Using Suitability Assessments to Determine the Degree of Zebra Mussel Colonization Potential

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Zebra Mussels in Wisconsin And Minnesota

	Wisconsin	Minnesota
1st Observed	1989	2000
Number of Water Bodies Infested	131	75 (includes wetlands)
Number of Lakes Not Infested	Many	A lot

Zebra mussels don’t take over every lake they invade

Photo courtesy of USGS

Zebra Mussel Growth Characteristics

Light Growth

Heavy Growth

What Is Needed for Growth?

- Water Column Parameters
  - Living conditions: DO and temp
  - Shell formation: Ca, pH, alkalinity, conductivity
  - Food: chl a, TP, Secchi disc

Water Column Parameters

			Low Potential for Adult Survival	Low Potential for Larval Development	Moderate (survivable, but will not flourish)	High (favorable for optimal growth)
Living Conditions	Dissolved oxygen (mg/l)	Mackie and Claudi 2010	<3	3 - 7	7 - 8	>8
	Temperature (C)	Mackie and Claudi 2010	<10 or >32	26 - 32	10 - 20	20 - 26
Shell Formation	Calcium (mg/l)	Mackie and Claudi 2010	<8	8 - 15	15 - 30	>30
	pH	Mackie and Claudi 2010	<7.0 or >9.5	7.0 - 7.8 or 9.0 - 9.5	7.8 - 8.2 or 8.8 - 9.0	8.2 - 8.8
	Alkalinity (as mg $CaCO_3$/l)	Mackie and Claudi 2010	<30	30 - 55	55 - 100	100 - 280
	Conductivity (umhos)	Mackie and Claudi 2010	<30	30 - 60	60 - 110	>110
Food	Secchi depth (m)	Mackie and Claudi 2010	<1 or >8	1 - 2 or 6 - 8	4 - 6	2 - 4
	Chlorophyll a (ug/l)	Mackie and Claudi 2010	<2.5 or >25	2.0 - 2.5 or 20 - 25	8 - 20	2.5 - 8
	Total phosphorus (ppb)	Mackie and Claudi 2010	<5 or >50	5 - 10 or 35 - 50	10 - 25	25 - 35

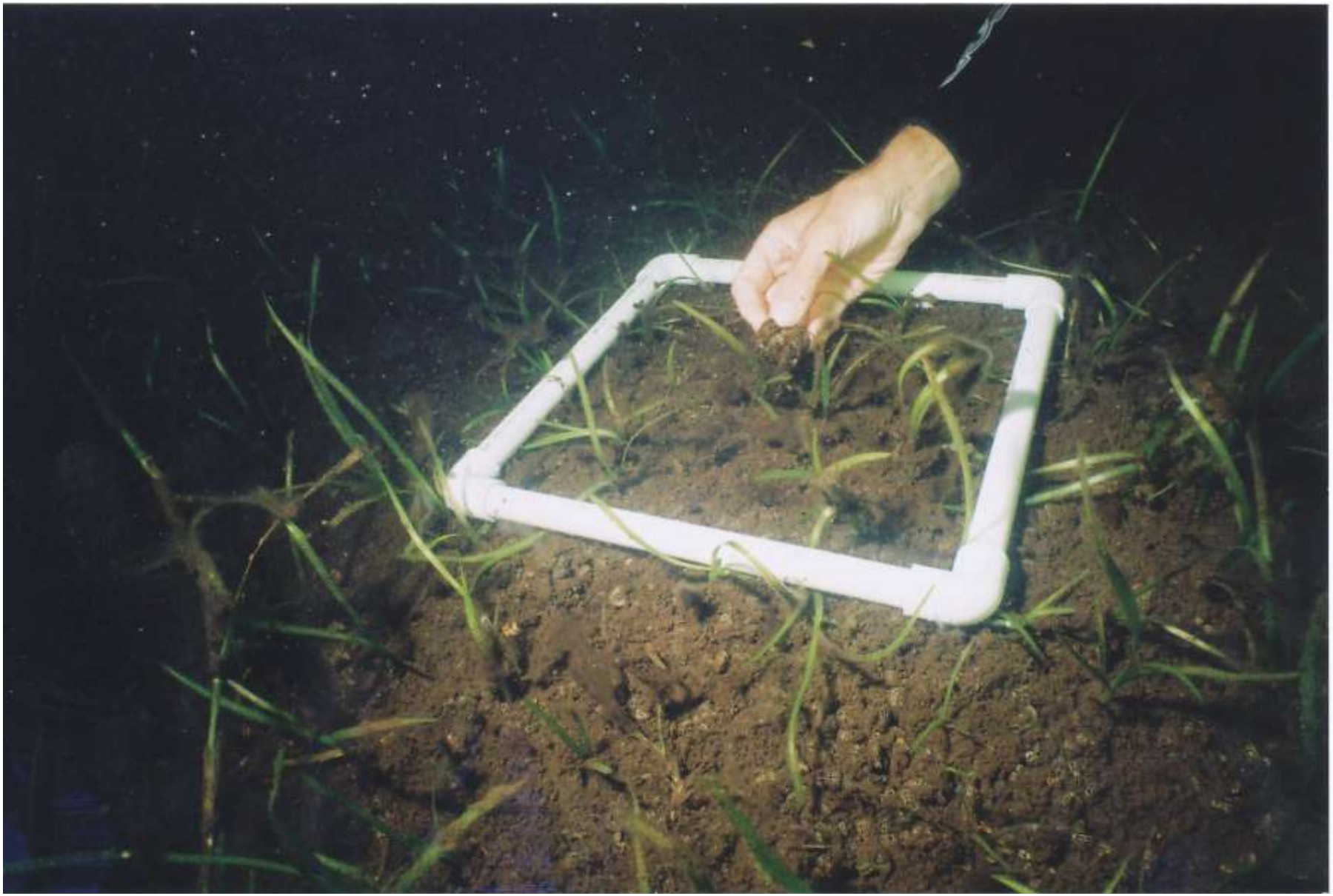
Substrate Parameters

- Bottom Conditions (Horizontal)
  - Sand/Silt
  - Rock
- Plants and Structures (Vertical)
  - Plants
  - boat lifts

Substrate – Sand/Silt

Sub-optimal

Substrate – Sand/Silt



Substrate – Sand/Silt

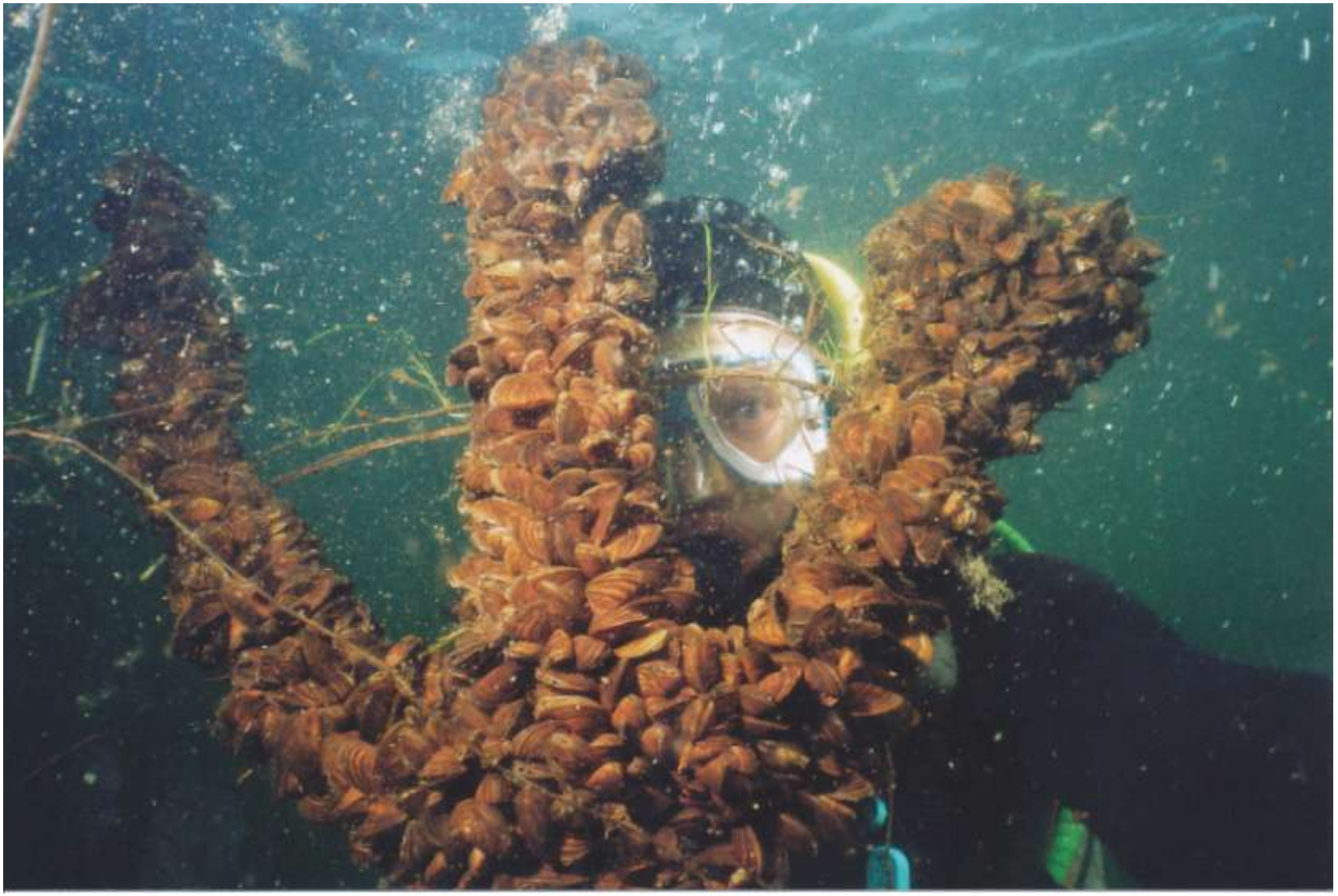
Substrate – Clumps on Sand/Silt

Substrate - Clumps

Substrate - Rocks

Optimal

Substrate - Wood



Optimal

Substrate – Vertical - Plants

Zebra Mussels Grow on Plants

Substrate – Vertical – Boat Lifts

Lake Conditions Were Calibrated with Zebra Mussel Densities in Lakes

- Zumbro – Mussels first observed in 2000
  - Population increased and then collapsed
- In 2010 growth is considered to be light

Zumbro Conditions

- Shell formation - optimal
- Food – sub-optimal (blue-green algae)
- Overall: food trumps calcium,
  density is sub-optimal (light growth)

Ossawinnamakee Conditions
(First Observed in 2003)

- Shell formation - optimal

- Food – optimal then changed to sub-optimal (less than 1 ug/l of chlorophyll)

Ossawinnamakee

- Heavy growth appeared to change to moderate growth

Filamentous algae in 2009

Filamentous algae in 2010

Lake Minnetonka Suitability Assessment

- Assessment conducted in June 2010

(*Zebra mussels found in July 2010*)

Lake Minnetonka – 14,000 Acres

Habitat Varies Within the Lake

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	Total phosphorus (ppb)	Mackie and Claudi 2010	<5 or >50	5 - 10 or 35 - 50	10 - 25	25 - 35

Chart found at MnDNR zebra mussels, link to Lake Minnetonka

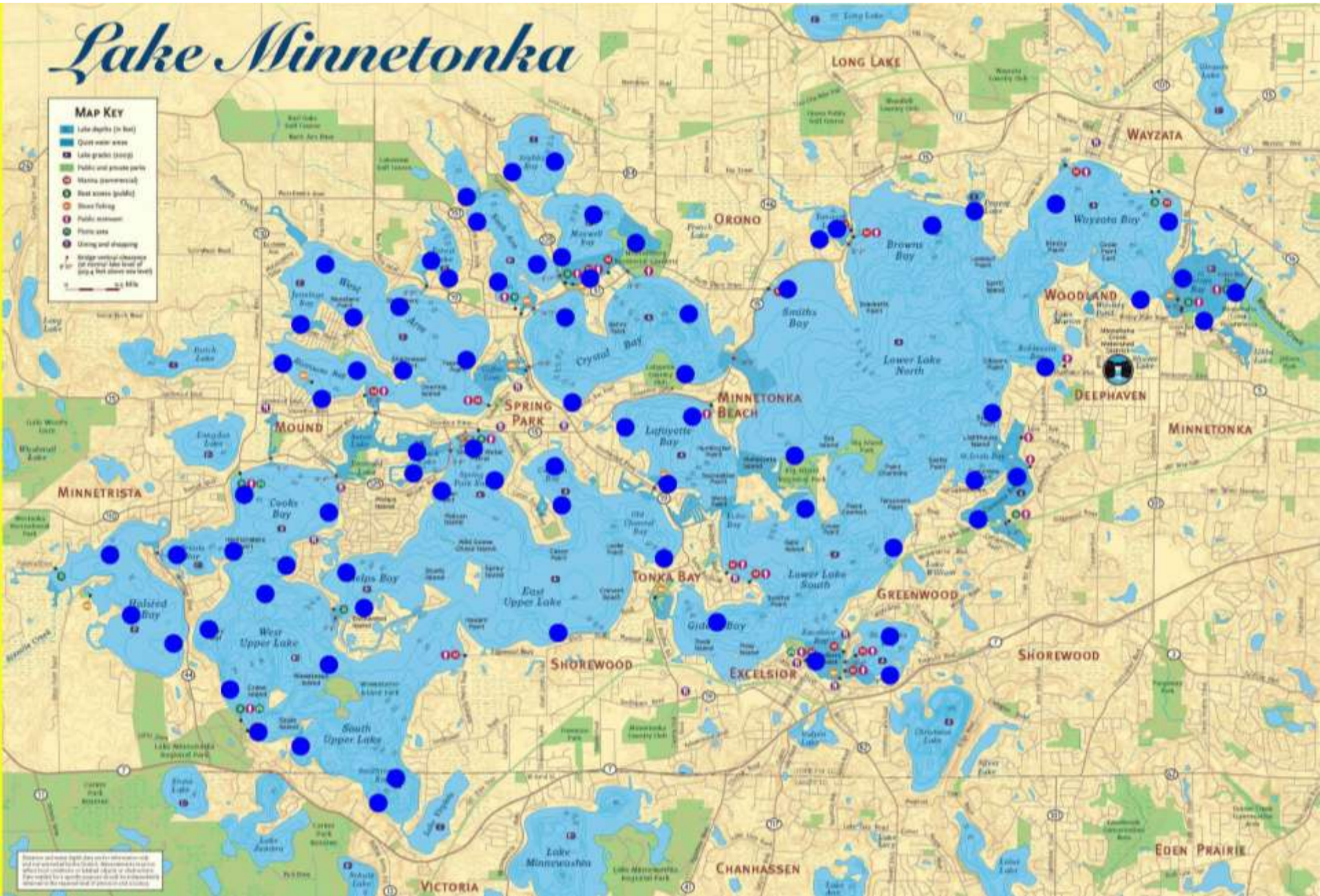
Water Column Results (partial)

Water Column Suitability Rating for Individual Bays	Dissolved Oxygen			Calcium (mg/l)	pH	Alkalin (mg/l)	Conduct	Secchi Disc (m)	Total Phosphorus (ug/l)	Chlorophyll a (mg/l)
	Depth where DO is less than 3 mg/l (ft)	Depth range where DO is 3-6 mg/l (ft)	Depth range where DO is greater than 6 mg/l (ft)							
Black Lake	20	13 – 20	0 – 13	33 - 34	7.9 - 8.3	130	405	1.3 - 2.5	30 - 35	12 - 20
Carman Bay	36	26 – 36	0 – 26	35	7.5 - 8.1	138	415	3.2 - 3.3	15 - 27	3 - 8
Carsons Bay	20	13 – 20	0 – 13	32 - 36	7.8 - 8.4	123	420	3.0 - 3.6	18 - 20	1 - 5
Cooks Bay	30	20 – 30	0 – 20	35 - 36	7.8 - 8.1	128	400	1.6 - 2.3	25 - 30	10 - 14
Crystal Bay	30	23 – 30	0 – 23	37 - 38	7.4 - 7.7	138	460	2.6 - 3.1	19 - 24	5 - 6
Forest Lake	20	13 – 20	0 – 13	32 - 39	7.5 - 8.0	138	470	0.4 - 1.1	56 - 62	33 - 101
Grays Bay	23	16 – 23	0 – 16	35 - 36	8.0 - 8.4	135	420	1.7 - 3.0	22 - 28	5 - 8
Halsted Bay	23	13 – 23	0 – 13	40 - 42	7.7 - 8.1	145	380	0.4 - 0.8	96 - 116	60 - 122

Substrate Parameters

- Muck
- Silt/Sand
- Rock
- Plant coverage

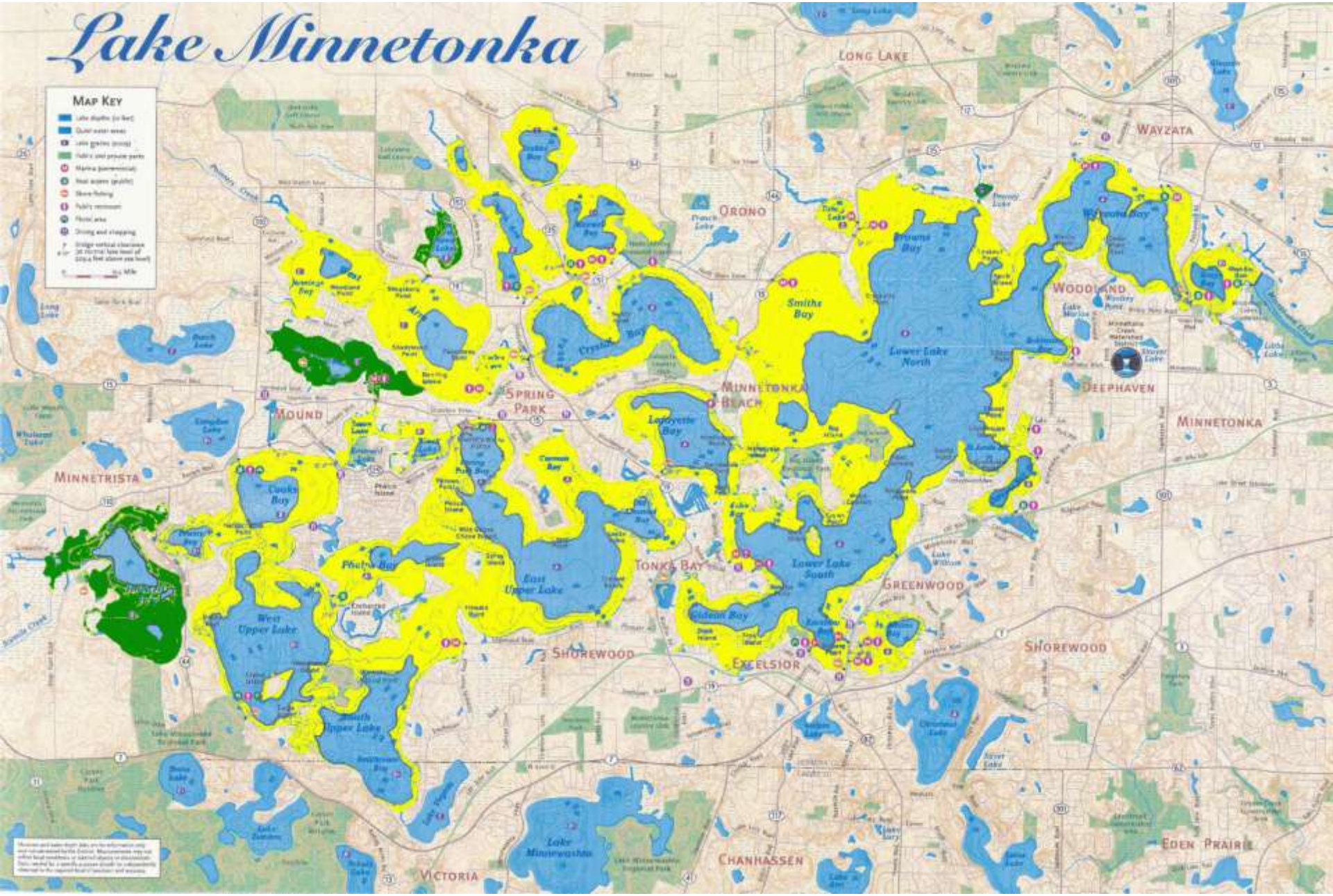
Substrate Assessment Locations (June 16-21, 2010)



Substrate Assessment Results (partial)

Growth Potential Based on Water Column Criteria	Size of Bay (ac)	Maximum Depth in Bay (ft)	Depth Mudline Starts in Bay (ft)	Substrate Composition (out to mudline)		Aquatic Plants	
				Sand-Silt (%)	Rock-Cobble (%)	Plant Growing Depth (ft)	% Plant Coverage
Black Lake	25	25	4 - 6	100	0	14 - 16	80
Carman Bay	307	52	5 - 8	100	0	17	90
Carsons Bay	152	23	7 - 11	100	0	18 - 25	75
Cooks Bay	362	43	8 - 12	100	0	16	90
Crystal Bay	800	113	5 - 11	99	1	14 - 16	80
Forest Lake	84	42	6	100	0	6 - 7	40
Grays Bay	207	28	5 - 7	100	0	7 - 11	50
Halsted Bay	544	36	9 - 16	100	0	9	20

Habitat Suitability Map



Zebra Mussel Suitability in Other Lakes

Minnesota

	Shell Formation	Food	Substrate	Overall Potential
Sylvia, Wright Co	23-24 mg/l Ca Sub-optimal	3-4 ug/l Optimal	Mostly Sub-optimal	Moderate Growth
Marion, Dakota Co	30 mg/l Ca Optimal	4-40 ug/l Sub-optimal	Sub-optimal	Low -- Moderate Growth
Orchard, Dakota Co	33 mg/l Ca Optimal	2-11 ug/l Optimal	Sub-optimal	Moderate Growth
White Bear, Ramsey Co	23 mg/l Ca Sub-optimal	3-20 ug/l Sub-optimal	Mostly Sub-optimal	Moderate Growth

Zebra Mussel Suitability in Other Lakes

Wisconsin

	Shell Formation	Food (Chl a)	Substrate	Overall Potential
Pike, Price Co	10 mg/l Ca Low	5-9 ug/l Optimal	Mostly Sub-optimal	Low
Round, Price Co	9 mg/l Ca Low	5-10 ug/l Optimal	Mostly Sub-optimal	Low
Turner, Price Co	9 mg/l Ca Low	4-10 ug/l Optimal	Sub-optimal	Low
Amik, Vilas Co	12 mg/l Ca Low	4-46ug/l Sub-optimal	Sub-optimal	Low

Zebra Mussels Can Alter Water Column and Substrate Conditions

- Ca – fairly constant over the year although there can be hotspots (like in Lake George, NY)
- Food – can fluctuate from year to year
- Substrate – can change, from sand-silt to shelly

Ossawinamakee Conditions Changed

	Heavy (2008)	Moderate (2009)
Ca	(no data)	33 mg/l
pH	8.0	8.0
Chl a	1-3 ug/l	**Less than 1 ug/l**
Substrate	Silt, sand, woody habitat, some shells	Silt, sand, woody habitat, shells

Unfortunately, Shells Don’t Go Away
– They Accumulate Changing Substrate Conditions

Zebra mussels washed up on Lake Erie beach. Photo courtesy of EPA's Great Lakes National Program Office

Conclusions

- Zebra mussels don’t take over every lake they invade.
- Water column characteristics and substrate characteristics help determine the zebra mussel growth potential.
- Water column and substrate characteristics can change over time.
- Zebra mussel populations will fluctuate over time.