Golden Sands Resource Conservation & Development Council, Inc.

Lake Joanis
Portage County, WI
Summary Report
Predator exclusion cages 2016

This experiment followed predator exclusion cage experiments in 2014 and 2015 by Dan Miller, UWSP graduate student. Miller's exclusion cages were stocked with various levels of weevils (*Euhrychiopsis lecontei*) but unstocked control cages performed just as well, leading to the idea for this 2016 experiment by Golden Sands RC&D.

Lake Joanis's natural weevil population density has historically been low to non-detectable, typically 0.01 to 0.04, with one year at an unusually high value of 0.15 N/stem. (Table 1) It has been documented that natural crashes may occur with populations as low as 0.25 N/stem (Newman and Biesboer 2000), but artificial stocking targets a population density of 1.0 N/stem, a density more likely to stress Eurasian watermilfoil (*Myriophyllum spicatum*) (EWM) and cause a crash (Newman 2004).

Weevil stocking occurred in Lake Joanis in 2008 (13,041) and 2009 (9,994) for a total of 23,035 weevils added. This is a large number of weevils for a lake this size, and yet the whole-lake average did not increase significantly (2008 = 0.01, 2009 = 0.02, 2010 = ND).

Table 1. Historical Summary of
Milfoil Weevil and Aquatic Plant Survey (PI) Data

Year	Weevil population density				Eurasian watermilfoil		
	Weevil sampling method	N/stem	% of stems w/ weevil damage	% of sample pts w/ weevil damage	Relative Frequency	Frequency in vegetated locations	Ave Rake Fullness
2016[1]	PI	0.25	na	37%	27%	45%	1.27
2016 exclusion cages[1]*	Quad	0.07	na	96%			
2015[2]**	T	0.04	14%	35%			
2014[2]	T	0.15	4%	13%			
2013[2]	T	ND	<1%	2%			

2012[3]	T	0.01	5%	11%			
2011[3]	T	0.02	12%	31%	50%	78%	1.85
2010	T	ND[3]	3%[3]	7%[3]	49%[4]	84%[4]	1.74[4]
2009[5]	T	0.02	10%	31%	42%	77%	1.70
2008[5]	T	0.01	1%	4%	29%	55%	1.85

PI = Point intercept method; weevil sample stems collected at each PI point
Quad = Quadrant method; weevil sample stems pulled from each quadrant of the cage
T = Transect method; weevil sample stems collected at each sample point along a transect
ND = non-detectable levels
na = not available
*2016 predator exclusion cages were NOT artificially stocked with weevils. Fish were simply removed from cages.
**2015-2013 also had predator exclusion cages placed and sampled. Cages were stocked at various treatment levels of weevils, fish removed from cages. Control cages (not stocked) showed levels of weevil activity similar to stocked cages, leading to the 2016 experiment. For this data, see Daniel Miller, UWSP, masters thesis.
[1] Data collected by: Amy Thorstenson, Golden Sands RC&D
[2] Data collected by: Daniel Miller, UWSP graduate student
[3] Data collected by: Paul Skawinski, UWSP graduate student, formerly with Golden Sands RC&D
[4] Data collected by: WDNR
[5] Data collected by: Amy Thorstenson, UWSP graduate student and Golden Sands RC&D

Fish predation pressure is known to be one possible limiting factor for weevils (Ward and Newman 2006), and this was suspected to be one possible reason the artificial stocking on Joanis did not have an impact. Predation exclusion cages were one possible way to ameliorate that problem by providing a “safe zone” for weevils to reproduce in and spread out from there. With Miller’s results in his un-stocked control cages in 2015, placing all 25 exclusion cages unstocked in 2016 seemed a worthy experiment.

METHODS

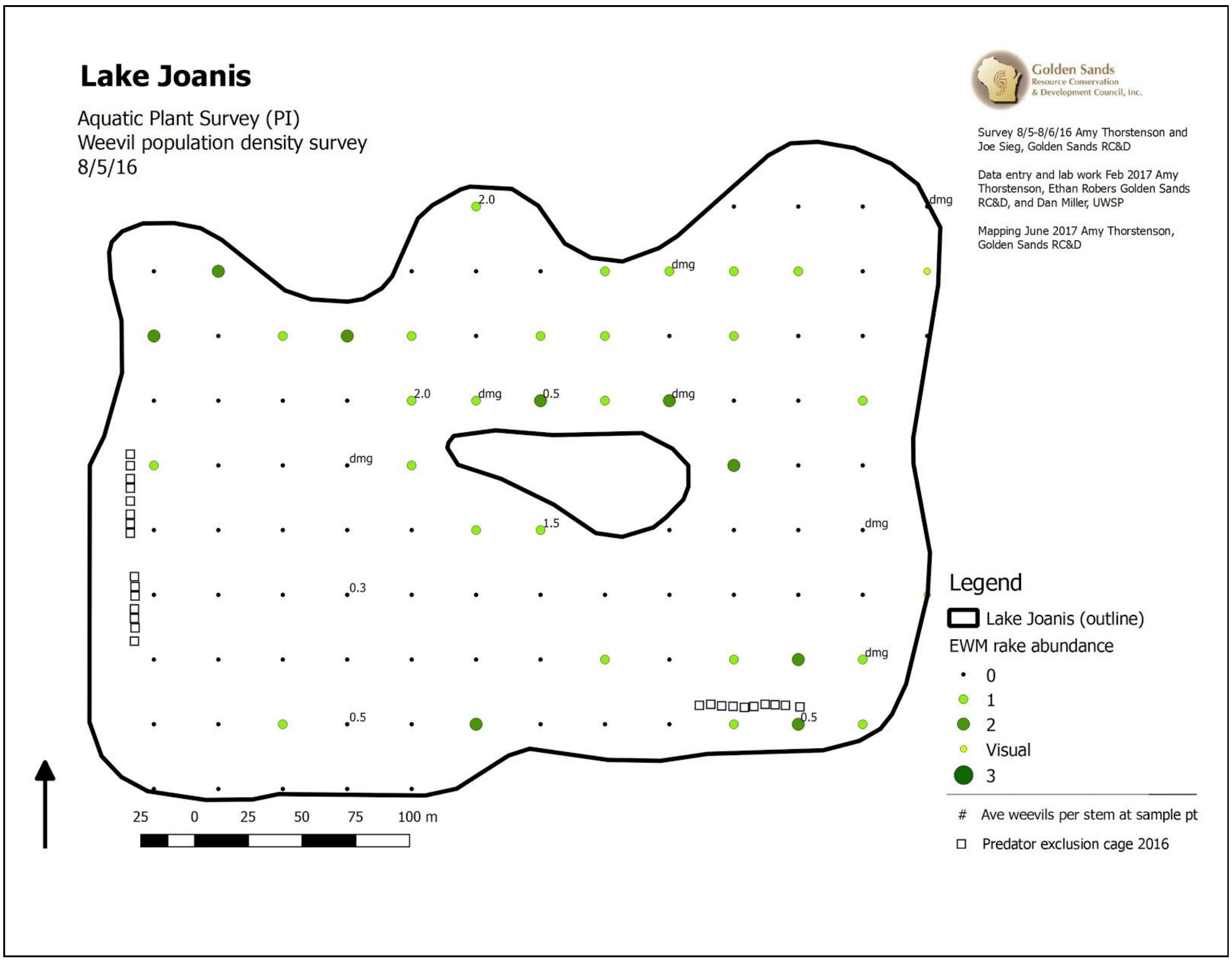
On June 8, 2016, 25 predator exclusion cages were placed in Lake Joanis in approximately 2 ½ feet water depth. Cages were 2’L x 2’W x 3’H with galvanized angle iron frames and black plastic netting. Cages were placed in thick beds of EWM along the west and south sides of the lake. (See map in Figure 1.) These were the same cages used by Miller in 2015 and locations were near the locations used in 2015. Staff returned the following day to fish for any fish trapped in the predation cages, using small hooks so small panfish could be caught and removed. Cages were covered with black plastic netting held in place by bungee cords to prevent disturbance from above.

Cages were left undisturbed throughout the summer, and checked on periodically to ensure netting covers were still in place. On August 17-18, 2016, aquatic macrophytes were surveyed using standard point intercept method. All species were surveyed. Where EWM was found, the rake was dropped a second time to collect fresh EWM stems for weevil sampling. Two stems were collected and the top 24” were retained in a plastic resealable bag. Bags were labelled by sample point, isopropyl alcohol added and kept refrigerated until examined.

At each cage, 4 stems (top 24”) were collected from inside the cage, one from each quadrant of the cage. Each cage sample was bagged and labelled separately, isopropyl alcohol added and the bags refrigerated until examination.

Each sample was examined by floating it in water in a 9”x13” glass pan over a light table. 10x magnification goggles were used to scan the stems for signs of weevil damage and for any weevils of any lifestage. The additional assistance of a 50x magniscope was used to confirm egg identification.

Figure 1. Map of predator exclusion cage placement in Lake Joanis, 2016. Also shown are EWM relative rake abundance and locations of milfoil weevils or evidence (damage).



RESULTS AND DISCUSSION

EWM was found to be a relative frequency of 27%, frequency in vegetated locations of 45%, and average rake fullness of 1.27. (Appendix I) All of these numbers are lower than recorded in past years. (Refer back to Table 1.)

Whole lake average weevil population density was found to be 0.25 N/stem. (Appendix II) This is the highest weevil density ever recorded at Lake Joanis. Over one-third of the EWM sample points (37%) showing evidence of weevil damage, also a high value for Joanis. Typically, densities have been at or near non-detectable levels (i.e. 0.3 N/stem, 0.1, or ND), with one year (2014) at recorded at an unusually high level of 0.15 N/stem. Target level when stocking weevils is 1.0 N/stem, a level that maximizes the possibility of successful control, however, research shows that levels of 0.25 or higher may be sufficient to achieve biological control in some lakes.

Weevil densities <u>inside</u> the predation cages were found to be extremely low (0.06 N/stem), but weevil damage was seen in 24 of 25 cages (96% of cages). (Appendix III) It was observed during cage sampling that stems were observed to have blackened, hollowed-out stems with tips broken of. It was also observed that stems surrounding the outside of the cages were similarly damaged. (See photos.) The data and observations suggest that weevils had fed on EWM inside the cages then emmigrated out of the cages as food supplies were exhausted.

Locations of weevils found in the lake shows weevils well-distributed throughout Lake Joanis. (Refer back to map.) Weevils were not recorded in the same locations as stocking or predator exclusion cages of past years, and this may be expected. Weevils migrate to shore every winter and migrate back to the lake every spring, resulting in redistribution every year. This highlights the importance of maintaining healthy shoreline habitat all around the lake to ensure weevils have optimum opportunity to overwinter successfully. Lake Joanis is surrounded by healthy habitat, disturbed only by walking trails.

Observations during field surveys were that the EWM bed on the east side of the island, which had persisted as dense mats in past surveys, was much less thick in 2016 surveys. The northeast bay, which typically has had small pockets of EWM, had nearly none observed Observed changes in EWM beds - west side of island much less thick, NW bay has nearly none observed in the shallower depths, and none was collected while rake sampling. There were pockets of weevil damage visible in the northwest bay, north side of the island, and the southwest bay. It has previously been difficult to locate visible signs of weevil damage at Lake Joanis. The data and observations may be indicating a change beginning in Lake Joanis.

Conclusion: This experiment supports Miller's observation that unstocked cages may be capable of ameliorating predation pressure by providing a refuge for weevil production when native weevil populations are present in the lake. Since thick EWM beds create a trophic cascade by promoting a stunted panfish community that predates on weevils, which becomes a self-reinforcing cycle, predator exclusion cages may be one possible tool for breaking that cycle and tipping the lake back towards a balanced plant and fish community. Further testing of this theory is needed to move the science of biocontrol forward.

Recommendations: Predation has been a suspected limiting factor for biocontrol at Lake Joanis. This experiment suggests that predation pressure may be possible to ameliorate in Lake Joanis via simple predator exclusion cages.

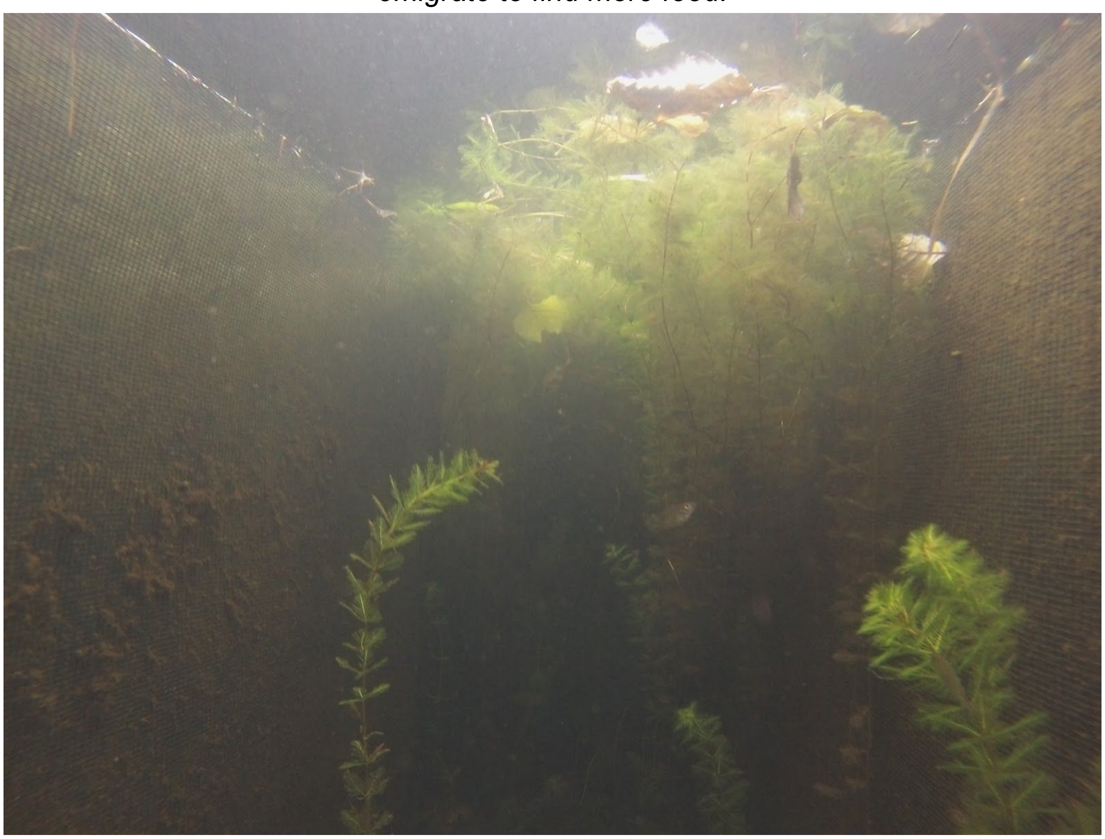
Cages located on the southern end of the western side of Lake Joanis, in approximately 2 ½ - 3 ft water depth. (See map for location.)

Cage placement crew. Cage placement/removal crew included Amy Thorstenson (RC&D AIS Coordinator), Chris Hamerla (RC&D AIS Coordinator), Abby Krueger (RC&D LTE), Joe Seig (RC&D volunteer), and Dan Miller (UWSP MS graduate and RC&D volunteer).

Cage structure, cages on eastern edge of southern shore. Cages were made by Dan Miller during his UWSP graduate work on weevils. Cages were constructed of angle iron, approximately 2'Lx2'Wx3'H, with a black rubber mesh fine enough to keep out minnows but large enough allow weevils to freely move in and out.

Cages on northern end of western side. Cages were covered with black rubber mesh and held fast by bungee cords.

View of damage stems from top, INSIDE CAGE. Cages were often left with sparse EWM that was blackened and broken. Survey results showed that while cages had high weevil damage (96%), there were only 6 weevils (any life stages) detected in samples. Weevils likely had to emigrate to find more food.



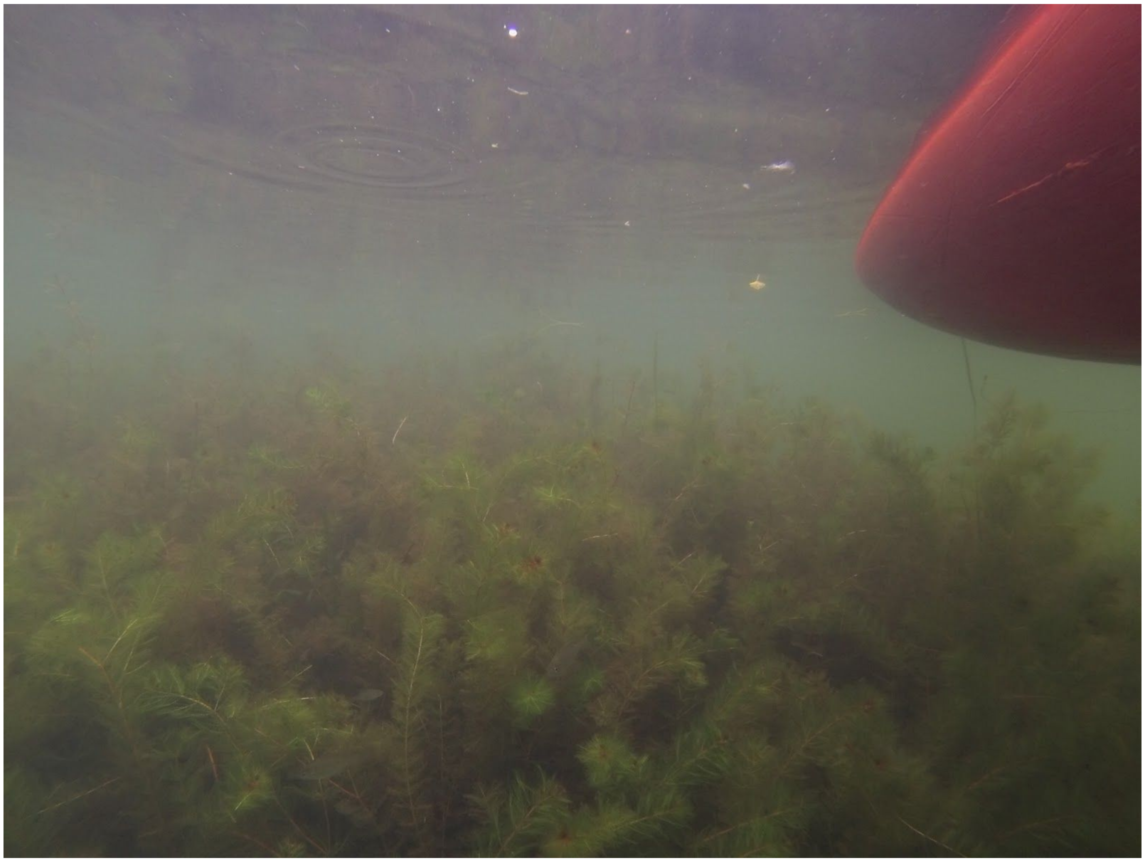
Damaged stems between cages. Cages were usually just 8-10" apart, so the space in between usually showed EWM stems that were nearly as damaged as the stems inside the cages. (Especially stems at the surface, which is where weevils are most likely found.)

Damaged stems next to cage, especially at surface.

Damaged stems between cages.

A close-up of a broken, damaged stem next to a cage.

This is what stem damage look like; blackened, flaccid and friable stem, top has often broken away. This photo is from a non-caged EWM bed in the northwest corner of Lake Joanis. There were pockets of visible weevil damage throughout Lake Joanis. The whole lake average for 2016 was at an all-time high of 0.25 N/stem, with weevils well-distributed around the lake.



A healthy bed of milfoil. While pockets of weevil damage were spotted throughout the lake, healthy EWM persists in Lake Joanis and efforts to continue promoting biological control should continue.

References

Newman, R.M. 2004. Biological control of Eurasian watermilfoil by aquatic insects: basic insights from an applied problem. Archiv fur Hydrobiologie 159 (2):145-184.

Newman, R.M. and D.D. Biesboer. 2000. A decline of Eurasian watermilfoil associated the milfoil weevil Euhrychiopsis lecontei. J. of Aquat. Plant Manage. 38:105-111.

Ward, D.M. and R.M. Newman. 2006. Fish predation on Eurasian watermilfoil (Myriophyllum spicatum) herbivores and indirect effects on macrophytes. Can. J. of Fisheries and Aquat. Sci. 63:1049-1057.

Appendix I
Aquatic macrophyte point intercept surveys

	STATS	Total vegetation	Myriophyllum spicatum, Eurasian water milfoil	Chara sp., Muskgrasses	Eleocharis acicularis, Needle spikerush	Elodea canadensis, Common waterweed	Nitella sp., Nitella	Potamogeton amplifolius, Large-leaf pondweed	Potamogeton diversifolius, Water-thread pondweed	Potamogeton gramineus, Variable pondweed	Potamogeton illinoensis, Illinois pondweed	Potamogeton natans, Floating-leaf pondweed	Potamogeton pusillus, Small pondweed	Vallisneria americana, Wild celery
Lake	Lake Joanis													
County	Portage													
WBIC	3000096													
Survey Date	11/07/17													
	INDIVIDUAL SPECIES STATS:													
	Frequency of occurrence within vegetated areas (%)		45.21	8.22	1.37	5.48	12.33	28.77	41.10	1.37	6.85	1.37	1.37	9.59
	Frequency of occurrence at sites shallower than maximum depth of plants		37.93	6.90	1.15	4.60	10.34	24.14	34.48	1.15	5.75	1.15	1.15	8.05
	Relative Frequency (%)		27.7	5.0	0.8	3.4	7.6	17.6	25.2	0.8	4.2	0.8	0.8	5.9
	Relative Frequency (squared)	0.19	0.08	0.00	0.00	0.00	0.01	0.03	0.06	0.00	0.00	0.00	0.00	0.00
	Number of sites where species found		33	6	1	4	9	21	30	1	5	1	1	7
	Average Rake Fullness	1.67	1.27	1.00	1.00	1.25	1.78	1.62	1.63	1.00	1.00	1.00	1.00	1.00
	#visual sightings		2	1					7		2			6
	present (visual or collected)		present	present	present	present	present	present	present	present	present	present	present	present
	SUMMARY STATS:													
	Total number of sites visited	96												
	Total number of sites with vegetation	73												
	Total number of sites shallower than maximum depth of plants	87												
	Frequency of occurrence at sites shallower than maximum depth of plants	83.91												
	Simpson Diversity Index	0.81												
	Maximum depth of plants (ft)**	20.00												
	Number of sites sampled using rake on Rope (R)	81												
	Number of sites sampled using rake on Pole (P)	15												
	Average number of all species per site (shallower than max depth)	1.37												
	Average number of all species per site (veg. sites only)	1.63												
	Average number of native species per site (shallower than max depth)	0.99												
	Average number of native species per site (veg. sites only)	1.43												
	Species Richness	12												

Appendix II
Weevil population density surveys
Whole lake average

Waterbody: **Lake Joanis, Point intercept samples**
Sample Date: 8/17-18/2016
Lab Date: 2/12/2017

# of sample points: 26
# of stem samoles: 59
Ave. # weevils per stem: **0.25**

Lab Date	;ed #	Point #	# of Stems	L (inches)	Algae/Marl Covered (1=yes, 0=no)	# Broken Tips	# Apical Tips (branches)	Weevil Damage? larval pinholes present	larval tunnels present	used pupal chambers present	dmg meris. Present	# Eggs	# Larvae	# Pupae	# Adults	Comments
NW bed																
2/12/17		27	2		0	0	5	0	0	0	0	0	0	0	0	13.5ft.
3/18/17		10	2	10	0	0	4	0	0	0	0	0	0	0	0	4 3/4 ft deep
2/26/17		19	2	9	1	0	3	0	0	0	0	0	0	0	0	algal covered
N bed																
2/12/17		44	2		0	3	6	1	1	1	1	0	2	1	1	2.5ft.
2/12/17		59	2		0	0	5	0	0	0	0	0	0	0	0	6ft.
Middle																
3/18/17		28	3	6	0	0	3	0	0	0	0	0	0	0	0	**Control;** N end; rake-3, sun, dmg vis, 2 1/2 ft
3/1/17		29	3	9	0	0	4	0	0	1	1	0	0	0	0	**Control;** dmg visible; sun; M over S
2/12/17		30	2		0	1	9	0	0	0	0	0	0	0	0	1ft.
3/18/17		31	3	9	0	0	5	0	0	0	1	0	0	0	1	Visible dmg, **cages located here last yr**
2/12/17		32	2		0	0	6	0	0	0	0	0	0	0	0	2ft. sand, little damage visible
NE bed																
3/1/17		65	2	9	0	0	4	0	0	1	1	0	0	0	0	8 1/2 ft
2/27/17		99	3	8	0	0	3	0	1	0	1	0	0	0	0	a lot of caddisfly
SW bed																
2/12/17		25	2		0	0	8	0	0	0	0	0	0	0	0	13.25ft.
2/12/17		33	2		0	4	10	1	1	0	1	0	1	0	0	2ft. no flower, damage visable
3/19/17		51	2	8	0	0	2	0	0	0	0	0	0	0	0	5 1/2 ft deep
Island																
2/12/17		54	2		0	1	5	0	0	0	0	0	1	0	0	6ft.
2/28/17		67	3	8	0	0	3	0	0	1	1	0	0	0	0	6 1/2 ft deep
2/12/17		61	2		0	4	11	1	1	0	1	0	1	0	2	1.5ft, rake=1
2/12/17		55	2		0	1	5	0	0	0	0	0	0	0	0	9.5ft.
2/12/17		76	2		0	0	8	0	0	0	0	0	0	0	0	10ft.
2/27/17		47	2	6	0	0	3	0	1	1	1	0	0	0	0	1 1/2 ft
2/26/17		37	2	12	0	0	4	0	0	0	0	4	0	0	0	11 ft deep
SE bed																
2/12/17		89	2		0	1	4	0	0	0	0	0	1	0	0	2.5ft., **near CAGES**
2/12/17		88	2		0	0	13	0	0	0	0	0	0	0	0	11.5ft.
2/12/17		63	2		0	1	5	0	0	0	0	0	0	0	0	13.75ft.
2/12/17		80	2		0	1	5	0	0	0	0	0	0	0	0	1.5ft., **near CAGE**
3/1/17		97	2	10	0	0	3	0	0	1	1	0	0	0	0	9 3/4 ft
		Totals =	59		1	17	146	3	5	6	10	4	6	1	4	
		Averages per stem =			0.0	0.3	2.5	5%	8%	10%	17%	0.1	0.1	0.0	0.1	

* - 1 = present, 0 = not present

Total weevils (all life stages) = 15
% Of Pts With Weevil Damage = **37%** Weevils Per Stem (15/59) = **0.25**

Survey Notes:
PI survey 2016, had predator exclusion cages in the lake on west and SE shorelines.
No stocking of weevils into cages, only predator exclusion, see Exclusion datasheet for results inside cages.
PI points that were in 2 1/2 ft of water (similar to cage locations) were identified as "Control" points (see notes column).
Note: This is the highest weevil density recorded so far at Lake Joanis. Typically, densities have been at or near non-detectible levels (i.e. 0.3 N/stem, 0.1, or ND)
Survey Note: stem samples could not aleways be measured for length due to breakage, but those measured were <24", which may mean low sampling biase. Stem samples should be 24" to capture late instar larvae and pupae.
This experiment followed exclusion cages in 2014 and 2015 by Dan Miller, UWSP graduate student - his cages were stocked with various levels of weevils but control cages performed just as well, leading to the idea for this 2016 experiment.
Lab examination of samples: Dan Miller

Appendix III
Weevil population density surveys
Predator exclusion cage samples

Waterbody: **Lake Joanis, predator exclusion cages**

# of stems: 81
# of samples (1 per cage): 24
Ave. **#** weevils per stem: **0.07**

Sample Date: 8/16/2016

Lab Date	Bed No.	Bag No.	Stem No.	Length (in)	Algae/Marl Covered (1=yes, 0=no)	# Broken Tips	# Apical Tips	Weevil Damage? dmg meris. present	pinholes present	tunnels present	pupation chambers present	# Eggs	# Larvae	# Pupae	# Adults	Comments
		Cage 10	1	10	0	0	1	0	0	0	0	0	0	0	0	2 1/2 ft deep, dmg visible (med)
			2	11	0	0	2	0	0	0	0	0	0	0	0	
			3	12	0	0	1	0	0	0	0	0	0	0	0	rake= 1, sand bottom
			4	12	0	0	2	0	0	0	0	0	0	0	0	
			5	11	0	0	2	1	0	0	0	0	0	0	0	damaged flowers and plants in and around cage
		Cage 22	1	18	0	1	3	1	0	0	1	0	0	0	0	2 1/2 ft, dmg vis in and out of cage
			2	15	0	0	5	0	0	0	0	0	0	0	0	Muck, shade
			3	16	0	0	3	1	0	0	1	0	0	0	0	rake=2, multiple pupal blast areas
			4	12	0	0	2	0	0	0	0	0	0	0	0	
		Cage 09	1	15	0	0	2	0	0	0	0	0	0	0	0	2 1/2 ft deep sand shade
			2	13	0	0	3	0	0	0	0	0	0	0	0	rake = 1
			3	14	0	0	2	0	0	0	0	0	0	0	0	
			4	14	0	0	3	0	0	0	0	0	0	0	0	
		Cage 24	1	10	0	1	1	1	1	1	0	0	2	0	0	2 ft muck sun rake=2
			2	9	0	0	3	1	0	1	0	0	0	0	0	Heavy damage in and out short plants
			3	7	0	0	2	1	0	1	0	0	0	0	0	
			4	9	0	0	1	0	1	0	0	0	0	0	0	
			5	7	0	1	3	1	0	0	1	0	0	0	0	
		Cage 21	1	13	0	1	3	1	0	1	1	0	0	0	0	2 feet muck shade rake=2
			2	15	0	1	4	1	0	1	1	0	0	0	0	Damage visible
			3	11	0	0	2	0	0	0	0	0	0	0	0	
			4	17	0	0	3	0	0	0	0	0	0	0	0	Robust/full stems very little damage
		Cage 08	1	18	0	1	3	1	0	1	1	0	0	0	0	2 1/2 fee sand shade
			2	14	0	0	2	0	0	0	0	0	0	0	0	less damage lots of snails
			3	12	0	1	2	1	0	1	0	0	0	0	0	
			4	15	0	0	3	1	0	1	0	0	0	0	0	
		Cage 07	1	17	1	0	2	0	1	0	0	0	0	0	0	2 3/4 fee sand/muck shade
			2	14	0	0	3	1	0	0	1	0	0	0	0	lots of damage
			3	11	0	2	3	1	0	1	1	0	0	0	0	

Lab Date	Bed No.	Bag No.	Stem No.	Length (in)	Algae/Marl Covered (1=yes, 0=no)	# Broken Tips	# Apical Tips	Weevil Damage? dmg meris. present	pinholes present	tunnels present	pupation chambers present	# Eggs	# Larvae	# Pupae	# Adults	Comments
			4	12	0	0	2	0	0	0	0	0	0	0	0	
		Cage 05	1	17	0	0	4	0	0	0	0	0	0	0	0	2 1/2 fee sand part sun
			2	12	0	1	2	1	1	0	1	0	0	0	0	lots of damage
			3	12	0	1	2	1	0	1	1	0	0	0	0	
			4	9	0	1	3	1	0	1	1	0	0	0	0	Stunted growth on specimen
		Cage 06	1	13	0	1	3	1	0	1	0	0	0	0	1	muck shade
			2	15	0	1	4	0	0	0	1	0	0	0	0	
			3	11	0	0	3	1	0	0	1	0	0	0	1	
			4	13	0	0	4	0	0	1	0	0	0	0	0	
		Cage 20	1	11	0	1	3	0	0	1	0	0	0	0	0	2 1/2 ft muck rake=2
			2	13	0	0	4	0	1	0	0	0	0	0	0	Heavy damage in and out
			3	16	0	2	4	1	1	1	0	0	0	0	0	
			4	14	0	1	4	1	1	0	0	0	0	0	0	
		Cage 27	1	11	0	1	2	0	1	0	0	0	0	0	0	2 feet muck shade rake=2
			2	15	0	0	4	0	0	0	0	0	0	0	0	Damage in area around cage
			3	18	0	1	6	0	0	0	0	0	0	0	0	
			4	13	0	0	2	1	0	1	0	0	0	0	0	
		Cage 25	1	9	0	0	2	1	0	1	0	0	0	0	0	2 feet muck/sand rake=2
			2	11	0	2	3	1	0	1	0	0	0	0	0	Damage in and out of cage; short stems
			3	10	0	0	3	0	0	0	0	0	0	0	0	
		Cage 02	1	13	0	1	4	0	0	0	0	0	0	0	0	2 1/2 ft sand rake=2
			2	14	0	0	3	1	1	0	0	0	0	0	0	
			3	17	0	2	4	1	1	1	0	0	0	0	0	
			4	13	0	0	2	1	0	1	0	0	0	0	0	
		Cage 03	1	11	0	1	3	0	0	0	0	0	0	0	0	2 1/2 feet, sun, rake=2
			2	16	0	0	4	0	0	0	0	0	0	0	0	Damage visible
			3	13	0	0	4	1	0	1	0	0	0	0	0	
			4	12	0	1	3	1	0	1	1	0	0	0	0	
		Cage 23	1	11	0	2	3	1	0	1	0	0	0	0	0	2 1/2 feet, muck, rake = 2
			2	13	0	3	4	1	0	1	0	0	0	0	0	Damage visible in and out
			3	15	0	1	4	1	1	1	1	0	0	0	0	
			4	20	0	0	3	0	0	0	0	0	0	0	0	
		Cage 26	1	16	0	0	3	1	0	1	0	0	0	0	0	2 feet, muck, rake=2
			2	18	0	0	4	0	0	0	0	0	0	0	0	lots of visible damage
			3	13	0	1	3	0	0	0	0	0	0	0	0	
			4	15	0	0	3	0	0	0	0	0	0	0	0	
		Cage 16	1	13	0	1	3	1	0	1	0	0	0	0	0	2 1/4 ft, muck, rake=2 (almost 3)
			2	15	2	1	4	1	1	0	0	0	0	0	0	damage visible in and out
			3	11	0	0	2	0	0	0	0	0	0	0	0	
			4	20	0	4	7	1	1	1	1	0	0	0	0	VERY heavy amount of damag on stem 4 that was very large
		Cage 15	1	11	0	1	3	1	0	1	0	0	0	0	0	2 1/4 muck shade
			2	14	0	2	4	1	0	1	1	0	0	0	0	damage visible in and out
			3	16	0	1	3	0	0	0	0	0	0	0	1	
			4	17	0	2	4	1	0	0	1	0	0	0	0	
		Cage 12	1	12	0	1	4	1	0	0	1	0	0	0	0	2 feet sand shade rake=2
			2	16	0	0	2	0	0	1	0	0	0	0	0	
			3	18	0	0	2	0	0	0	0	0	0	0	0	
			4	17	0	1	3	1	0	1	1	0	0	0	0	
2/12/17		Cage 18	4		0	3	8	1	1	0	1	0	0	0	1	2.25ft. muck, rake=2
2/12/17		Cage 14	4		0	5	9	1	1	0	1	0	0	0	0	2.25ft. sand, rake=2
2/12/17		Cage 11	4		0	4	8	1	1	0	1	0	0	0	0	2ft. sand, rake=1
2/12/17		Cage 13	4		0	3	9	1	1	0	1	0	0	0	0	2ft. sand, rake=2
2/12/17		Cage 19	4		0	3	7	1	1	0	1	0	0	0	0	2.5ft. muck, rake=2
		Totals =	81	1037	3	66	271	46	18	32	25	0	2	0	4	
		Averages per stem =		14	4%	0.81	3.3	57%	22%	40%	31%	0.00	0.02	0.00	0.05	

Total weevils (all life stage 6

NWM - Northern Water Milfoil

EWM - Eurasian Water Milfoil

% Of Cages w/ Weevil Damage = **96%**

Ave Weevils Per Stem (6/81) = **0.07**

Survey Notes: OVERALL NOTE: THERE WERE LARGE AMOUNTS OF ZYGOPTERA IN EACH OF THE SAMPLES. THEY ARE PREDATORY. ALSO LARGE AMOUNTS OF SNAILS. (Exclusion cages made nice hiding places for them to live also?)
25 cages. Located in the lake on west and SE shorelines, apx 3' water depth - no stocking of weevils into cages, only predator exclusion.
Many cages showed heavy damaged, and so was the EWM immediately adjacent, possibly indicating that they were running out of food and migrating out of the cages.
PI survey 2016, see In Lake datasheet for results outside cages and in rest of the lake.
This experiment followed exclusion cages in 2014 and 2015 by Dan Miller, UWSP graduate student - his cages were stocked with various levels of weevils but control cages performed just as well, leading to the idea for this 2016 experiment.