SPINY WATER FLEA DENSITIES IN THE GILE FLOWAGE 2004 - 2008

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Background Information

The Gile Flowage is a 3,384 acre impoundment in Iron Co. Wisconsin. It has a maximum depth of 25 feet. It was the first inland lake in Wisconsin found to contain spiny water fleas (*Bythotrophes cederstroemi*). Spiny water fleas (SWF's) are an exotic species of zooplankton native to northern Europe. SWF's are predaceous, feeding on other zooplankton. Their long spiny tails prevent them from being eaten by juvenile or small fish. They cause shifts in the native zooplankton community. They may also impair recruitment of juvenile fish into the adult population by competing for their food supply. They were first found in the Gile Flowage in the late summer of 2003.

Monitoring Methods

The flowage was monitored during 2004-8 to assess the population of SWF's present. Four sites were sampled (figure 1). Sites were usually sampled monthly from June to October. At each site four vertical tows were made from two feet off the bottom to the surface. A 0.5 m diameter plankton net with a 253 micron screen was used. Surface water temperature was measured. Water elevation was also recorded, using the gage at the dam.

Monitoring Results

Two previous reports, "Spiny Water Flea Densities in the Gile Flowage 2004-2005"and "Spiny Water Flea Densities in the Gile Flowage 2006" provide the detailed monitoring results and graphs of densities for those years. Monitoring results for 2004-8 are summarized in table 1 below:

Table 1. Gile Flowage Spiny Water Flea Densities (number/m^3)							
Year	June	July	Aug.	Sept.	Oct.	Nov.	June-Oct. mean
2004	--	13.4*	**23.2***	4.0	7.7	11.4	12.1**
2005	**27.2**	9.9	4.1	5.9	9.5	--	11.3
2006	7.1	12.5	7.0	**32.3**	12.9	--	14.4
2007	3.5	**29.6**	20.0	--	17.6	--	17.7**
2008	**19.6**	14.0	11.8	9.9	--	--	13.8**
Monthly mean	14.4	15.9	13.2	13.0	11.9	--	--

*Value is the mean of 2 samples that month
**A missing value for one of the 5 months is not included in the calculated mean
Emboldened monthly densities are the peak densities for the year.

The June through October mean densities are fairly similar over the 5 year period and ranged from 11.3 to 17.7 SWF's per m^3. There is no apparent trend in the SWF population.

The 5 year monthly mean densities show even less variability and range from 11.9 to 15.9 SWF's per m^3. Seasonal patterns of densities are variable from year to year. Peak densities occurred in June through September over the 5 year period (see emboldened values in table 1).

Detailed sampling results for 2007-8 are presented in tables 2 – 9.

Other Observations

Duration of SWF presence

SWF sampling was attempted on May 24, 2005 when the surface water temperature was 59°F. SWF's were not found. SWF's overwinter in a resting stage on the sediment surface and presumably had not yet emerged for the season. The latest date sampled was November 4, 2004, and SWF's were still present (table 1).

Water level and drawdown effects

Water levels in the Gile Flowage are usually drawn down several feet over the course of the summer to generate electricity at downstream dams. Water levels often drop from about June through September or October. A total water volume loss of about 40% is estimated. This is likely to contribute to lower SWF densities during this period, since a

substantial portion of the population will be passed over the dam. However, this effect does not appear to dominate the density trends observed.

Water temperature effects

SWF's are known to be sensitive to water temperatures above 25^{o}C. In the western basin of Lake Erie, SWF's rapidly disappear during periods of high water temperatures. Low SWF densities in August of 2005 were preceded by a period of hot weather. Inadequate flowage water temperature data prevents a more meaningful evaluation of temperature effects.

Mass die-offs

Masses of dead SWF's were observed washed up on the shoreline on September 17th, 2004 by Dr. Jake Vander Zanden of UW-Madison. Water temperatures were not high that summer. This phenomenon has also been observed on other lakes with SWF's. The cause of these mass die-offs is not known.

Other Zooplankton

Other zooplankton in the samples were not systematically identified or counted. However, general observations were made. Substantial numbers of other large cladocerans were only observed in the samples collected May 24th, 2005 when SWF's were not present. This is presumably due to the predation on these cladocerans by SWF's. Small copepods were the most numerous form of zooplankton on other dates. Some Chaoborus were present in July 2004.

Holopedium increased in abundance from 2004 through 2006, with large numbers of individuals present in the June through September 2006 samples. Counts of 25 to >200 per tow sample were estimated for those months. *Holopedium* has a gelatinous bivalved mantle that probably protects it from predation by SWF's and provides it with a competitive advantage. *Holopedium* has also been observed to increase in abundance in Lake Superior following the introduction of SWF's. *Holopedium* abundance in the Gile Flowage declined in 2007 and 2008, but they were still present on all sampling dates.

Leptodora is a large native predaceous zooplankter, which was commonly observed in 2004 and 2005 but was nearly absent in 2006, with only a single individual observed in August. Seasonal *Leptodora* counts were usually highest when SWF density was at its lowest. Several *Leptodara* were observed in August and October of 2007. No *Leptodora* were observed in 2008. *Leptodora* populations have been observed to decline elsewhere following the introduction of SWF's.

Fishery

During 2004-8, the most notable change in the fishery reported by the local DNR fish manager, Jeff Roth, was the development of exceptional bluegill fishing in 2006. Numerous bluegills in the 8-11 inch range were caught. SWF's are a potential food source for bluegills and their presence may have contributed to the upsurge in larger bluegills.

A large transfer of bluegills and pumpkinseeds from Mercer Lake to the Gile Flowage was made during June 12th -22nd, 2006. 16,258 bluegills and 3,329 pumpkinseeds were transferred. Sizes ranged from 3.6 to 5.9 inches. A similar transfer of bluegills had previously been made in June 2005. The bluegills stocked in 2005 and 2006 would not have reached 8-11 inches in size during 2006.

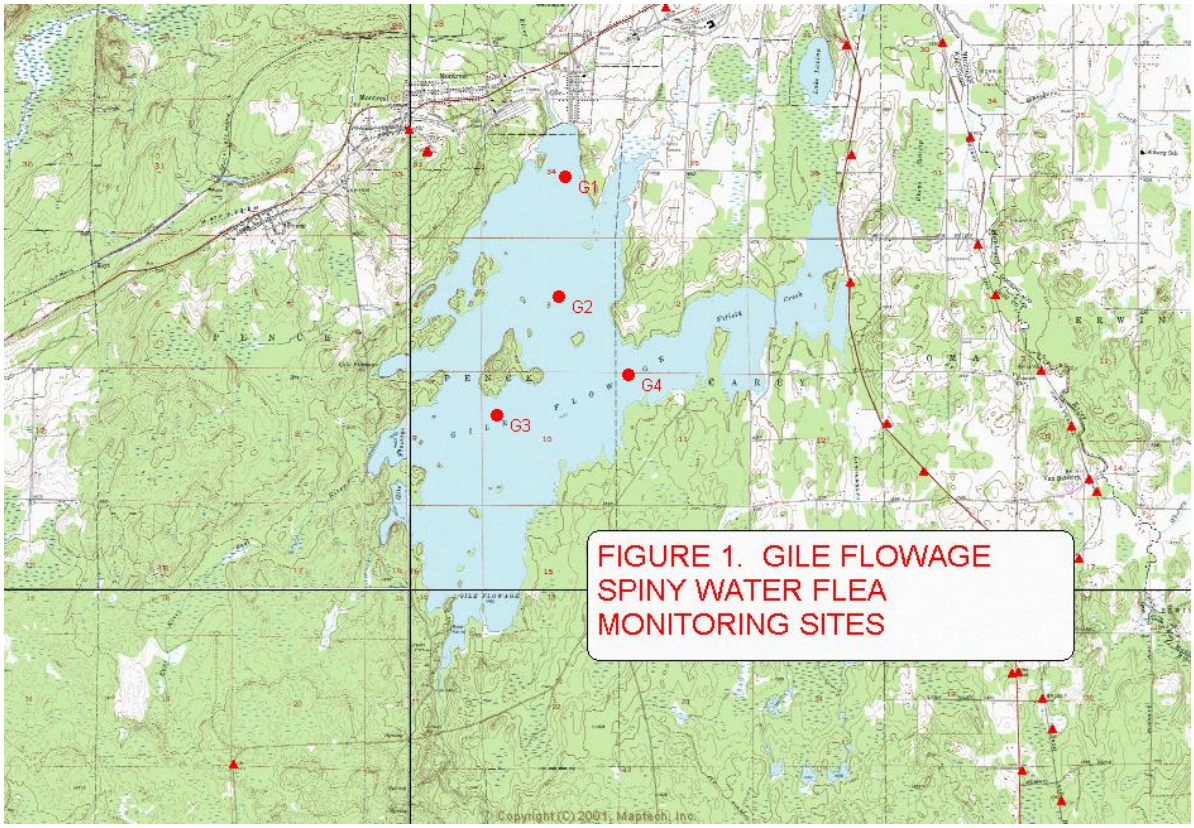

FIGURE 1. GILE FLOWAGE SPINY WATER FLEA MONITORING SITES

TABLE 2. 2007 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, JUNE 14th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites.

DATE = 14-Jun-07

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 20 Vertical tow depth (ft) = 18

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	1	5.1	0.9
B	1	5.1	0.9
C	1	5.1	0.9
D	7	35.7	6.5

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 22 Vertical tow depth (ft) = 20

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	2	10.2	1.7
B	2	10.2	1.7
C	5	25.5	4.2
D	4	20.4	3.3

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 17 Vertical tow depth (ft) = 15

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	4	20.4	4.5
B	2	10.2	2.2
C	8	40.8	8.9
D	0	0	0.0

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 14 Vertical tow depth (ft) = 12

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	2	10.2	2.8
B	4	20.4	5.6
C	4	20.4	5.6
D	4	20.4	5.6

MEAN =	3.2	16.3	3.5
STANDARD DEV. =		11.4	2.5
90% CONF. INTERVAL =		41.4	8.6

OTHER DATA, COMMENTS

Small copepods sparse; Holopedium abundant with estimates of 25-100/tow

Leptodora not observed.

Water elevation at dam gage = 1487.8 ft.

Surface temp = 74 F

TABLE 3. 2007 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, JULY 19th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites

DATE = 19-Jul-07

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 20 Vertical tow depth (ft) = 18

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	6	30.6	5.6
B	74	377.4	68.8
C	33	168.3	30.7
D	60	306	55.8

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	48	244.8	47.3
B	11	56.1	10.8
C	49	249.9	48.2
D	42	214.2	41.3

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 13 Vertical tow depth (ft) = 11

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	24	122.4	36.5
B	7	35.7	10.6
C	20	102	30.4
D	14	71.4	21.3

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 11 Vertical tow depth (ft) = 9

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	23	117.3	42.8
B	2	10.2	3.7
C	7	35.7	13.0
D	4	20.4	7.4

MEAN =	26.5	135.2	29.6
STANDARD DEVIATION =		113.1	20.1
90% CONF. INTERVAL =		46.5	8.2

OTHER DATA, COMMENTS

Small copepods abundant. Holopedium variable with 20 - 150 / tow.
Leptodora not observed.
Water elevation at dam gage = 1485.5 ft.
Surface water temp. = 68 F

TABLE 4. 2007 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, AUGUST 20th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites

DATE = 20-Aug-07

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	17	86.7	16.7
B	9	45.9	8.9
C	3	15.3	3.0
D	12	61.2	11.8

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 17 Vertical tow depth (ft) = 15

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	24	122.4	26.8
B	11	56.1	12.3
C	17	86.7	19.0
D	44	224.4	49.1

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 14 Vertical tow depth (ft) = 12

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	12	61.2	16.7
B	17	86.7	23.7
C	7	35.7	9.8
D	6	30.6	8.4

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 11 Vertical tow depth (ft) = 9

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	1	5.1	1.9
B	34	173.4	63.2
C	16	81.6	29.8
D	10	51	18.6
MEAN =	15.0	76.5	20.0
STANDARD DEVIATION =		57.0	16.3
90% CONF. INTERVAL =		23.5	6.7

OTHER DATA, COMMENTS

Small copepods abundant. Holopedium sparse with 0 - 5 / tow.
4 Leptodora observed.
Water elevation at dam gage = 1484.8 ft.
Surface water temperature = 65 F

TABLE 5. 2007 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, OCTOBER 3rd

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites

DATE = 03-Oct-07

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 16 Vertical tow depth (ft) = 14

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	5	25.5	6.0
B	4	20.4	4.8
C	6	30.6	7.2
D	6	30.6	7.2

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	11	56.1	10.8
B	8	40.8	7.9
C	5	25.5	4.9
D	7	35.7	6.9

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 14 Vertical tow depth (ft) = 12

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	4	20.4	5.6
B	6	30.6	8.4
C	9	45.9	12.6
D	11	56.1	15.3

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 11 Vertical tow depth (ft) = 9

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	11	56.1	20.5
B	12	61.2	22.3
C	25	127.5	46.5
D	51	260.1	94.8

MEAN =	11.3	57.7	17.6
STANDARD DEVIATION =		59.9	23.1
90% CONF. INTERVAL =		24.6	9.5

OTHER DATA, COMMENTS

Small copepods sparse to common. Holopedium sparse with <10 / tow.
13 Leptodora observed.
Water elevation at dam gage = 1484.3 ft.
Surface water temperature = 55 F

TABLE 6. 2008 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, JUNE 20th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites.

DATE = 20-Jun-08

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 21 Vertical tow depth (ft) = 19

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	13	66.3	11.5
B	27	137.7	23.8
C	19	96.9	16.7
D	24	122.4	21.1

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 22 Vertical tow depth (ft) = 20

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	6	30.6	5.0
B	10	51	8.4
C	13	66.3	10.9
D	11	56.1	9.2

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	19	96.9	18.7
B	6	30.6	5.9
C	9	45.9	8.9
D	12	61.2	11.8

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 14 Vertical tow depth (ft) = 12

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	40	204	55.8
B	16	81.6	22.3
C	20	102	27.9
D	40	204	55.8

MEAN =	17.8	90.8	19.6
STANDARD DEV. =		53.7	15.7
90% CONF. INTERVAL =		41.4	8.6

OTHER DATA, COMMENTS

Small copepods abundant; Holopedium present with estimates of <10/tow

Small number of Daphnia; Leptodora not observed.

Water elevation at dam gage = 1489.2 ft.

Surface temp = 67 F

TABLE 7. 2008 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, JULY 18th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites

DATE = 18-Jul-08

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 21 Vertical tow depth (ft) = 19

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	12	61.2	10.6
B	6	30.6	5.3
C	11	56.1	9.7
D	13	66.3	11.5

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 21 Vertical tow depth (ft) = 19

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	17	86.7	15.0
B	20	102	17.6
C	24	122.4	21.1
D	28	142.8	24.7

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 17 Vertical tow depth (ft) = 15

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	3	15.3	3.3
B	28	142.8	31.2
C	20	102	22.3
D	5	25.5	5.6

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 12 Vertical tow depth (ft) = 10

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	4	20.4	6.7
B	1	5.1	1.7
C	10	51	16.7
D	13	66.3	21.8

MEAN =	13.4	68.5	14.0
STANDARD DEVIATION =		44.3	8.6
90% CONF. INTERVAL =		18.2	3.5

OTHER DATA, COMMENTS

Water elevation at dam gage not recorded

Surface water temp. = 71 F

TABLE 8. 2008 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, AUGUST 18th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites

DATE = 18-Aug-08

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	10	51	9.8
B	6	30.6	5.9
C	8	40.8	7.9
D	10	51	9.8

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	11	56.1	10.8
B	10	51	9.8
C	17	86.7	16.7
D	13	66.3	12.8

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 15 Vertical tow depth (ft) = 13

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	20	102	25.7
B	4	20.4	5.1
C	7	35.7	9.0
D	10	51	12.9

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 10 Vertical tow depth (ft) = 8

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	5	25.5	10.5
B	4	20.4	8.4
C	14	71.4	29.3
D	2	10.2	4.2
MEAN =	9.4	48.1	11.8
STANDARD DEVIATION =		25.0	6.9
90% CONF. INTERVAL =		10.3	2.8

OTHER DATA, COMMENTS

Small copepods abundant. Holopedium common with about 50 / tow.
Leptodora not observed.
Water elevation at dam gage not recorded

TABLE 9. 2008 GILE FLOWAGE SPINY WATER FLEA MONITORING RESULTS, SEPTEMBER 15th

A plankton net with a 0.5 m diameter and 253 micron screen was used to make 4 vertical tows at each of 4 sites

DATE = 15-Sep-08

SITE 1 N46 25 12.0, W90 13 31.5

Water Depth (ft) = 19 Vertical tow depth (ft) = 17

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	2	10.2	2.0
B	3	15.3	3.0
C	2	10.2	2.0
D	8	40.8	7.9

SITE 2 N46 24 24.9, W90 13 35.0

Water Depth (ft) = 18 Vertical tow depth (ft) = 16

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	9	45.9	9.4
B	10	51	10.5
C	4	20.4	4.2
D	16	81.6	16.7

SITE 3 N46 23 38.2, W90 14 10.5

Water Depth (ft) = 14 Vertical tow depth (ft) = 12

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	10	51	13.9
B	3	15.3	4.2
C	6	30.6	8.4
D	3	15.3	4.2

SITE 4 N46 23 54.4, W90 12 54.9

Water Depth (ft) = 11 Vertical tow depth (ft) = 9

TOW	NO. SWF'S	SWF'S/m2	SWF'S/m3
A	8	40.8	14.9
B	3	15.3	5.6
C	9	45.9	16.7
D	19	96.9	35.3

MEAN =	7.2	36.7	9.9
STANDARD DEVIATION =		25.5	8.5
90% CONF. INTERVAL =		10.5	3.5

OTHER DATA, COMMENTS

Small copepods abundant. Holopedium sparse with <4 / tow.
Leptodora not observed.