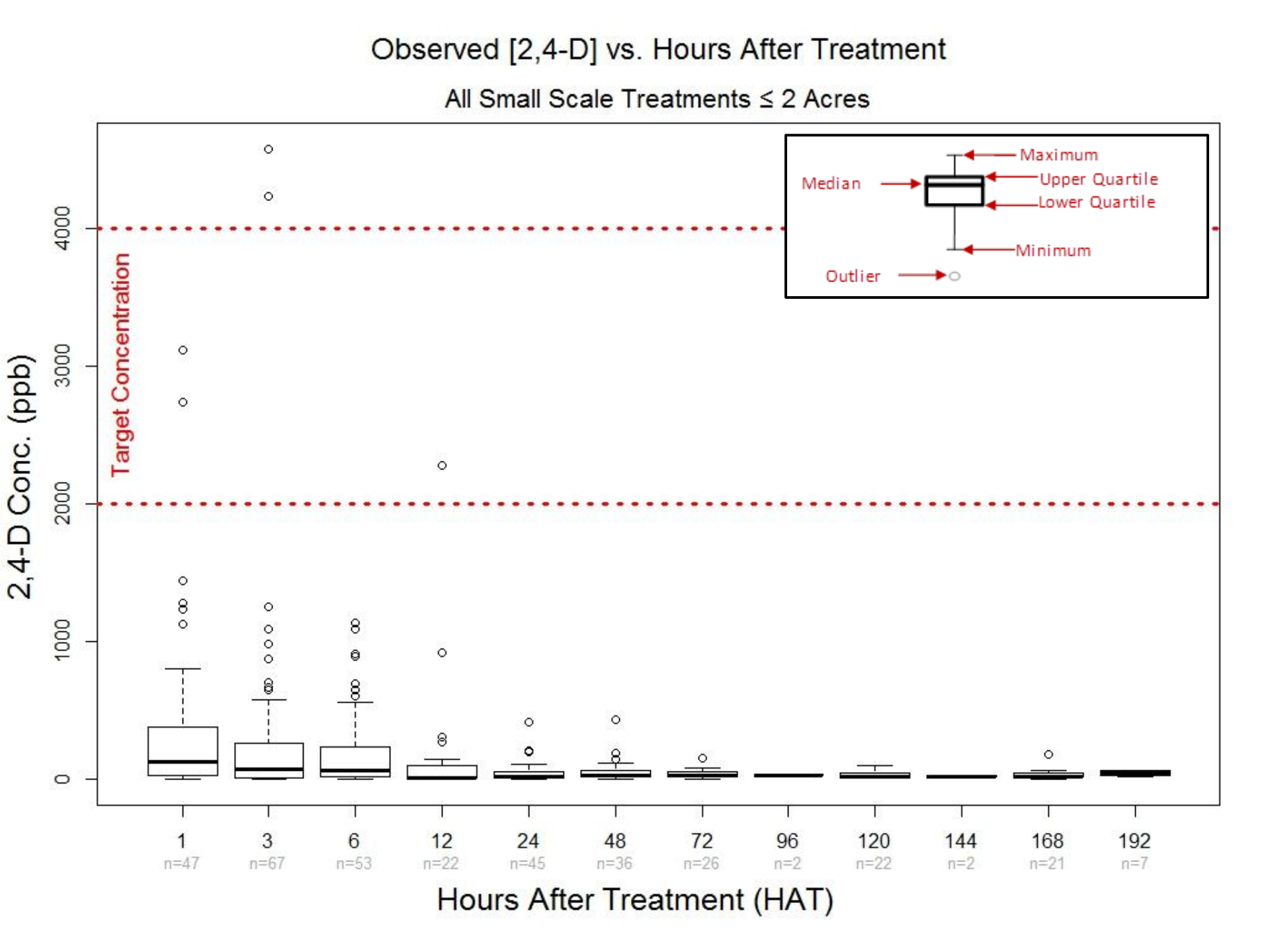


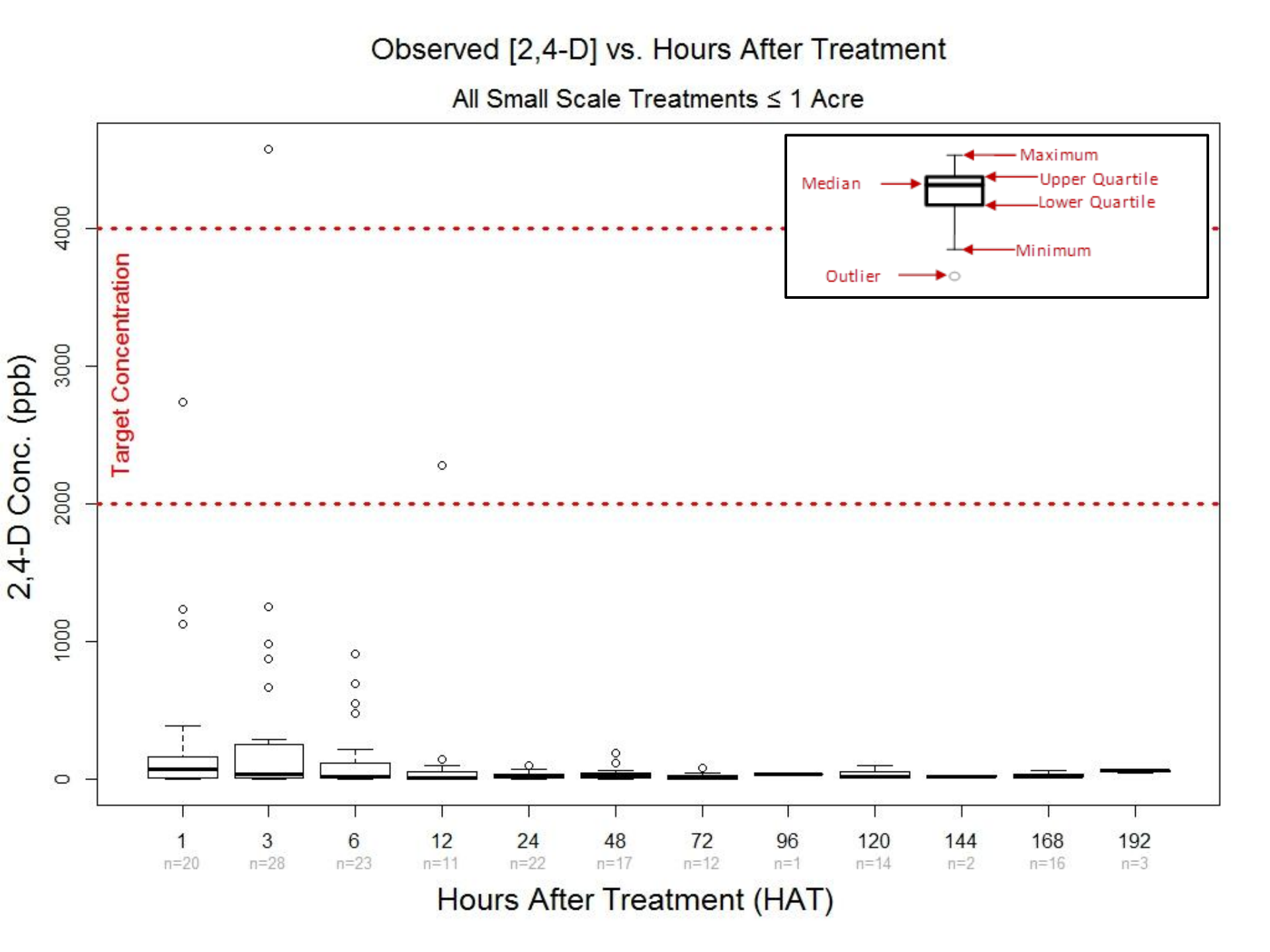
Recommended label rate:
2.0 – 4.0 ppm

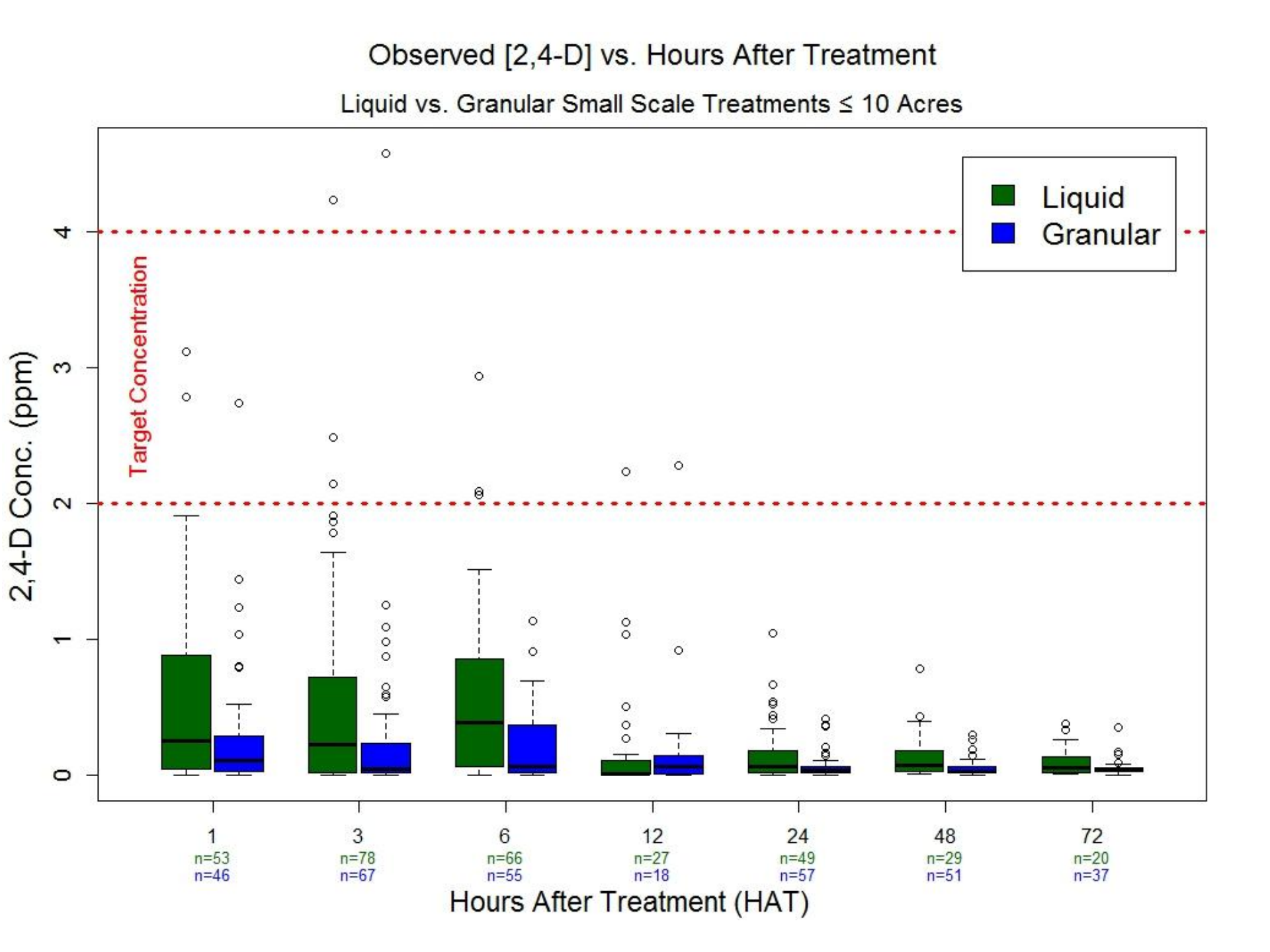
1.0 ppm = 1.0 mg/L = 1000 ppb


Observed [2,4-D] vs. Hours After Treatment
All Small Scale Treatments ≤ 10 Acres
Maximum
Upper Quartile
Median
Lower Quartile
Minimum
Outlier
Target Concentration
2,4-D Conc. (ppb)
0
1000
2000
3000
4000
1
n=99
3
n=145
6
n=121
12
n=45
24
n=106
48
n=80
72
n=57
96
n=6
120
n=47
144
n=4
168
n=53
192
n=12
Hours After Treatment (HAT)


Observed [2,4-D] vs. Hours After Treatment
All Small Scale Treatments ≤ 5 Acres
Maximum
Upper Quartile
Median
Lower Quartile
Minimum
Outlier
Target Concentration
2,4-D Conc. (ppb)
0
1000
2000
3000
4000
1
n=77
3
n=113
6
n=86
12
n=36
24
n=79
48
n=63
72
n=46
96
n=4
120
n=36
144
n=4
168
n=40
192
n=11
Hours After Treatment (HAT)


Observed [2,4-D] vs. Hours After Treatment
All Small Scale Treatments ≤ 2 Acres
Maximum
Upper Quartile
Median
Lower Quartile
Minimum
Outlier
Target Concentration
2,4-D Conc. (ppb)
0
1000
2000
3000
4000
1
n=47
3
n=67
6
n=53
12
n=22
24
n=45
48
n=36
72
n=26
96
n=2
120
n=22
144
n=2
168
n=21
192
n=7
Hours After Treatment (HAT)


Observed [2,4-D] vs. Hours After Treatment
All Small Scale Treatments ≤ 1 Acre
Maximum
Upper Quartile
Median
Lower Quartile
Minimum
Outlier
Target Concentration
2,4-D Conc. (ppb)
0
1000
2000
3000
4000
1
n=20
3
n=28
6
n=23
12
n=11
24
n=22
48
n=17
72
n=12
96
n=1
120
n=14
144
n=2
168
n=16
192
n=3
Hours After Treatment (HAT)


Observed [2,4-D] vs. Hours After Treatment
Liquid vs. Granular Small Scale Treatments ≤ 10 Acres
Liquid
Granular
Target Concentration
2,4-D Conc. (ppm)
0
1
2
3
4
1
n=53
n=46
3
n=78
n=67
6
n=66
n=55
12
n=27
n=18
24
n=49
n=57
48
n=29
n=51
72
n=20
n=37
Hours After Treatment (HAT)

Preliminary Findings

- Actual CET in the field is more difficult to predict and maintain in smaller scale treatments
- Aquatic plant data is more difficult to collect and analyze in smaller scale treatments – efficacy of control is variable
- Rapid dissipation occurs with both granular and liquid 2,4-D formulations and concentrations were below what laboratory CET analysis recommend for effective control
- Future research into sediment porewater and herbicide uptake mechanisms
- No “one size fits all” solution - future research into other herbicides (diquat, triclopyr, combos)
- Future research into other IPM (hand-removal, DASH, biocontrol, etc.) for small-scale AIS control
- Future research into extending exposure time (i.e. barrier curtains)

DISCUSSION

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http://dnr.wi.gov/lakes/plants/research/