2016 Project Report:
Update on the Impact of Walleye Stocking and Milfoil Herbivorous Insects on the Growth of Eurasian watermilfoil in DeRuyter Reservoir

Milfoil midge and milfoil leaf damage found in 2016 sampling. Photo by A. Barber

Paul H. Lord
paul.lord@oneonta.edu

SUNY Oneonta Biological Field Station
5838 State Highway 80
Cooperstown, New York 13326

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DeRuyter Milfoil tips: minimally damaged (left) and extensively damaged (right). Photos by L. Adams

Prepared for the

Tioughnioga Lake Preservation Foundation

(Attn: Carol Jeschke)

Authors:

Paul H. Lord
Paul.lord@oneonta.edu
lordp@usa.net

Amanda L. Barber
barbera@hartwick.edu

SUNY Oneonta Biological Field Station
5838 State Highway 80
Cooperstown, New York 13326

Summary

The DeRuyter Reservoir Lake Association, the Tioughnioga Lake Preservation Foundation, Inc., and Madison County have long sought to manage Eurasian watermilfoil (*Myriophyllum spicatum*) hereinafter referred to as "milfoil," because we found no native milfoils persisting in DeRuyter Reservoir. Milfoil management facilitates lake recreational uses that are obstructed by milfoil's aggressive, invasive growth. This report summarizes the work of the 2016 cooperative effort of the Tioughnioga Lake Preservation Foundation, Inc.. the DeRuyter Reservoir Lake Association and the Biological Field Station, SUNY Oneonta (BFS, Cooperstown). Prepared for Tioughnioga Lake Preservation Foundation and the DeRuyter Reservoir Lake Association, it presents the 2016 DeRuyter Reservoir data collected, its analysis, and offers recommendations on milfoil management and research.

Key conclusions include:

- Milfoil growth has increased throughout the Reservoir
  - with the most recreational impeding milfoil at the south end
- DeRuyter Reservoir holds a modestly diverse submersed plant community
  - 20 aquatic plant and macroalgae species as of 2016
- No advance in biocontrol was achieved in 2016
- Silt deposition from tributaries may be facilitating milfoil growth
  - particularly in southern end of Reservoir.

Recommendations include:

- Stocking with 37,000 walleye (*Sander vitreus*) fingerlings
  - to meet our recommended stocking rates in addition to adjusting for inadequate sizes stocked in 2015 and inadequate numbers in 2016
  - to ensure consistent suppression of insect eating fish
  - to facilitate diversity of milfoil herbivores
- Continued monitoring of DeRuyter Reservoir milfoil, herbivores and fish including autumn electrofishing
  - to evaluate stocking efficacy
  - to adjust stocking in subsequent years.

Organization

The following three contents pages describe the organization of this report. Tables and figures herein are referred to as "Table 1, Table 2..." and "Figure 1, Figure 2…" respectively if they are contained in the main report while tables and figures contained in the appendices are referred to with the letter assigned to that appendix (*e.g.*, "Figure A1," "Table B1," *etc.*). The main report is numbered 1 through 34 with appendices numbered with a letter, a dash, and the appendix page number (*e.g.*, "B-3").

Contents

Tables

Figures

Background

Biological Field Station, SUNY Oneonta and DeRuyter Reservoir

The Tiougnioga Lake Association, the Tioughnioga Lake Preservation Foundation and Madison County Planning Department face a continuing challenge in their goal of suppressing Eurasian watermilfoil (*Myriophyllum spicatum*) to facilitate recreation on DeRuyter Reservoir (aka DeRuyter Lake) while minimizing unintended ecological consequences to DeRuyter Reservoir. Our 2016 research supported achievement towards that goal.

Our Biological Field Station, SUNY Oneonta (BFS, Cooperstown) research focuses on developing protocols for the biological control (biocontrol) of this noxious exotic aquatic plant. (Appendix B [p. B-1] provides definitions for technical terminology.) Previous BFS, Cooperstown work in Madison County demonstrated that augmented populations of milfoil herbivores (*e.g.*, Madison County's Lake Moraine 1998; 2000 and Lebanon Reservoirs 2001) do not necessarily have lake-wide milfoil- reducing impacts while work in Chautauqua Lake (2004 – 2012) demonstrated that augmented populations in some lakes can have an impact that spreads from the point of augmentation (unpublished data). Additional research in 2003 involving eight Madison County lakes, established a connection between sunfish (*Lepomis* sp.) numbers and the numbers of an important milfoil insect herbivore, the aquatic macrophyte moth (*Acentria ephemerella* pictured below) which has been confirmed by work in Minnesota (Ward & Newman, 2006). Moreover, aquatic macrophyte moth populations were associated with reduced Eurasian watermilfoil density (Lord, 2004).

Aquatic macrophyte moth larvae found in 2016 sampling. Photo by A. Barber

DeRuyter Reservoir is a moderately productive (mesotrophic) lake of approximately 557 acres (CSLAP DeRuyter Reservoir, 2010) located in Madison County (Towns of DeRuyter and Cazenovia) and in Onondaga County (Town of Fabius) (Delorme, 1998). DeRuyter Reservoir is an artificially deepened lake with a maximum depth of approximately 53 feet (16m) and good water clarity (CSLAP DeRuyter Reservoir, 2010) facilitating rooted plant growth to depths of 18 feet which encompasses approximately 55% of the Reservoir (our estimate). Recreational uses of DeRuyter Reservoir are the focus of concern in regard to algae and plant growth with the

result that the Reservoir is "listed" in the NYSDEC Priority Waterbody Listing for the Susquehanna River (NYSDEC PWL, 2015).

The purpose of our 2016 effort in DeRuyter Reservoir was to monitor milfoil presence and density, milfoil herbivores, and fish community changes in DeRuyter Reservoir in the aftermath of walleye fingerling stocking. We made collections of milfoil plant stems to ascertain the presence or absence of milfoil herbivores and the impact, if any, that they were having on the Eurasian watermilfoil. Concurrent with our mapping of Eurasian watermilfoil, we mapped native aquatic plants found in the DeRuyter Reservoir. Herein we report DeRuyter Reservoir physical and chemical data collected by SUNY Cobleskill. Additionally, SUNY Cobleskill electrofished the Reservoir in July to determine numbers of sunfish so that we could consider what impacts sunfish are having on milfoil herbivores. Figure 1 (modified from Lord *et al*, 2004) provides a summary of supporting research and our current working hypothesis in regard to fish community impacts on milfoil herbivores and Eurasian watermilfoil (Lord, 2004; Lord *et al*., 2004).

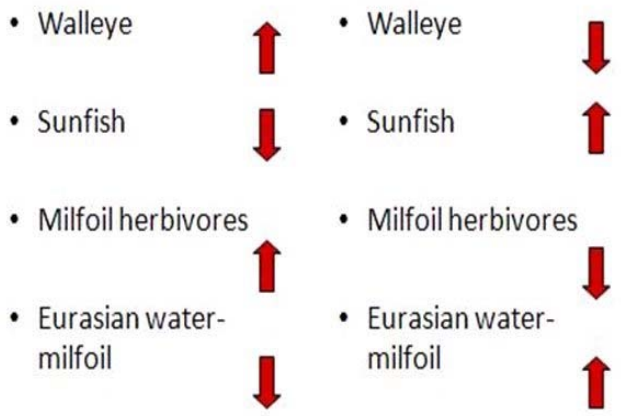

Figure 1. Hypothetical model illustrating understood trophic relationships between walleye (*Sander vitreus*), bluegill and pumpkinseed sunfish (*Lepomis* spp.), milfoil insect herbivores, and Eurasian watermilfoil (*Myriophyllum spicatum*) as perceived from NY State lakes data. Columns represent contrasting walleye and Eurasian watermilfoil population sizes. Up arrows represent larger populations whereas down arrows represent smaller populations.

Eurasian watermilfoil and Control Methods

See our previous reports (especially Lord & Pokorny 2013) for DeRuyter Reservoir for background on Eurasian watermilfoil control methods.

Methods & Rationale

Water Quality Sampling

SUNY Cobleskill sampled DeRuyter Reservoir water quality parameters on 11July 2016 at a deep location in the southern part of the Reservoir (Figure 2). This is not the deepest location, but it is the area consistently sampled at the time of electrofishing. The specific sampling site (18T 0426692 4741877 [UTM coordinates; NAD83 datum]) is depicted in Figure 2 as WQ2. Water quality was assessed using a multi-probe device calibrated per manufacturer's instructions, to measure water oxygen levels, pH, conductivity, and temperature.

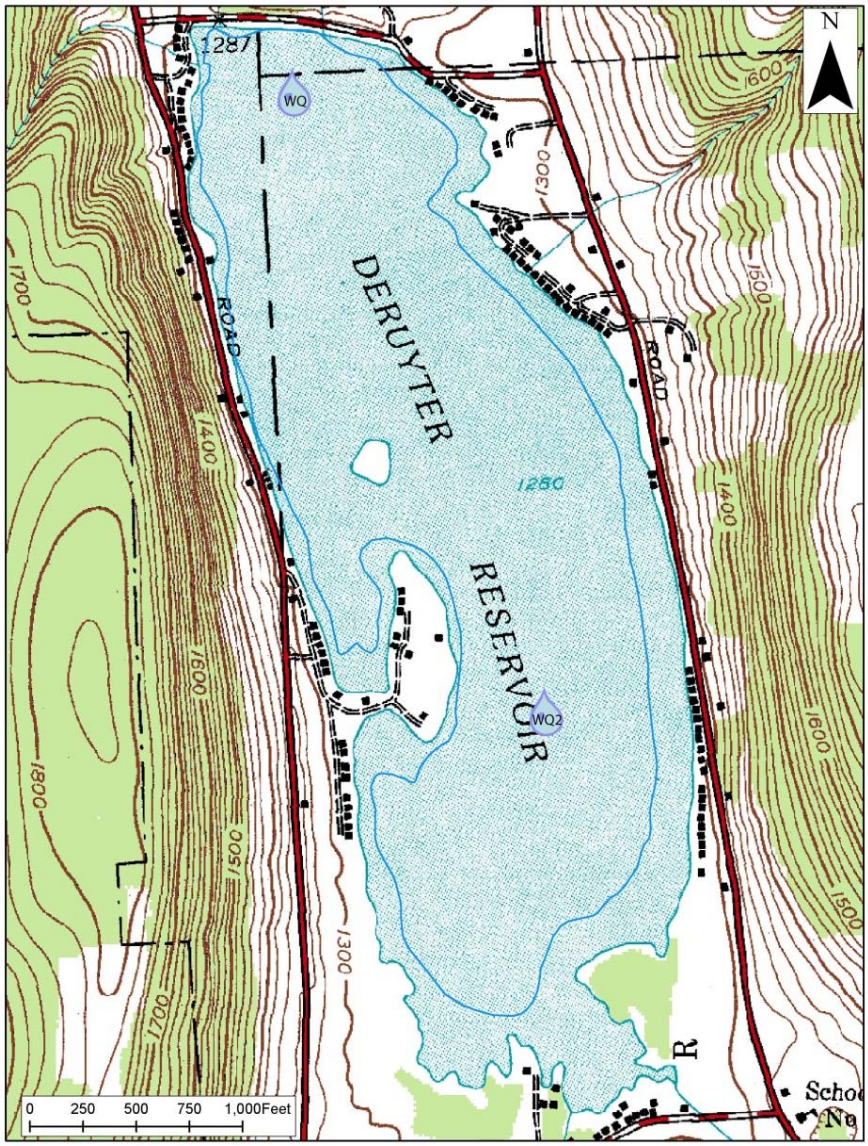

Figure 2. Location of DeRuyter Reservoir water quality sample (WQ2) obtained in 2016.

Macrophyte Sampling by the Point intercept rake toss relative abundance method (PIRTRAM)

Please see our report for 2012 (Lord & Pokorny, 2013) for a description of our PIRTRAM sampling methods. Specific 2016 sampling sites are identified as colored dots in Figure 3.

Milfoil Stem Sample Collection and Processing

Please see our report for 2012 (Lord & Pokorny, 2013) for a description of our milfoil stem sampling and processing methods. Specific 2016 sampling sites are identified in Figure 3.

Electrofishing

SUNY Cobleskill completed electrofishing of DeRuyter Reservoir's warm water fish on July 11, 2016. Please see our report for 2012 (Lord & Pokorny, 2013) for a description of SUNY Cobleskill's electrofishing methods. Specific 2016 sampling sites are identified in Figure 4. They are the same sites used previously.

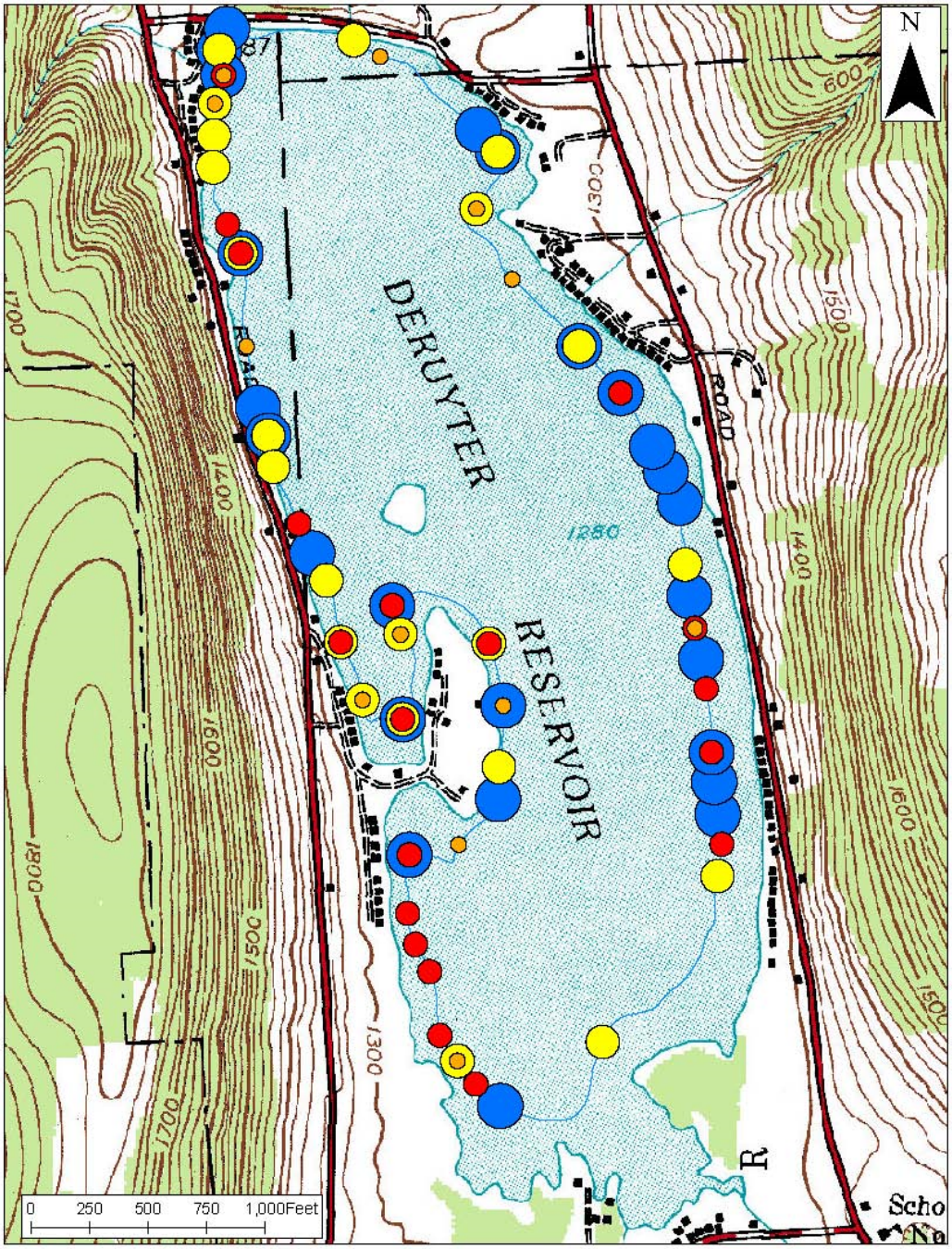

Figure 3. DeRuyter Reservoir collection sites used to evaluate herbivory and herbivore presence on stem tops of Eurasian watermilfoil (*Myriophyllum spicatum*) during 2016. All locations were originally randomly chosen from locations along the ten foot depth contour. Blue dots indicate June collection sites. Red dots indicate July collection sites. Yellow dots indicate August collection sites. Orange dots indicate September collection sites.

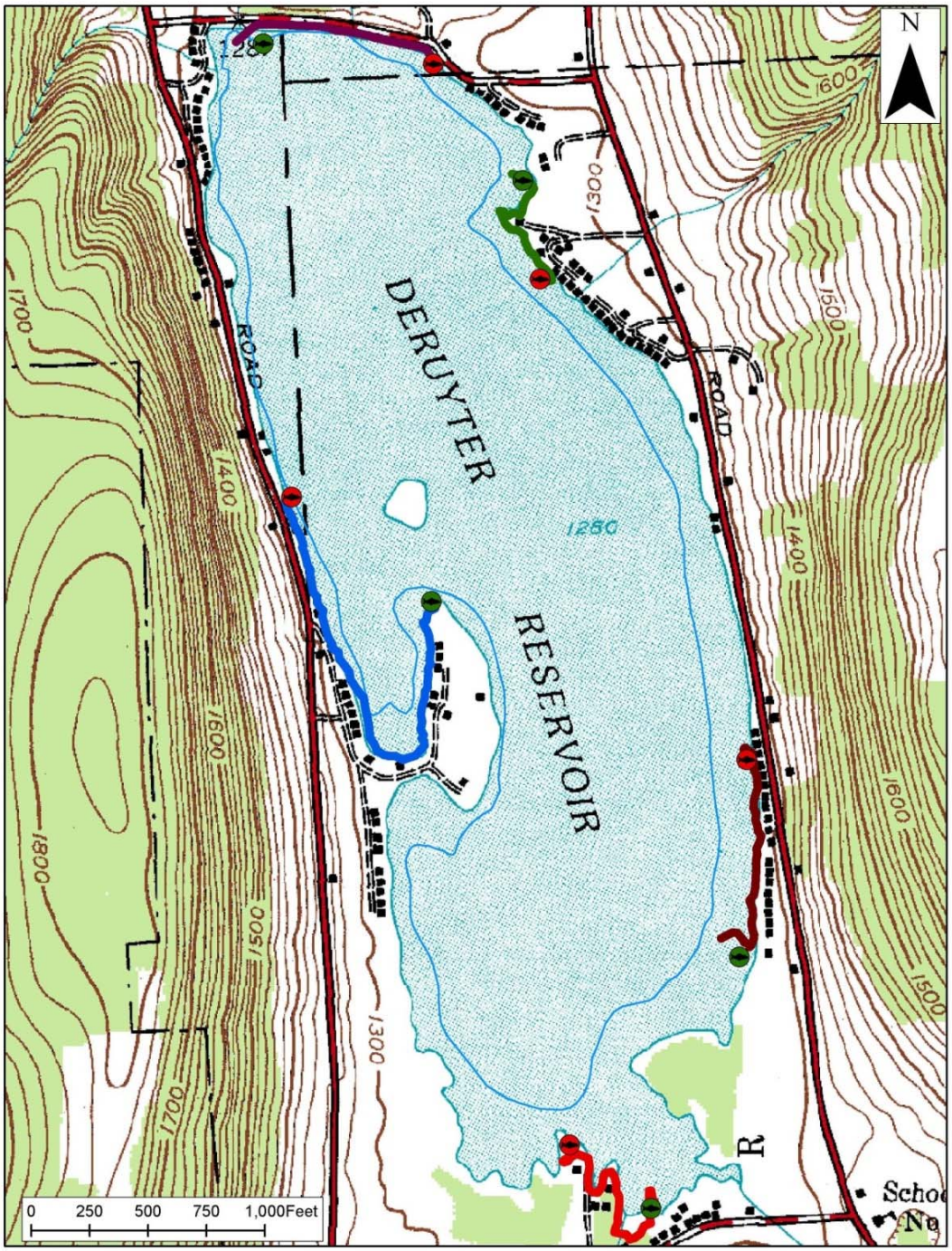

Figure 4. Locations of DeRuyter Reservoir electrofishing samples obtained on 11 July 2016. Red line = sample 1; brown line = sample 2; blue line = sample 3; purple line = sample 4; green line = sample 5. Green circle = sample start; red circles = sample stop.

Results

Water quality data are displayed in Table 1. Water quality data from the 11 July sample is consistent with data from previous years and documents a consistent temperature from the surface to the bottom. Similar measurements, from the surface to the bottom, are evident in conductivity, pH and oxygen.

Table 1. Results of water quality samples obtained from site WQ2 on DeRuyter Reservoir as sampled 11 July 2016 using a multi-probe device, calibrated per manufacturer's instructions, to measure water oxygen levels, pH, conductivity, and temperature. m=meters; ºC=Centigrade degrees; mg/L=milligrams per liter; TDS=total dissolved solids; g/L=grams per liter

Depth (m)	Temperature (ºC)	Conductivity (µS/cm)	Oxygen (mg/l)	pH	TDS (g/l)
Surface	22.16	0.191	9.47	7.91	0.1
1	22.20	0.191	9.16	7.62	0.1
2	22.10	0.191	9.09	7.3	0.1
3	21.81	0.189	9.06	7.02	0.1
4	21.44	0.187	9.16	6.64	0.1
5	21.32	0.186	9.64	6.45	0.1
6	20.62	0.183	9.79	6.22	0.1
7	20.63	0.183	10.11	6.15	0.1
8	Bottom	Bottom	Bottom	Bottom	Bottom

Overall plant density in 2016 increased compared to 2015 with four sites documented as dense and only 1 site documented as sparse. Eurasian milfoil has become more abundant in 2016 and was found at every site. The majority of Eurasian watermilfoil found was sparse (55%) to medium (45%).Point intercept rake toss relative abundance method (PIRTRAM) data for DeRuyter Reservoir as sampled in 2011, 2012, 2014, 2015 and 2016 are summarized in Table 2. Figure 5 depicts the 2016 abundances of aquatic plants from PIRTRAM sampling while Figure 6 does the same for Eurasian watermilfoil. Appendix A provides detailed data from PIRTRAM sampling. Table 3 provides a summary of the aquatic plant species noted in DeRuyter Reservoir in our surveys & observations.

Table 2. Density summary for all plants and for Eurasian watermilfoil (*Myriophyllum spicatum*) in DeRuyter Reservoir as sampled from 2011, 2012, 2014, 2015 and 2016 from the same randomly chosen locations along the 10 foot depth contour using the point intercept rake toss relative abundance method (PIRTRAM).

	2011	%	2012	%	2014	%	2015	%	2016	%
All plants abundances										
Dense	2	10%	3	15%	5	25%	0	0%	4	20%
Medium	17	85%	17	85%	15	75%	17	89%	15	75%
Sparse	1	5%	0	0%	0	0%	2	11%	1	5%
Trace	0	0%	0	0%	0	0%	0	0%	0	0%
No plants	0	0%	0	0%	0	0%	0	0%	0	0%
Eurasian watermilfoil abundances										
Dense	0	0%	0	0%	2	10%	0	0%	0	0%
Medium	0	0%	3	15%	10	50%	7	37%	9	45%
Sparse	5	25%	16	80%	8	40%	10	53%	11	55%
Trace	5	25%	0	0%	0	0%	0	0%	0	0%
No milfoil	10	50%	1	5%	0	0%	2	11%	0	0%
Total	20	100%	20	100%	20	100%	19	100%	20	100%

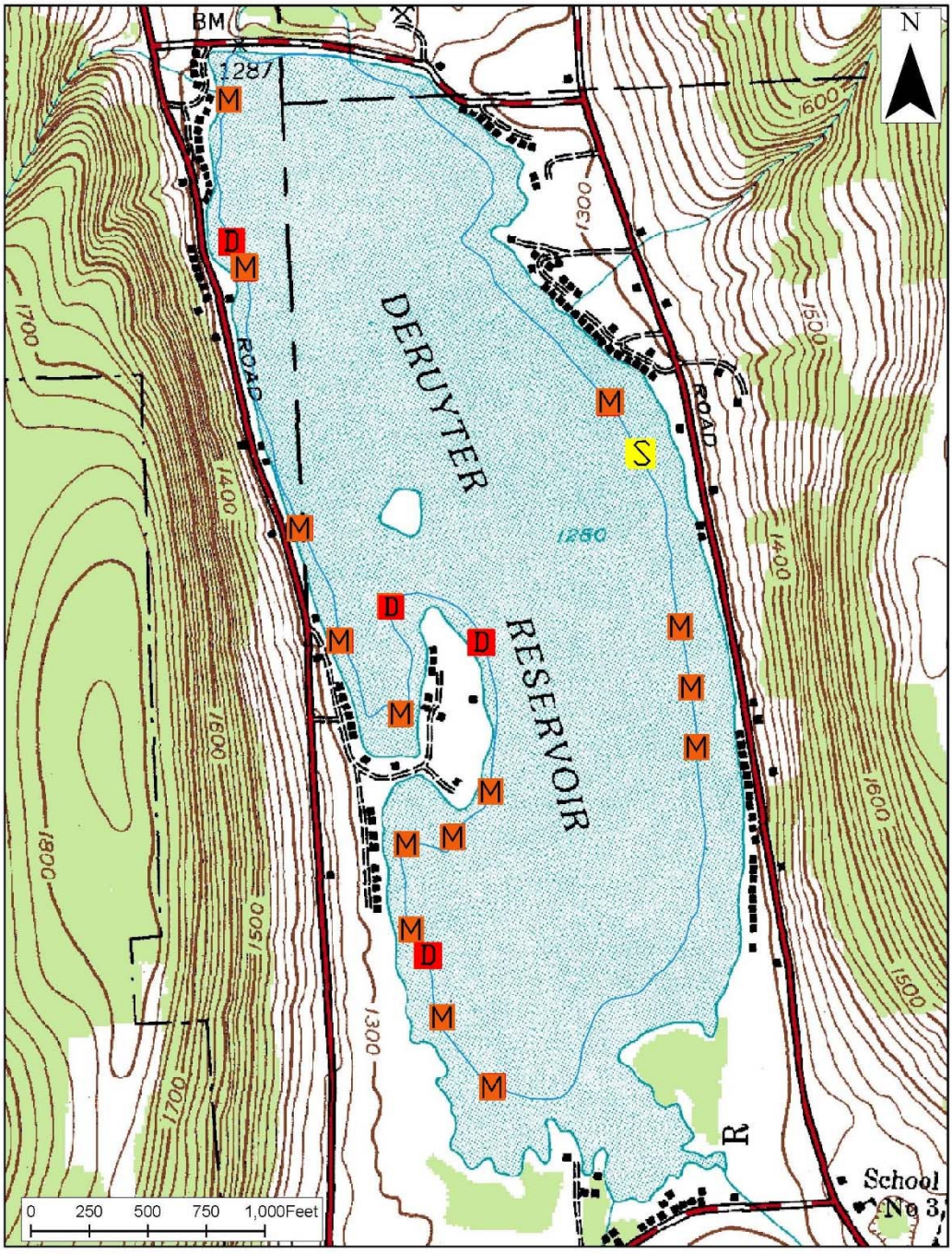

Figure 5. All aquatic plants abundances and locations in DeRuyter Reservoir from point intercept rake toss relative abundance method (PIRTRAM) samples obtained July 2016. "D" = dense plants; "M" = medium plants; "S" = sparse plants. See Lord & Pokorny, 2012 ("Methods and Rationale" p. 26, Table 1) for weights associated with abundance categories and methods details.

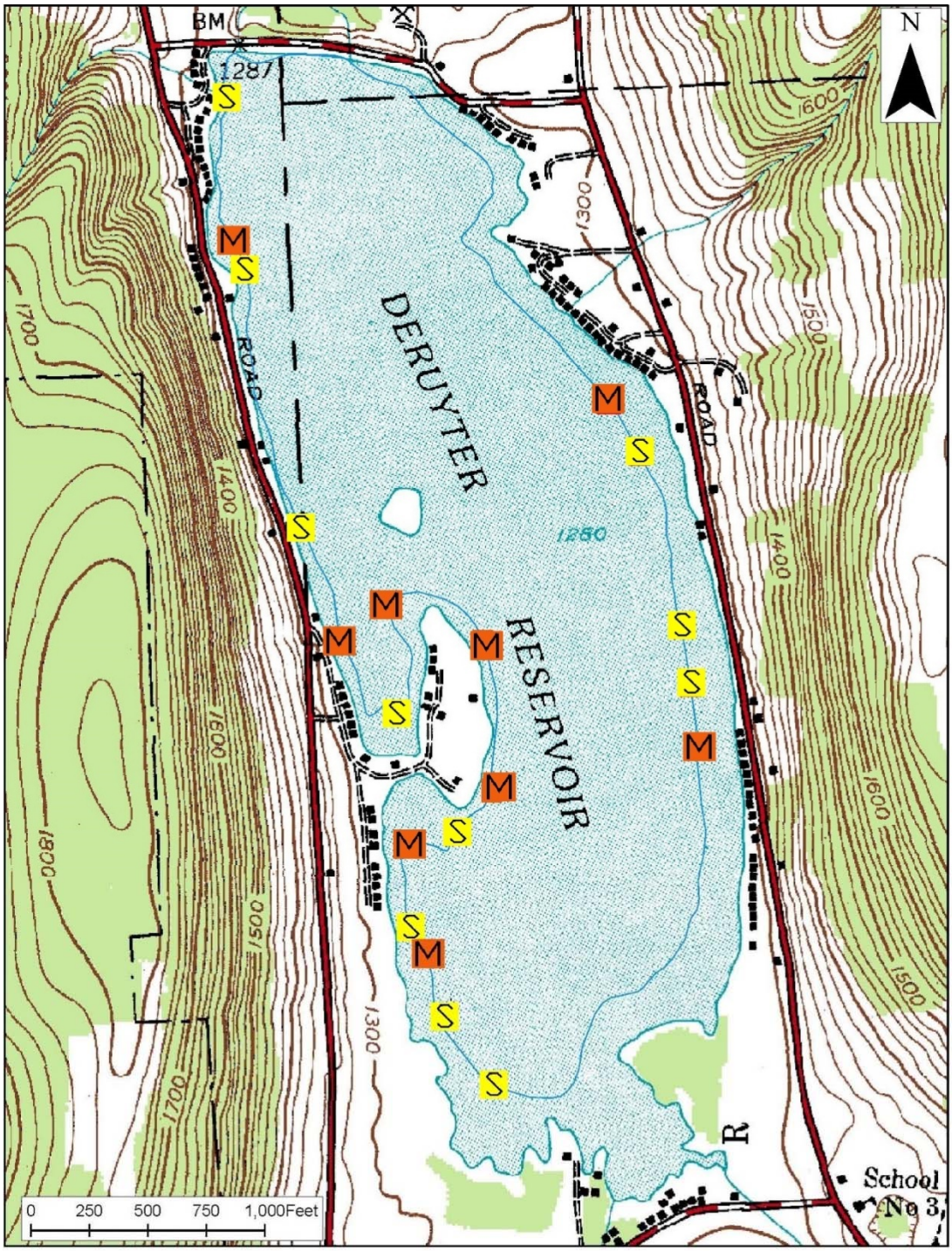

Figure 6. Eurasian watermilfoil (*Myriophyllum spicatum*) abundance and locations in DeRuyter Reservoir from point intercept rake toss relative abundance method (PIRTRAM) samples obtained July 2016. "S" = sparse Eurasian watermilfoil; "T"= trace Eurasian watermilfoil; "Circle Z" = no Eurasian watermilfoil. See Lord & Pokorny, 2012 ("Methods and Rationale" p. 26, Table 1) for weights associated with abundance categories and methods details.

Table 3. Names of all submersed plants and the two macro algae found in DeRuyter Reservoir as sampled in 2011, 2012, 2014, 2015and 2016 from all samplings and observations.

	Common Name	Scientific Name
1	Clasping leaf pondweed	*Potamogeton richardsonii*
2	Coontail	*Ceratophyllum demersum*
3	Curly leaved pondweed	*Potamogeton crispus*
4	Eurasian watermilfoil	*Myriophyllum spicatum*
5	Filamentous algae	
6	Flat-stemmed pondweed	*Potamogeton zosteriformis*
7	Hybrid pondweed	*Potamogeton* sp. x sp.
8	Illinois pondweed	*Potamogeton illinoensis*
9	Nitella	*Nitella sp.*
10	Sago pondweed	*Stuckenia pectinata*
11	Small pondweed	*Potamogeton pusillus*
12	Slender naiad	*Najas flexilis*
13	Southern naiad	*Najas guadalupensis*
14	Starry Stonewort	*Nitellopsis obtusa*
15	Stonewort	*Chara vulgaris*
16	Tape-grass	*Vallisneria americana*
17	Water-crowfoot	*Ranunculus trichophyllus*
18	Water-plantain	*Alisma gramineum*
19	Water stargrass	*Heteranthera dubia*
20	Waterweed	*Elodea* sp.

Milfoil herbivore data document reduced numbers of milfoil herbivores in DeRuyter Reservoir in 2016 from 2015. Data from our milfoil stem sampling are summarized in Table 4. We found one aquatic macrophyte moth larvae, one adult weevil, three weevil larvae and 13 weevil eggs. We found milfoil midges (*Cricotopus myriophylli*) in all sampling periods (June = 14, 0.54 per stem; July = 32, 0.51 per stem; August = 9, 0.32 per stem; October = 5, 0.33 per stem), which are all decreases from 2015. Caddisfly numbers decreased considerably in all months compared to 2015. The most notable decrease was in the July sampling, with 27 caddisflies compared to 108 found in 2015. The number of damaged tips (submission page picture) was highest in July which is consistent with the milfoil midge lifecycle.

Table 4. Results of Eurasian watermilfoil (*Myriophyllum spicatum*) stem samples obtained from DeRuyter Reservoir in June, July, August and October 2016. One hundred and thirty-two stem samples were collected. Presence of aquatic macrophyte moths (*Acentria ephemerella*), milfoil midges (*Cricotopus myriophylli*), and milfoil weevils (*Euhrychiopsis lecontei*) in any life stage were noted.

Date	Tip (#)	Moth Adult (#)	Moth LARVAE (#)	Pupae in cocoons (#)	Eggs (#)	Weevil Adult (#)	Weevil LARVAE (#)	Pupae in pupal chamber (#)	Eggs (#)	Midges non-damaging (#)	Midges DAMAGING Milfoil (#)	Caddisflies (#)
6-Jun-16	26	0	0	0	0	0	0	0	1	443	14	17
# per tip		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	17.04	0.54	0.65
19-Jul-16	63	0	0	0	0	0	2	0	12	496	32	27
# per tip		0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.19	7.87	0.51	0.43
22-Aug-16	28	0	1	0	0	1	1	0	0	143	9	6
# per tip		0.00	0.02	0.00	0.00	0.04	0.04	0.00	0.00	5.11	0.32	0.21
4-Oct-16	15	0	0	0	0		0	0	0	102	5	0
# per tip		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.80	0.33	0.00

Table 4 continued. Results of Eurasian watermilfoil (*Myriophyllum spicatum*) stem samples obtained from DeRuyter Reservoir in June, July, August and October 2016. One hundred and thirty-two stem samples were collected. Presence of aquatic macrophyte moths (*Acentria ephemerella*), milfoil midges (*Cricotopus myriophylli*), and milfoil weevils (*Euhrychiopsis lecontei*) in any life stage were noted.

Date	Tip (#)	Healthy apical tip	Minor (a few leaflets missing)	Moderate (many leaflets gone)	Extensive (most grazed/deformed)	Tip Missing (end of stem)	Healthy Stem	Minor (1-4 scars or <cm mined)	Moderate (>4 scars or 2-4 cm mined)	Extensive (8 scars or >4 cm mined)	Weevil mining (#)	Pupal chambers (#)	Scars (# moth, weevil, or other)	Healthy Leaflets	Minor (leaflets gone in 1 place)	Moderate (leaflets gone, 2-4 places)	Extensive (leaflets gone, >4 places)	Retreats (# total)	Cocoons (#)
6-Jun-16	26	17	3	6	10	4	6	16	2	1	7	0	30	1	3	6	13	19	19
# per tip		0.65	0.12	0.23	0.38	0.15	0.23	0.62	0.04	0.04	0.25	0.00	1.15	0.04	0.12	0.23	0.50	0.73	0.73
19-Jul-16	63	54	15	1	24	11	24	34	7	0	11	9	53	5	26	20	5	42	24
# per tip		0.86	0.24	0.02	0.38	0.17	0.38	0.54	0.11	0.00	0.17	0.14	0.84	0.08	0.41	0.32	0.08	0.67	0.38
22-Aug-16	28	43	2	4	6	6	23	9	1	0	7	13	6	7	14	8	0	6	1
# per tip		1.54	0.07	0.14	0.21	0.21	0.82	0.32	0.04	0.00	0.26	0.46	0.21	0.25	0.50	0.29	0.00	0.21	0.04
4-Oct-16	15	25	5	1	5	3	8	7	0	0	5	0	12	9	4	1	0	5	18
# per tip		1.67	0.33	0.07	0.33	0.20	0.53	0.47	0.00	0.00	0.33	0.00	0.80	0.60	0.27	0.07	0.00	0.33	1.20

2016 had the highest percentage of sunfish (51 %) in the past 6 years. Bluegill total numbers increased in 2016 and young-of-the-year were found in our 2016 electofishing in contrast to our 2015 and 2014 sampling. Table 5 provides the electrofishing summaries for 2016 and preceding years, and Figure 7 is a graph depicting our electrofishing sample of bluegill population composition by size. Catch per unit effort (catch per hour) for bluegill increased from 129 fish per hour in 2015 to 170 fish per hour in 2016. Pumpkinseed increased from 186 per hour in 2015 to 284 per hour in 2016. Largemouth bass increased from 31 fish per hour in 2015 to 58 fish per hour in 2016. As was seen in 2015, 2016 bluegill length frequency data shows distinct age classes (age 1 = 60-80 mm, age 2 =90-120mm, age 3 = 145-170 mm). The largest proportion of bluegill were in the 90-110 mm size range. Unlike in 2015, 2016 had young-of-the-year (age 0 = 0-50 mm) bluegill and they were present in larger numbers than in 2014. Yellow bullhead were caught for the first time in the past six years.

Table 5. Electrofishing data summarized from four years (2008, 2011, 2012, 2014, 2015 and 2016) in DeRuyter Reservoir.

Species	Catch/hr 7/1/2008	Catch/hr 6/30/2011	Catch/hr 6/27/2012	Catch/hr 6/26/2014	Catch/hr 6/24/2015	Catch/hr 7/11/2016	6 Year Average	6 Year Standard Deviation
Brown Bullhead	4.7	7.4	1.1	11.4	10.7	6.6	7.0	3.8
Black Crappie	0.0	0.0	0.0	0.9	0.8	0.0	0.3	0.4
Bluegill	100.2	131.0	101.3	156.8	129.4	170.4	131.5	28.5
Banded killifish	8.2	9.2	2.3	2.6	1.6	1.9	4.3	3.4
Bluntnose Minnow	1.2	14.8	21.4	10.6	6.6	13.1	11.3	7.0
Common Carp	23.3	0.0	0.0	0.0	0.0	0.0	3.9	9.5
Chain Pickerel	0.0	39.7	18.0	13.2	7.4	8.4	14.5	13.8
Emerald Shiner	17.5	0.0	1.1	0.0	0.0	0.0	3.1	7.1
Golden Shiner	24.5	40.6	9.0	7.9	23.1	17.8	20.5	12.0
Largemouth Bass	26.8	52.6	31.5	587.4	30.5	58.1	131.1	223.9
Central Mud Minnow	0.0	0.0	0.0	0.9	0.0	0.0	0.1	0.4
Pumpkinseed	152.6	98.7	47.3	298.5	186.3	283.7	177.8	99.8
Rock Bass	125.8	179.0	283.5	229.0	108.8	87.1	168.9	76.2
Smallmouth Bass	19.8	10.2	4.5	7.9	4.1	8.4	9.2	5.7
Spottail Shiner	15.1	0.9	6.8	32.6	0.0	1.9	9.5	12.6
Tessellated Darter	8.2	5.5	10.1	6.2	4.1	7.5	6.9	2.1
Walleye	8.2	3.7	4.5	2.6	0.8	1.9	3.6	2.6
White Sucker	0.0	0.9	3.4	2.6	0.8	0.0	1.3	1.4
Yellow Perch	349.4	121.8	398.3	374.3	204.4	228.5	279.4	110.5
Yellow Bullhead	0.0	0.0	0.0	0.0	0.0	0.9	0.2	0.4
Total fish:	885.1	716.1	943.9	1745.4	719.7	896.0	984.4	384.8
Total sunfish:	252.7	229.8	148.5	455.3	315.7	454.1	309.4	124.7
Sunfish as % of fish	29%	32%	16%	26%	44%	51%	33%	13%

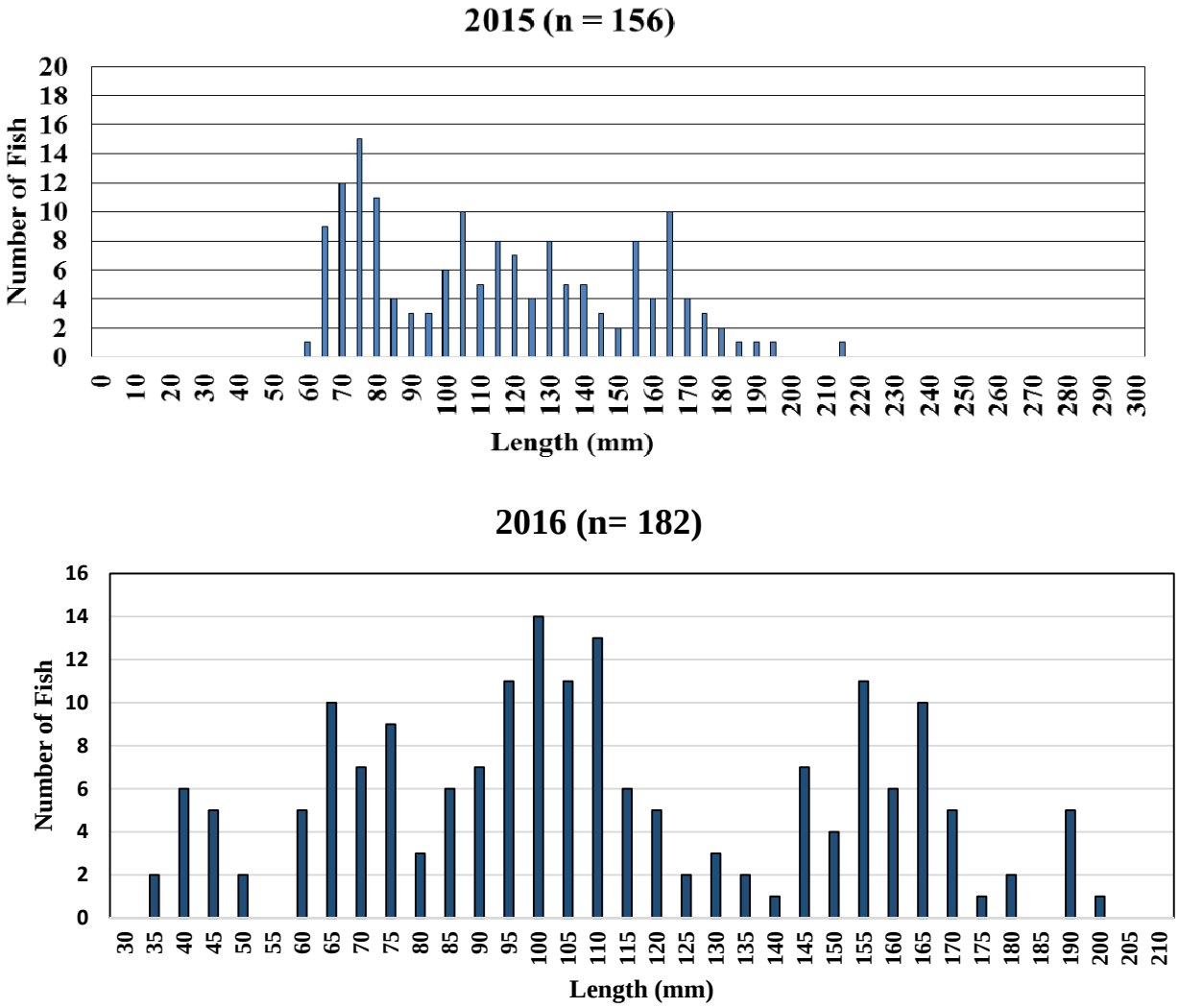

Figure 7. Length frequency histogram for bluegill (*Lepomis macrochirus*) in DeRuyter Reservoir for 2015 and 2016

Discussion

As is apparent to anyone familiar with DeRuyter Reservoir in previous years, Eurasian watermilfoil was a commonly seen aquatic plant throughout the entire 2016 summer. When sampling in 2016, no sites were located that were absent of Eurasian watermilfoil and all the sites contained medium to sparse abundances. Milfoil density has increased from the growth noted in 2015 and is comparable to the profuse growth seen in 2014.

Milfoil midges are still the overwhelming majority of the herbivorous insects found, their numbers and the number of caddisflies were down compared to the previous year. There was an increase in weevil eggs located (2015: found 2; 2016: found 13) and the other insects numbers located were near the same as 2015.

Water temperatures (Table 1) were high enough to ensure bluegill and pumpkinseed had an opportunity to hatch (Cooke & Philipp, 2009) prior to our electrofishing sampling and it was apparent by the combined 30 young-of-the-year pumpkinseed and bluegill obtained. We did harvest 15 young-of-the-year bluegill, so we know that we did not stop recruitment.

The suspected main cause of the increased numbers of sunfishes compared to 2015 was the walleye stocking. 2015 walleye stocked fingerlings were largely undersized and widely varying in size (pictured below). Additionally only 8000 were stocked in 2016, which is well below DEC recommended fish stocking rates and far below our recommendation for 2016. **The small sizes from the 2015 walleye stocking along with the reduced numbers in the 2016 walleye stocking will not provide effective biocontrol.**

Varying sizes of walleye stocked in 2015. Provided by J. Kennedy

Although all involved are disappointed at the inadequate stocking size and numbers of walleye, the data collected supports our current working hypothesis (Figure 1) in regard to fish community impacts on milfoil herbivores and Eurasian watermilfoil (Lord 2004; Lord *et al*. 2004). Inadequate stocking allowed sunfishes to increase in abundance and

size and to eat more of the herbivorous insects which, in turn, allowed more growth of healthy watermilfoil.

Our concern for runoff-delivered materials, sediments and salts, finding their way into DeRuyter Reservoir (detailed in Lord & Pokorny, 2013) persists because they exacerbate Eurasian watermilfoil growth in DeRuyter Reservoir.

Recommendations

Fish Stocking

We recommend a considerable increase in walleye fingerlings stocked into DeRuyter Reservoir compared to 2016. Specifically, we recommend stocking with 36,560 walleye fingerling in 2017 (Table 6) which includes our recommended stocking rate solution plus the deficiency from the 2016 stocking. We note NYSDEC has increased the minimum take length on DeRuyter Reservoir walleye to 18 inches, with a maximum daily limit of three walleye (NYSDEC, undated). This should facilitate control of sunfish and increase milfoil herbivore populations..

Table 6. DeRuyter Reservoir 2017 walleye stocking considerations.

Walleye Finglerlings Calculation		Number	Notes
DeRuyter Reservoir acreage:		557	
NYS stocking rate:		20	/ acre
NYS stocking rate solution for DeRuyter Reservoir:		11,140	
Hypothetical insectivore controlling initial stocking rate:		5 x NYS Rate	
	(not 10x because of previous stocking)		
	2013 summer fingerlings stocked:	50,000	(6,000 short of goal)
Hypothetical insectivore controlling maintenance stocking rate:		2 x NYS Rate with June fingerlings	
	(adjusted by fish populations data)		
	2014 fall finglerlings stocked:	10,000	(~4,000 short of goal)
	2015 fall fingerlings stocked	25,000	
	2016 fall fingerlings stocked	8,000	(estimated not counted; ~14,000 short of goal)
DeRuyter 2017 fingerlings to be stocked:		36,560	(maintenance rate + 2016 deficit)
Fry required:		197,089	
2017 June walleye finglerlings estimated cost:		**$16,452**	($0.45/fingerling estimated)
2017 Oct walleye finglerlings estimated cost:		**$53,012**	($1.45/fingerling estimated)

Electrofishing

Given past difficulties providing a timely autumn electrofishing survey with effective equipment, we recommend that SUNY Cobleskill provide a 2017 autumn electrofishing survey to ascertain walleye population status. This survey is in addition to the summer (late June) electrofishing survey to ascertain the bluegill population status.

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Appendices

Appendix A: Submersed aquatic plant relative abundances for DeRuyter Reservoir as sampled July 2016

Table A.1 Lake aquatic plants rake toss location abundance categories 2016 samples.

Station	Zone	UTM NAD27 Northing	UTM NAD27 Easting	Depth (m)	All Plants	All Natives	Milfoil	Coontail	Stonewort	Yellow water lily	White water lily	Curly leaved pondweed	Leafy pondweed	Fern leaved pondweed	Water Stargrass
2	042	470336	0426632	3.0	M	M	S	Z	Z	Z	Z	T	Z	Z	Z
7	042	470768	0426484	3.0	D	D	M	M	Z	Z	Z	Z	Z	Z	Z
8	042	470768	0426460	3.0	M	M	S	S	Z	Z	Z	T	Z	Z	S
17	042	471572	0426360	3.0	M	M	S	S	Z	Z	Z	Z	Z	Z	Z
21	042	471728	0426604	3.0	M	S	M	S	Z	Z	Z	Z	Z	Z	S
25	042	471594	0426942	3.0	M	M	S	S	Z	Z	Z	S	Z	Z	S
29	042	470527	0426852	3.0	D	M	M	S	Z	Z	Z	Z	Z	Z	T
33	042	470438	0427059	3.0	D	D	M	M	Z	Z	Z	Z	Z	Z	S
38	042	470402	0427558	3.0	M	M	M	S	Z	Z	Z	Z	Z	Z	Z
40	042	470286	0427587	3.0	M	M	S	M	Z	Z	Z	Z	Z	Z	T
42	042	470080	0427604	3.0	M	M	M	S	Z	Z	Z	Z	Z	Z	S
45	042	479838	0427604	3.0	M	M	S	S	Z	Z	Z	Z	Z	Z	S
46	042	479741	0426865	3.0	D	M	M	M	Z	Z	Z	Z	Z	Z	Z
48	042	479616	0427581	3.0	M	M	S	S	Z	Z	Z	T	Z	Z	Z
51	042	479443	0427514	3.0	M	M	S	S	Z	Z	Z	Z	Z	Z	T
67	042	470282	0422764	3.0	M	S	M	Z	Z	Z	Z	Z	Z	Z	S
69	042	474037	0427644	3.0	M	M	S	S	Z	Z	Z	Z	Z	Z	S
71	042	470192	0427025	3.0	M	M	S	S	Z	Z	Z	Z	Z	Z	S
77	042	470985	0427492	3.0	S	S	S	Z	T	Z	Z	Z	Z	Z	T
79	042	471138	0427432	3.0	M	S	M	S	T	Z	Z	Z	Z	Z	T

Appendix B: Glossary of Technical Terms Used

25 cm

10 inches

ab·scis·sion

Pronunciation: ab-'si-zh&n
Function: *noun*
Etymology: Latin *abscission-, abscissio,* from *abscindere*
: the act or process of cutting off : REMOVAL;
: the natural separation of flowers, fruit, or leaves from plants at a special separation layer.

aer·en·chy·ma

Pronunciation: "ar-'e[ng]-k&-m&, "er-

Function: *noun*

Etymology: New Latin

: the spongy modified cork tissue of many aquatic plants that facilitates

gaseous exchange and maintains buoyancy.

al·ga

Pronunciation: 'al-g&
Function: *noun*
Inflected Form(s): *plural* al·gae
Etymology: Latin, seaweed
: a plant or plantlike organism of any of several phyla, divisions, or LWLAsses of chiefly aquatic usually chlorophyll-containing nonvascular organisms.

api·cal

Pronunciation: 'A-pi-k&l *also* 'a-pi-
Function: *adjective*
Etymology: probably from New Latin *apicalis,* from Latin *apic-, apex*
: of, relating to, or situated at an apex.

Appendix B: Glossary of Technical Terms Used

aug·men·ta·tion

Pronunciation: "og-m&n-'tA-sh&n, -"men-
Function: *noun*
: the act or process of augmenting;

: the state of being augmented;
: something that augments.

aux·in

Pronunciation: 'ok-s&n
Function: *noun*
Etymology: from Greek *auxein*
: any of various usually acidic organic substances that promote cell. elongation in plant shoots and usually regulate other growth processes (as root initiation)

bas·al

Pronunciation: 'bA-s&l, -z&l
Function: *adjective*
: relating to, situated at, or forming the base

: arising from the base of a stem, e.g., *basal* leaves.

buoy·an·cy

Pronunciation: 'boi-&n(t)-sE, 'bü-y&n(t)-
Function: *noun*
: the tendency of a body to float or to rise when submerged in a fluid

: the power of a fluid to exert an upward force on a body placed in it; *also* : the upward force exerted.

can·o·py

Pronunciation: 'ka-n&-pE
Function: *noun*
Inflected Form(s): *plural* -pies
Etymology: Middle English *canope,* from Medieval Latin *canopeum* mosquito net, from Latin *conopeum,* from Greek *kOnOpion,* from *kOnOps*
: a protective covering: as

(1) **:** the uppermost spreading branchy layer of a forest or

(2) **:** parts of aquatic macrophytes floating horizontally at or near the water's surface.

Appendix B: Glossary of Technical Terms Used

ca·rot·en·oid

Variant(s): *also* ca·rot·in·oid /k&-'rä-t&n-"oid/
Function: *noun*
: any of various usually yellow to red pigments (as carotenes) found widely in plants and animals and characterized chemically by a long aliphatic polyene chain composed of eight isoprene units.
- carotenoid *adjective*.

dis·sect·ed vein

Pronunciation: di-'sekt-d; ÷dI-'sekt-d, ÷'dI-" 'vAn
Function: *noun*
Etymology: Latin *dissectus,* past participle of *dissecare* to cut apart, from *dis- + secare* to cut; Middle English *veine,* from Old French, from Latin *vena*
: vascular bundles forming the framework of a leaf with little or no leaf material between them.

eu·tro·phic

Pronunciation: yu-'trO-fik
Function: *adjective*
Etymology: probably from German *Eutroph* eutrophic, from Greek *eutrophos* well-nourished, nourishing, from *eu- + trephein* to nourish
of a body of water : characterized by the state resulting from eutrophication – compare to MESOTROPHIC.

ex·ot·ic

Pronunciation: ig-'zä-tik
Function: *adjective*
Etymology: Latin *exoticus,* from Greek *exOtikos,* from *exO*
: introduced from another country **:** not native to the place where found

ex·trap·o·late

Pronunciation: ik-'stra-p&-"lAt
Function: *verb*
Inflected Form(s): -lat·ed; -lat·ing
Etymology: Latin *extra* outside + English *-polate* (as in *interpolate*)
transitive senses
: to infer (values of a variable in an unobserved interval) from values within an already observed interval

- ex·trap·o·la·tion /-"stra-p&-'lA-sh&n/ *noun*.

fish·ery

Pronunciation: 'fi-sh&-rE
Function: *noun*
Inflected Form(s): *plural* -er·ies
: the occupation, recreation, industry, or season of taking fish or other sea animals (as sponges, shrimp, or seals) : FISHING.

ge·nus

Pronunciation: 'jE-n&s, 'je-
Function: *noun*
Inflected Form(s): *plural* gen·era /'je-n&-r&/
Etymology: Latin *gener-, genus* birth, race, kind
: a LWLAss, kind, or group marked by common characteristics or by one common characteristic; *specifically*

: a category of biological LWLAssification ranking between the family and the species, comprising structurally or phylogenetically related species or an isolated species exhibiting unusual differentiation, and being designated by a Latin or latinized capitalized singular noun.

her·bi·vore

Pronunciation: '(h)&r-b&-"vOr, -"vor
Function: *noun*
Etymology: New Latin *Herbivora,* group of mammals, from neuter plural of *herbivorus*
: a plant-eating animal.

her·biv·o·rous

Pronunciation: "(h)&r-'biv-r&s, -'bi-v&-
Function: *adjective*
Etymology: New Latin *herbivorus,* from Latin *herba* grass + *-vorus* -vorous
: feeding on plants.
- her·biv·o·ry /-'bi-v&-rE/ *noun.*

hy·poth·e·sis

Pronunciation: hI-'pä-th&-s&s
Function: *noun*
Inflected Form(s): *plural* hy·poth·e·ses
Etymology: Greek, from *hypotithenai* to put under, suppose, from *hypo- + tithenai*

to put
: a tentative assumption made in order to draw out and test its logical or empirical consequences.

in·star

Pronunciation: 'in-"stär
Function: *noun*
Etymology: New Latin, from Latin, equivalent
: a stage in the life of an arthropod (such as an insect) between two successive molts; *also* **:** an individual in a specified instar.

lim·it·ing

Function: *adjective*
: functioning as a limit : RESTRICTIVE, e.g., *limiting* value;

: being an environmental factor (as a nutrient) that limits the population size of an organism.

lit·to·ral

Pronunciation: 'li-t&-r&l; "li-t&-'ral, -'räl
Function: *adjective*
Etymology: Latin *litoralis,* from *litor-, litus* seashore
: of, relating to, or situated or growing on or near a shore.

: that area of a lake or pond where the bottom is covered with macrophytes.

log·a·rithm

Pronunciation: 'lo-g&-"ri-[th]&m

Function: *noun*
Etymology: New Latin *logarithmus,* from *log-* + Greek *arithmos* number
: the exponent that indicates the power to which a number is raised to produce a given number, e.g., the *logarithm* of 100 to the base 10 is 2.

mac·ro·phyte

Pronunciation: 'ma-kr&-"fIt
Function: *noun*
: a member of the macroscopic plant life, especially of a body of water, i.e., plants growing in water that can be seen with the naked eye.

mer·i·stem

Pronunciation: 'mer-&-"stem
Function: *noun*
Etymology: Greek *meristos* divided (from *merizein* to divide, from *meros*) + English *-em* (as in *system*)
: a formative plant tissue usually made up of small cells capable of dividing indefinitely and giving rise to similar cells or to cells that differentiate to produce the definitive tissues and organs.

me·so·tro·phic

Pronunciation: "me-z&-'trO-fik, "mE-, -s&-, -'trä-fik
Function: *adjective*
of a body of water : having a moderate amount of dissolved nutrients -- compare EUTROPHIC.

mi·cro·bi·al

Pronunciation: /mI-'krO-bE-&l/
Function: *adjective*
Etymology: International Scientific Vocabulary *micr-* + Greek *bios* life
: pertaining to microorganism, germ.

midge

Pronunciation: 'mij
Function: *noun*
Etymology: Middle English *migge,* from Old English *mycg;* akin to Old High German *mucka* midge, Greek *myia* fly, Latin *musca*
Date: before 12th century
: a tiny dipteran fly (as a chironomid).

mu·tu·al·ism

Pronunciation: 'myü-ch&-w&-"li-z&m, 'myü-ch&-"li-, 'myüch-w&-"li-
Function: *noun*
: mutually beneficial association between different kinds of organisms
- mu·tu·al·is·tic /"myü-ch&-w&-'lis-tik, "myü-ch&-'lis-, "myüch-w&-'lis-/ *adjective*.

Appendix B: Glossary of Technical Terms Used

na·scent

Pronunciation: 'na-s&nt, 'nA-
Function: *adjective*
Etymology: Latin *nascent-, nascens,* present participle of *nasci* to be born
: coming or having recently come into existence.

niche

Pronunciation: 'nich, ÷'nEsh
Function: *noun*
Etymology: French, from Middle French, from nicher to nest, from (assumed) Vulgar Latin nidicare, from Latin nidus nest -- more at NEST
: a habitat supplying the factors necessary for the existence of an organism or species

: the ecological role of an organism in a community especially in regard to food consumption.

over·win·ter

Pronunciation: "O-v&r-'win-t&r
Function: *intransitive verb*
: to survive the winter.

plank·ton

Pronunciation: 'pla[ng](k)-t&n, -"tän
Function: *noun*

Etymology: German, from Greek, neuter of *planktos* drifting, from *plazesthai* to wander, drift, middle voice of *plazein* to drive astray; akin to Latin *plangere* to strike
: the passively floating or weakly swimming usually minute animal and plant life of a body of water
- plank·ton·ic /pla[ng](k)-'tä-nik/ adjective.

pre·da·tion

Pronunciation: pri-'dA-sh&n

Function: *noun*

Etymology: Middle English *predacion*, from Latin *praedation-*,

praedatio, from *praedari*

: a mode of life in which food is primarily obtained by the killing and consuming of animals.

quad·rat

Pronunciation: 'kwä-dr&t, -"drat
Function: *noun*
Etymology: alteration of quadrate
: a usually rectangular plot used for ecological or population studies.

ref·uge

Pronunciation: 're-(")fyüj *also* -(")fyüzh
Function: *noun*
Etymology: Middle English, from Middle French, from Latin *refugium,* from *refugere* to escape, from *re- + fugere* to flee
: shelter or protection from danger or distress
: a place that provides shelter or protection.

rhi·zome

Pronunciation: 'rI-"zOm
Function: *noun*
Etymology: New Latin *rhizomat-, rhizoma,* from Greek *rhizOmat-, rhizOma* mass of roots, from *rhizoun* to cause to take root, from *rhiza* root

: a somewhat elongate usually horizontal subterranean plant stem that is often thickened by deposits of reserve food material, produces shoots above and roots below, and is distinguished from a true root in possessing buds, nodes, and usually scalelike leaves.

Sec·chi disk

Pronunciation: se-'kee desk
Function: *noun*
: disk used to measure water LWLArity.

se·nes·cence

Pronunciation: si-'ne-s&n(t)s
Function: *noun*
Etymology: *senescent,* from Latin *senescent-, senescens,* present participle of

senescere to grow old, from *sen-, senex* old
: the state of being old : the process of becoming old.

: the growth phase in a plant or plant part (as a leaf) from full maturity to death
- se·nes·cent /-sᵃⁿt/ *adjective.*

sub·strate

Pronunciation: 's&b-"strAt
Function: *noun*
Etymology: Medieval Latin *substratum*
: the base on which an organism lives, e.g., the soil is the *substrate* of most seed plants.

tur·i·on

Pronunciation: ter-'E-on

Function: *noun*

: a winter bud arising from vegetative material.

un·sus·tain·able

Pronunciation: n-s&s-'stA-n&-b&l
Function: *adjective*
: incapable of being sustained.

: of or relating to a lifestyle involving the use of sustainable methods, e.g., *unsustainable* society.

Most of the definitions in this appendix were modified from Merriam-Webster OnLine: The Language Center (http://www.m-w.com)

Appendix C: Data CD (available on request)

The CD contains the following file types and documents with the noted names:

Microsoft Office Access:

Plant Mapping Data:

DeRuyter Reservoir Rake Toss Samples 2016 as of ddmmmyy.mdb

Microsoft Office Excel:

Data:

DeRuyter Reservoir Electrofishing Data Jul2016 as of ddmmmyy.xls

Microsoft Office Powerpoint:

DeRuyter Milfoil Management as of 3Sep11.ppt

Adobe Acrobat:

This report:

2016 Project Report: Update on the Impact of Walleye Stocking and Milfoil Herbivorous Insects on the Growth of Eurasian watermilfoil in DeRuyter Reservoir

Various documents relating to mitigation of storm water impacts on lakes.