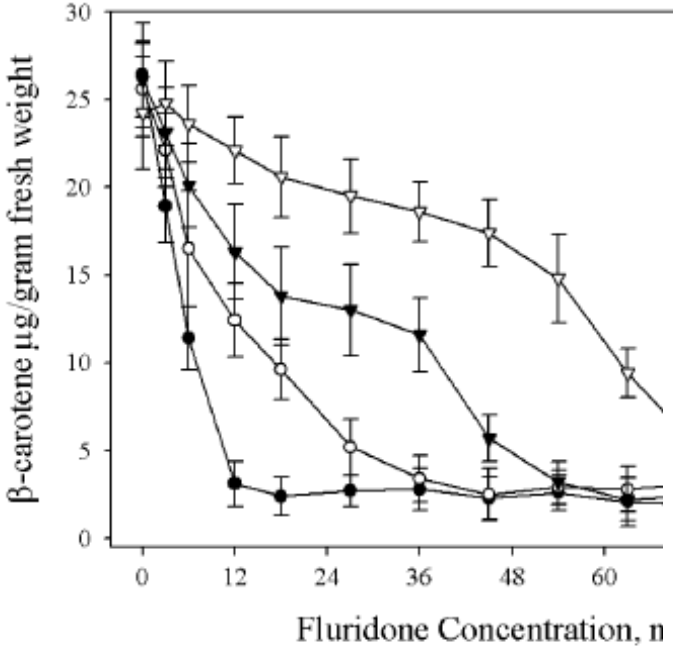
How do We Identify High-risk Genotypes for Adaptive Management of Eurasian and Hybrid Watermilfoil?

Ryan A Thum

MONTANA STATE UNIVERSITY

- Genetic variation can influence the potential for spread, impact, and control of invasive aquatic plants

http://www.northeastans.org/online-guide/files/9wpCqMpA/F4-Hydrilla-verticillata.jpg



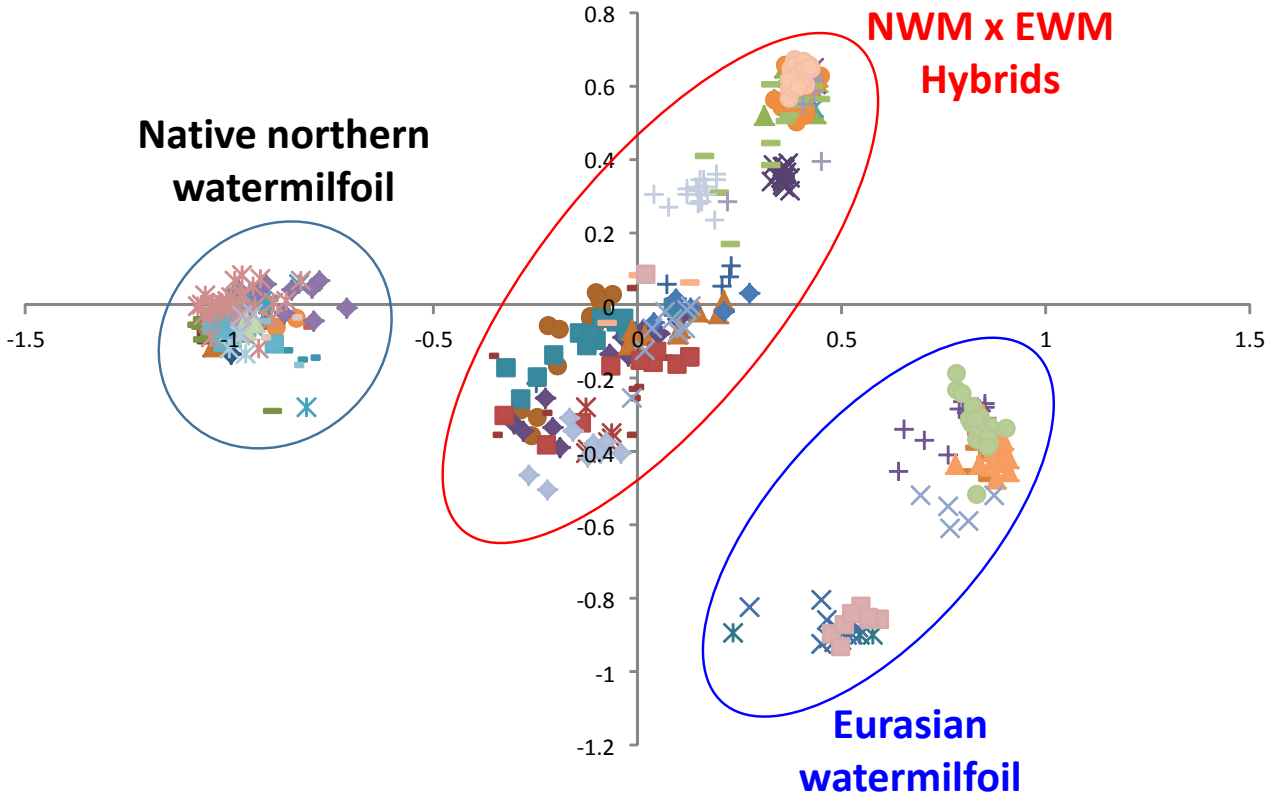
Molecular Ecology (2004) 13, 3229–3237

doi: 10.1111/j.1365-294X.2004.02280.x

Somatic mutation-mediated evolution of herbicide resistance in the nonindigenous invasive plant hydrilla (*Hydrilla verticillata*)

ALBRECHT MICHEL,* RENEE S. ARIAS,* BRIAN E. SCHEFFLER,* STEPHEN O. DUKE,* MICHAEL NETHERLAND† and FRANCK E. DAYAN*

Location		
Rainbow River	cDNA/genomic DNA	ATTGCCTTAAACCGTTTCCTTCAGGAA
	Amino acid	-I--A--L--N--**R**--F--L--Q--E-
Lulu	cDNA/genomic DNA	ATTGCCTTAAACAGTTTCCTTCAGGAA
	Amino acid	-I--A--L--N--**S**--F--L--Q--E-
Pierce	cDNA/genomic DNA	ATTGCCTTAAACTGTTTCCTTCAGGAA
	Amino acid	-I--A--L--N--**C**--F--L--Q--E-
Okahumpka	cDNA/genomic DNA	ATTGCCTTAAACCATTTCCTTCAGGAA
	Amino acid	-I--A--L--N--**H**--F--L--Q--E-



- Most populations are genetically different
- Many contain mixtures of taxa and genotypes

Netherland and Willey 2017 *JAPM*

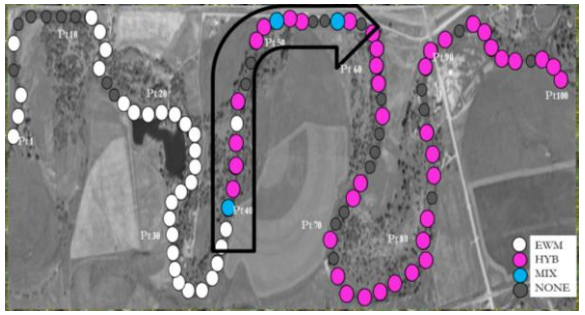
TABLE 1. PERCENTAGE OF BIOMASS COMPARED WITH UNTREATED REFERENCE PLANTS FOR FOUR WATERMILFOIL ACCESSIONS AT 1, 2, AND 4 WK AFTER TREATMENT (WAT) FOLLOWING APPLICATION OF THE HERBICIDES DIQUAT, ENDOTHALL, AND 2,4-D AT VARYING CONCENTRATIONS AND EXPOSURE TIMES ($N = 6$). LETTERS REPRESENT DIFFERENCES WITHIN AN HERBICIDE/EXPOSURE TREATMENT BETWEEN THE FOUR WATERMILFOIL ACCESSIONS.

		Diquat 0.37 mg/L		Endothall 1.5 mg/L		2,4-D 0.5 mg/L				
Taxon	Source	8 h	24 h	8 h	24 h	8 h	24 h	48 h	96 h	144 h
1 WAT										
Eurasian	Minnetonka	7 b	0 b	92	71 b	23 c	41 c	0 c	0 b	0
Hybrid	Townline	137 a	39 a	96	64 b	64 b	57 b	0 c	0 b	0
Hybrid	Frog	4 b	0 b	90	59 b	54 b	33 c	20 b	26 a	0
Hybrid	English	3 b	0 b	86	82 a	71 a	77 a	75 a	28 a	0
2 WAT										
Eurasian	Minnetonka	3 b	0 b	113 a	73 a	23 c	43bc	0 c	0 b	0
Hybrid	Townline	69 a	31 a	55 c	41 c	64 a	54 b	0 c	0 b	0
Hybrid	Frog	1 b	0 b	76 b	68 b	54 b	31 c	29 b	26 a	0
Hybrid	English	6 b	0 b	84 b	75 b	77 a	72 a	65 a	38 a	0
4 WAT										
Eurasian	Minnetonka	11 b	3 b	92 b	121 a	28 c	35 b	0 c	0 c	0 b
Hybrid	Townline	115 a	42 a	66 c	44 c	43 c	51 b	2 c	0 c	0 b
Hybrid	Frog	0 c	0 b	107 a	83 b	77 b	43 b	50 b	16 b	0 b
Hybrid	English	0 c	0 b	117 a	121 a	108a	98 a	97 a	42 a	18 a

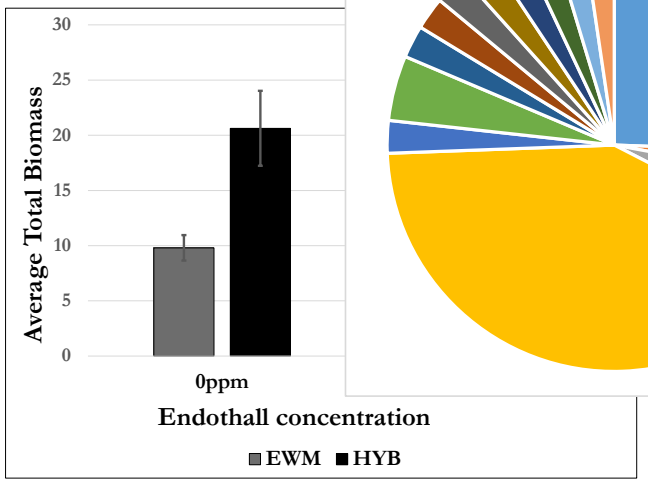
Glomski and Netherland 2010; Berger et al. 2012; Thum et al. 2012; LaRue et al. 2013;

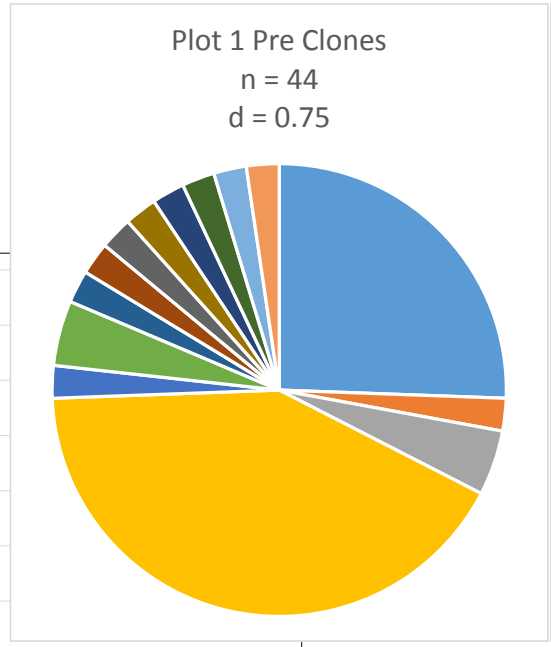
- **How do we identify “high-risk” genotypes**
  - Tolerant to control techniques
  - Faster growing/spreading (“weedier”)
- Herbicide screens

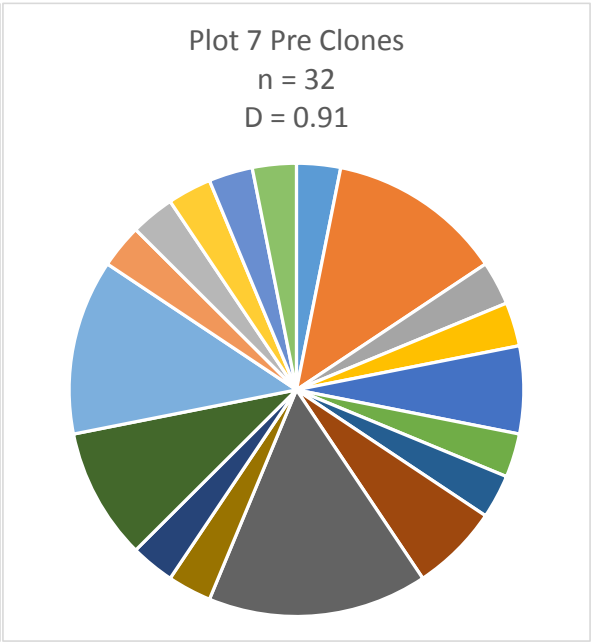
Jefferson Slough, Montana



Noxon Reservoir, Montana





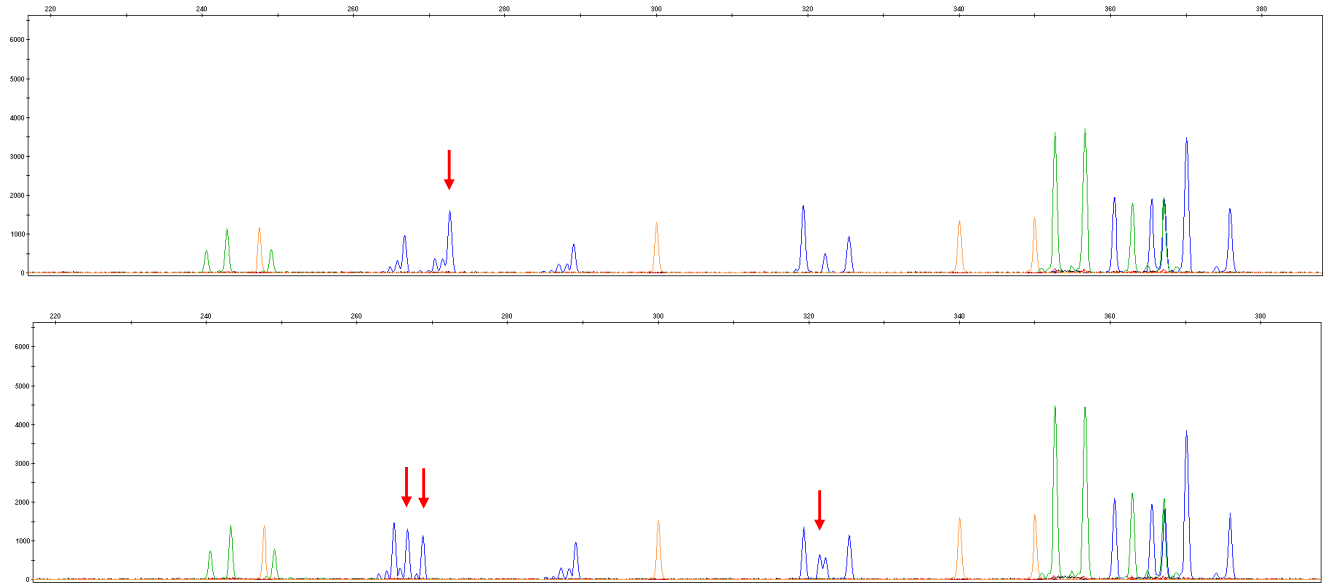


- **How do we identify “high-risk” genotypes**
  - Tolerant to control techniques
  - Faster growing/spreading (“weedier”)

- Herbicide screens
  - Limited in the number that can be studied at any one time under different CETs of different herbicides
  - Populations may not be genetically uniform, and may change over time

- **Use genetic surveys and monitoring to pre-screen large numbers of genotypes and focus herbicide screens on “red-flagged” genotypes**

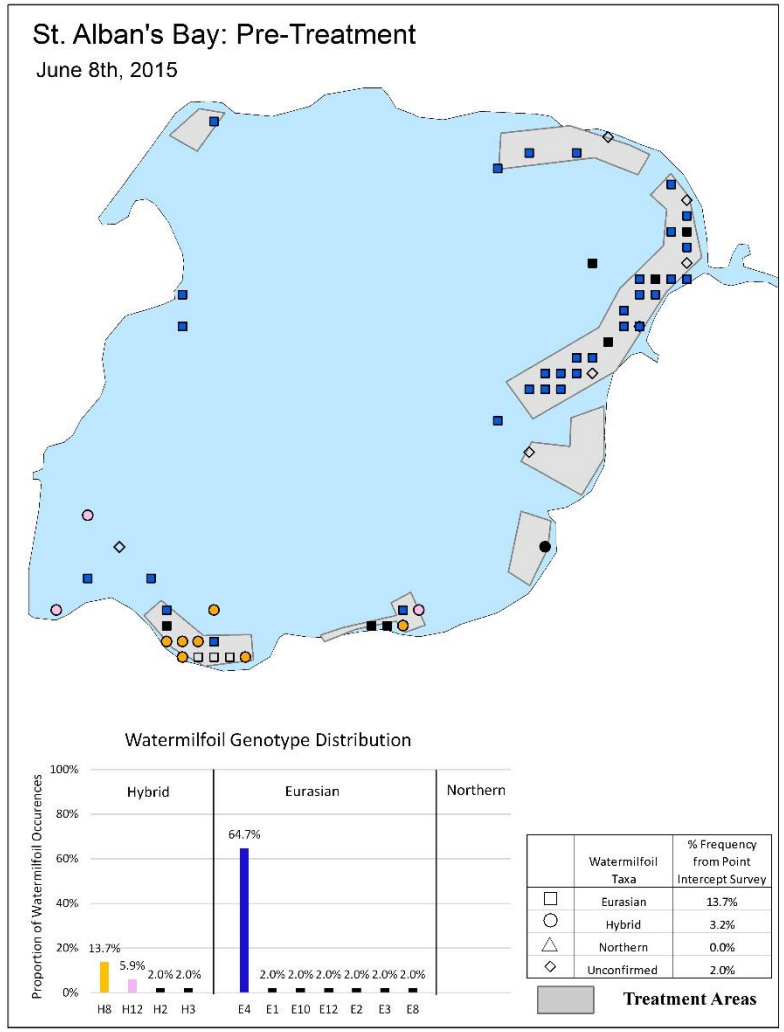
- Microsatellite genotyping

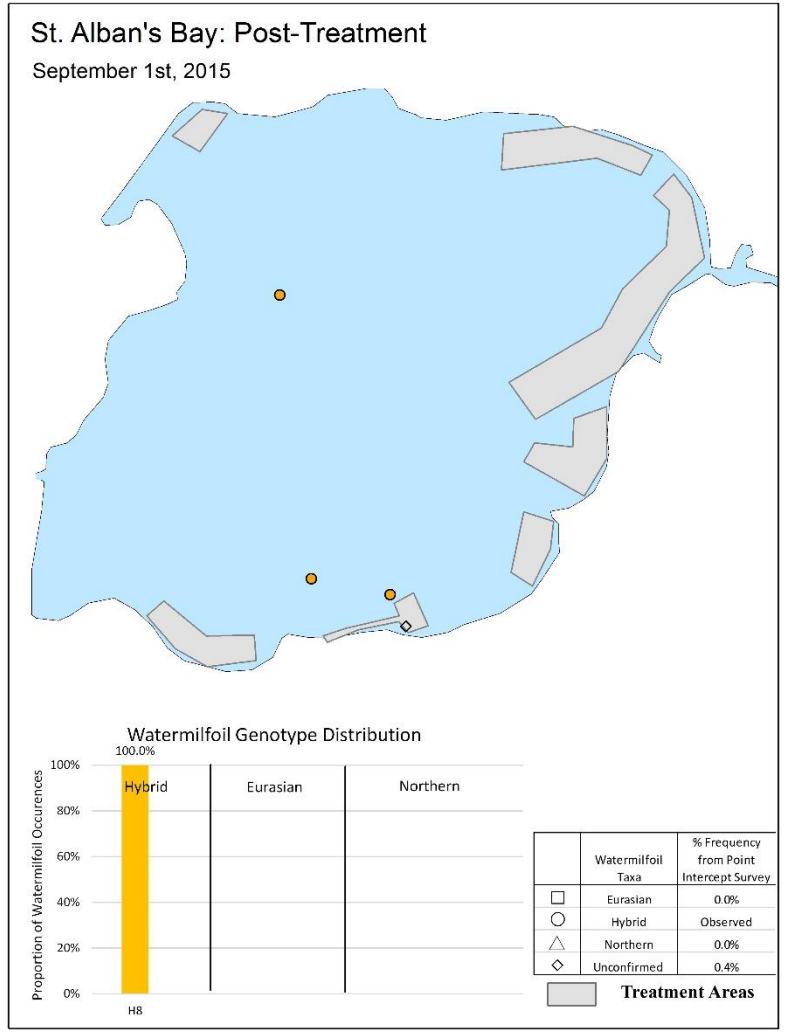


- Vegetative (clonal) reproduction common
  - Assume same microsatellite genotype same clone***

Results

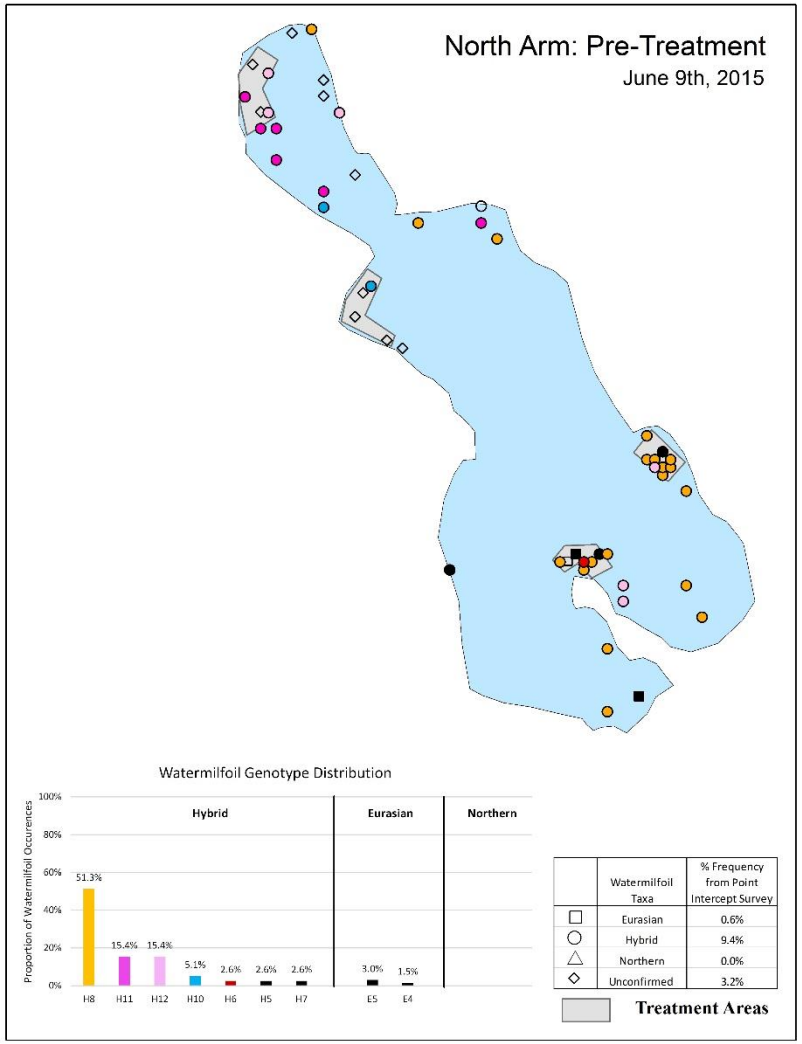
Herbicide Treatments: St. Alban's Bay

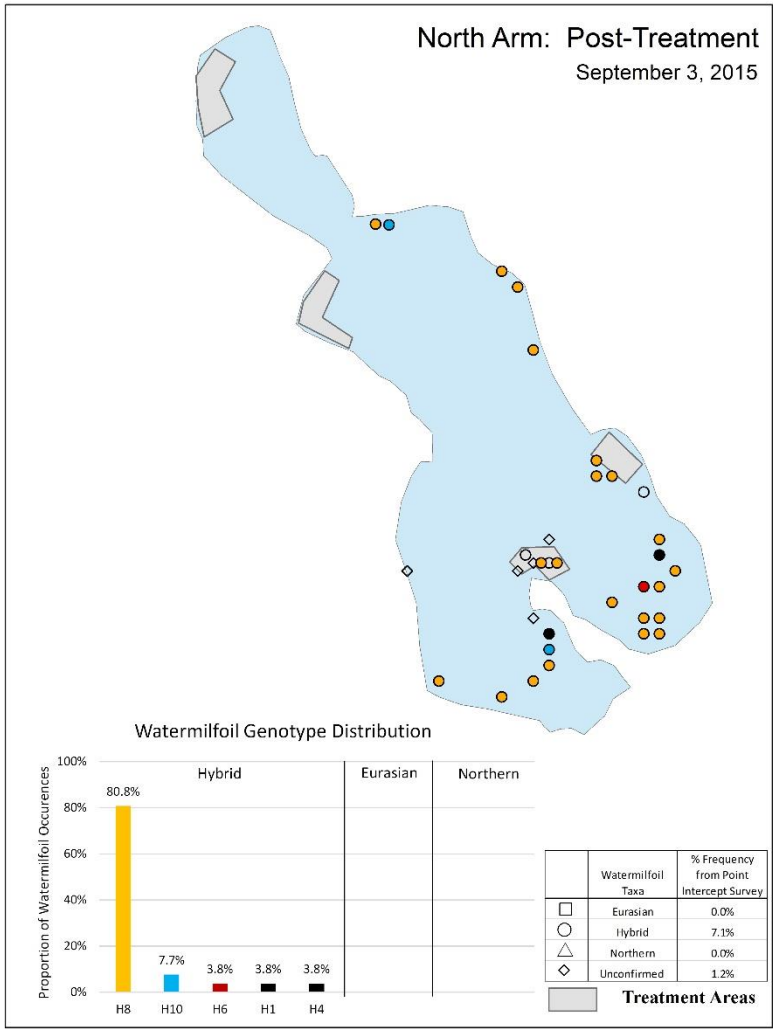




Results

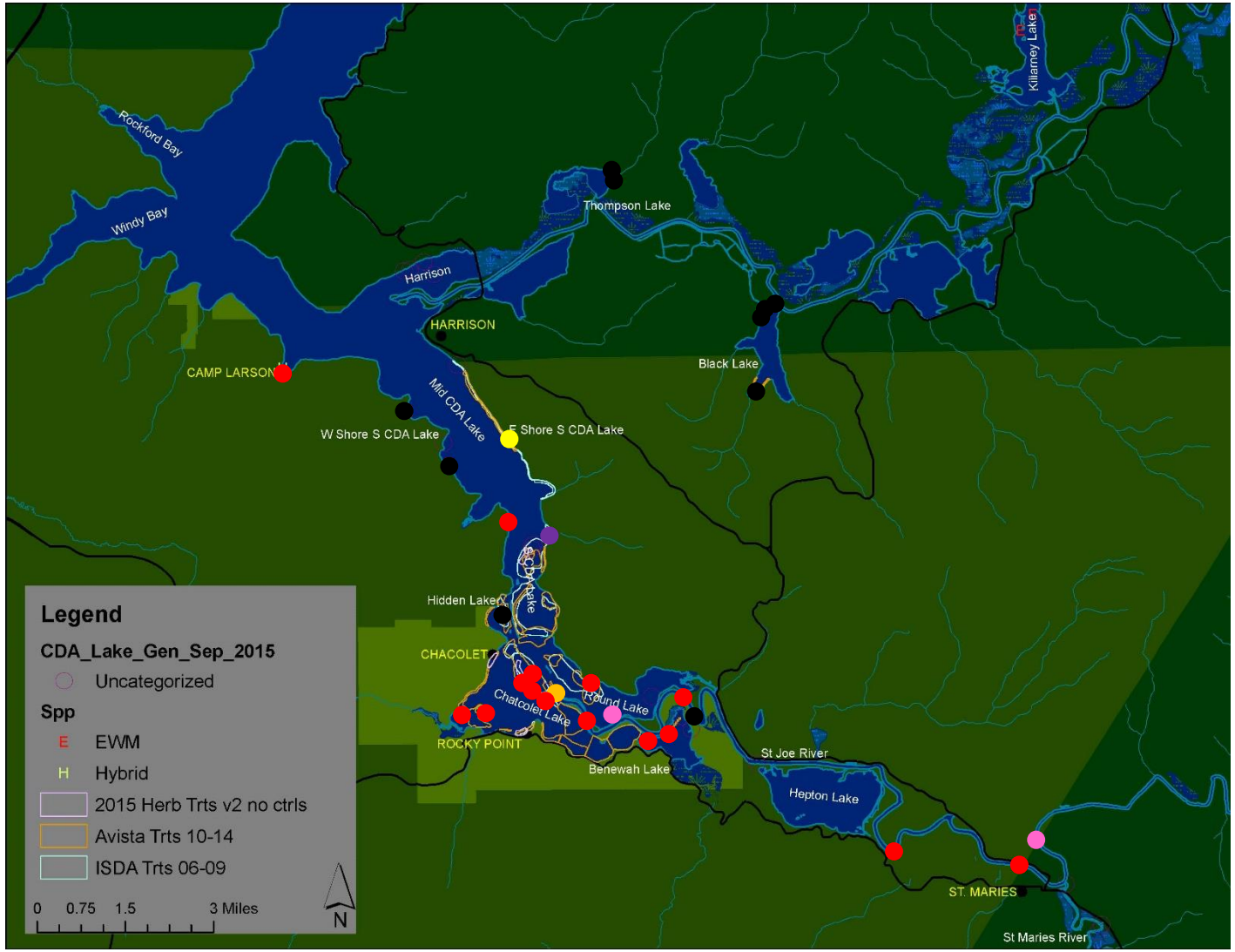
Herbicide Treatments: North Arm Bay





Results

Genetic variation in relation to herbicide treatment history



- **Criteria for identifying "high-risk" genotypes using genetic surveys and monitoring**
  - Genotype increase in relative abundance over time
    - North Arm Bay, Lake Minnetonka, MN
    - *Especially if in multiple lakes* – St. Alban's Bay
  - Genotype distribution that maps onto treatment history
    - Coeur d'Alene Lake, ID
  - Genotype monotypic or highly dominant
    - Townline Lake, MI – fluridone tolerant
    - Hayden Lake, ID – 2,4-D (endothall) tolerant
    - *Especially if in multiple water bodies*

- Distinguishing genotypes
  - Molecular marker pros/cons
    - AFLPs have high error rates
    - Microsatellites have relatively few molecular markers
    - Genotyping-by-sequencing/SNPs
- Over-interpreting genetic data
  - “Genetic drift” versus selection
  - Selection for other traits besides growth and herbicide response
- Informing herbicide screens (*not replacing*)
  - Prioritize genotypes for feasibility of scale

Acknowledgments

- Data Collection
  - Murat Buyukyoruk, Paula Guastello, Mitchell Herbert, Jeff Pashnick, Cara Still
- Eric Fieldseth, Ray Newman, Minehaha Creek Watershed District
- Ben Scofield, Tom Woolf, Idaho Department of Agriculture, Avista Corp.
- Jill Allen, Celestine Duncan, Tanner Mitchell, Erik Hansen, MT DNRC, Sanders County, MT