Pine River Flowage Zebra Mussel Population Initial Report, 2013

Florence County Land Conservation Department (F.C.L.C.D.)

Robert Richard, Haley Winchell, Margie Yadro

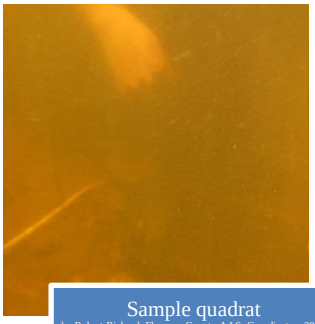
Background:

Zebra mussels (*Dreissena polymorpha*) were discovered on the Pine River Flowage on June 17, 2013. Their location appeared to be isolated to an area approximately fifteen meters in length and width centered at N 45.82943, W088.25550 ± 12 ft. The initial survey was conducted by wading the surrounding shores and boat landings. (Map 1.) To obtain more accurate information, the area was snorkeled (Map 2.) and population density samples were observed.

Pine River Flowage Boat Landing
by Robert Richard, Florence County A.I.S. Coordinator, 2013

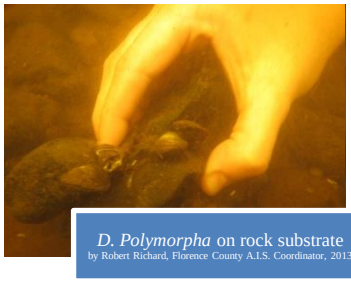
Methods:

In order to obtain sample densities, one meter quadrats were surveyed along a linear path oriented south. Samples were taken at three depths: zero, one, and two meters. *D. polymorpha* were counted in the quadrats to determine an estimated population density. Additionally, forty-three individuals of the population were collected for further analysis, and age assessment.



Sample quadrat
by Robert Richard, Florence County A.I.S. Coordinator, 2013

Haley Winchell demonstrating sampling techniques
by Robert Richard, Florence County A.I.S. Coordinator, 2013



D. Polymorpha on rock substrate
by Robert Richard, Florence County A.I.S. Coordinator, 2013

Results:

D. polymorpha were found in the location and area as previously described, but plausibly inhabit deeper areas. Initial age assessment indicates age classes of zero to four years. (Table 1.)

The most abundant age classes were two years old (55.81 percent), and three years old (32.56 percent), followed by four years (4.65 percent), one year (4.65 percent), and zero years (2.37 percent). The sample at zero meters did not contain live zebra mussels, but did contain numerous shells. (Table 2.) The quadrat observed at the one meter depth contained eleven live *D. polymorpha*, and the two meter sample contained eight individuals. No sample data was collected at three meters, due to extremely limited visibility, however, *D. polymorpha* were observed. Dissolved oxygen, pH, conductivity, and water temperatures were recorded for the site at zero and one meters. (Table 2.)

Discussion:

Snorkeling is effective to a depth of approximately three meters. At greater depths visibility becomes a limiting factor. *D. polymorpha* likely continue further into the river as they inhabited the three meter depth. Further investigation is necessary to confirm the deepest parameter of the *D. polymorpha* population. The boat landing is abundant in rocks, which provide a suitable substrate.[1] The area surveyed on 26 June 2013 mostly contained less-suitable substrates of silt and organics. The north shore is covered in 5-10 centimeters of silt, but does contain a few rock outcroppings, making it somewhat suitable in specific locations. The southern shore is covered in deep organics from the nearby forest. The substrate leading to the dam is unknown to F.C.L.C.D., but if it is composed of suitable substrates the dam will likely experience future problems associated with *D. polymorpha*.

The initial intent was to identify if removal of the *D. polymorpha* population could be done manually, due to the low population density. However, the average water temperature was 26.25°C, and had already passed through the majority of the prime breeding temperatures, residing in the higher end of the spectrum. *D. polymorpha* breed most effectively at temperatures between 12-27°C, with the peak of reproduction at 20°C.[2] Consequently, manual removal seemed unlikely to negatively affect the population. Manual removal is also not an option since the *D. polymorpha* population extends into the non-visible depths.

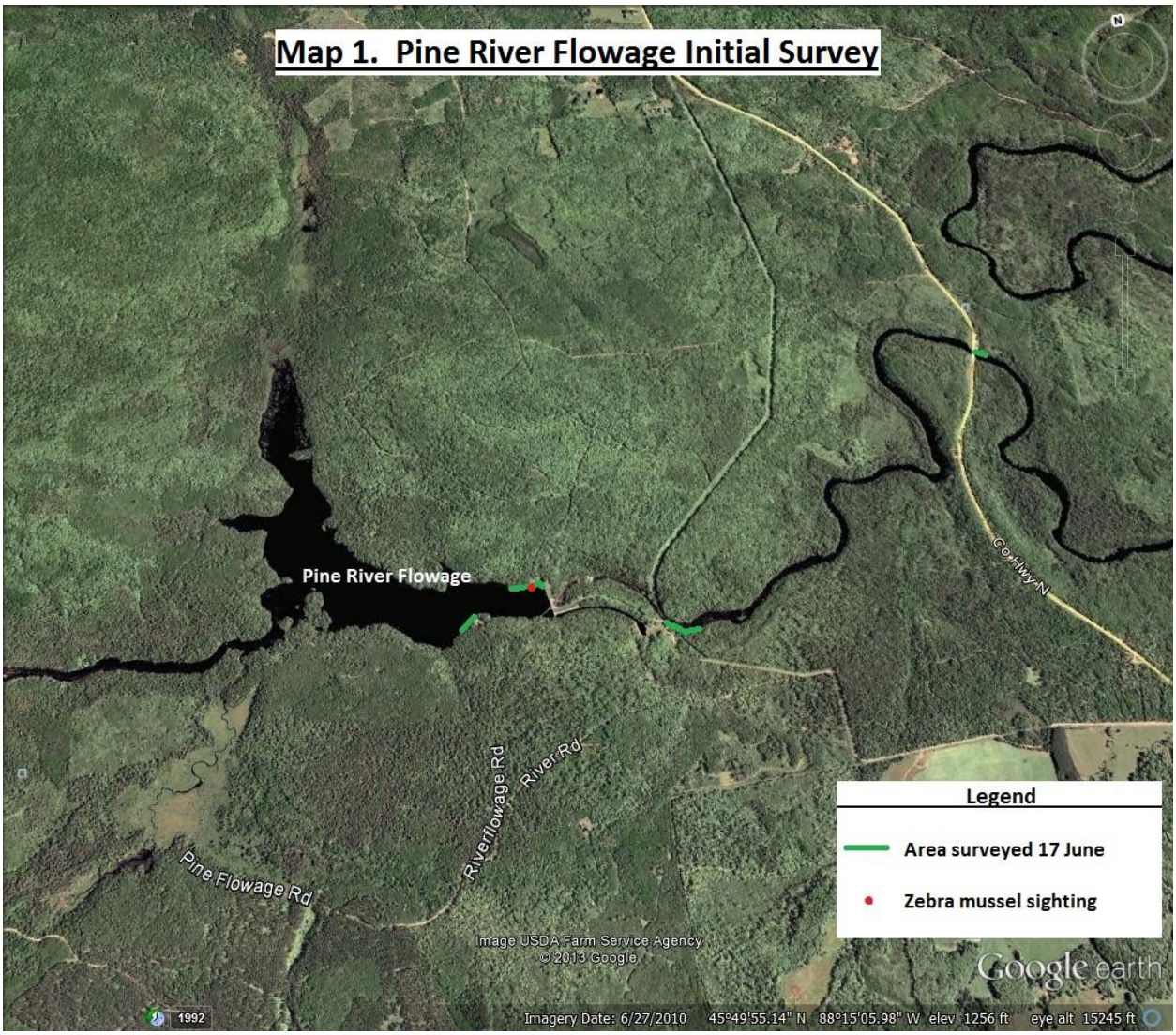
The Pine River Flowage presents a complex set of water chemistry data in regards to the susceptibility of *D. polymorpha* colonization. (Table 3.) *D. polymorpha* require a pH between 7.4-8.0, as a pH below 7.4 will hinder larval development, but have been found as low as 6.6.[3] The average pH level observed on the Pine River Flowage was 6.405. A pH level below 7.0 not only inhibits larval development, but also provides a low potential for adult survival.[4] The Pine River Flowage has been identified by the Invasive Species Interactive Mapping System as suitable for *D. polymorpha*, based on calcium concentrations.[5] The methods employed by Papes and Zanden did not necessarily involve lake sampling, but at times used a linear regression function [$\log(x) = -3.11018+1.2034 * \log(\text{conductivity})$] derived from the relationship between calcium and conductivity readings in the sampled lakes. The observed conductivity readings on the Pine River Flowage did confirm the water's susceptibility when entered into the function. The dissolved oxygen levels place the Pine River Flowage into moderate susceptibility under the

Mackie and Claudi classification scheme, meaning *D. polymorpha* can tolerate the dissolved oxygen levels, but will not thrive under the current conditions.

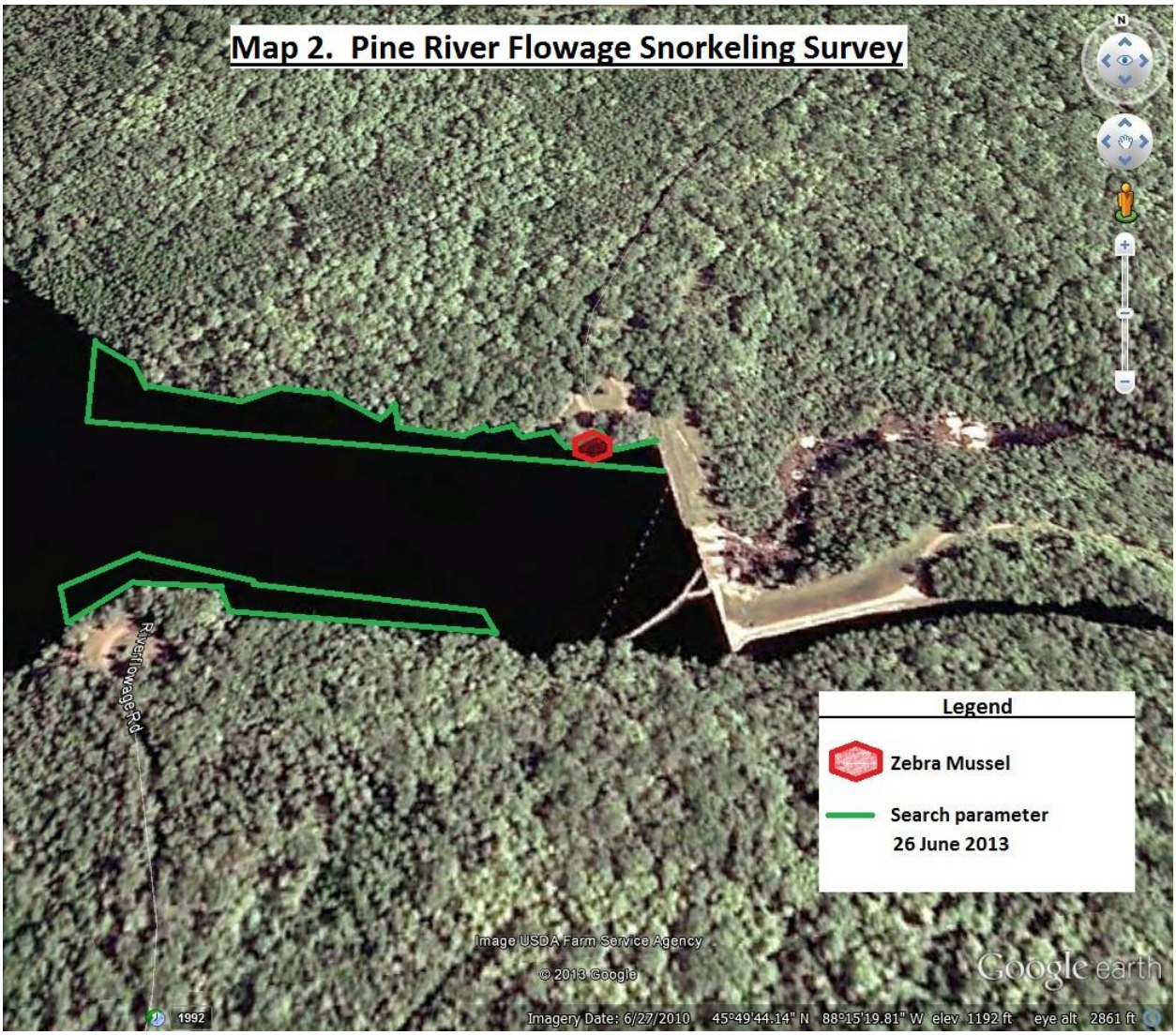
A specific date of *D. polymorpha* entry into the Pine River Flowage is difficult to identify, but analysis of age classes indicates *D. polymorpha* residence for a time span up to four years. The presence of *D. polymorpha* shells seems to confirm a presence for longer than one season. The annual mortality rate is seventy-four percent,[1] meaning *D. polymorpha* has been there at least one year to produce the observed shells from annual die-off. Therefore, *D. polymorpha* has had a residence time of one to four years in the Pine River Flowage.

Conclusion:

The low *D. polymorpha* population is likely due to several factors, but most importantly, water chemistry, and low availability of appropriate substrates. Based on reviewed sources and data collected on site, the river is appropriate *D. polymorpha* habitat. However, *D. polymorpha* may be unlikely to colonize the water in its entirety due to temperature, dissolved oxygen, substrate availability, and pH levels being limiting factors. Age analysis does seem to indicate successful breeding and residence time. Future monitoring of the population's location, density, and on site water chemistry is essential to understanding the population and predicting future conditions. A more complete survey near the dam may be required to assess the potential hazards posed by *D. polymorpha* colonization.



Map 1. Aerial view of locations surveyed on the Pine River Flowage, 17 June 2013.



Map 2. Aerial view of locations surveyed by snorkeling on the Pine River Flowage, 26 June 2013.

Table 1. *D. polymorpha* Age Classes		
Age (years)	**Count**	**Relative Frequency (%)**
0	1	2.33
1	2	4.65
2	24	55.81
3	14	32.56
4	2	4.65
Total	43	

Table 1. On 26 June 2013, forty-three *D. polymorpha* were collected from the Pine River Flowage. The mussels varied in age from 0-4 years.

Table 2. Water Chemistry and Population Density						
Depth (meters)	*D.polymorpha* Count (per m2)	Dissolved Oxygen (mg/L)	Saturation (%)	Conductivity (uS/cm)	pH (SU)	Average Temperature (˚C)
0	0	7.39	96.3	205.6	6.41	26.8
1	11	7.55	96.9	203.3	6.4	25.7
2	8	-	-	-	-	-
3	Observed	-	-	-	-	-

Table 2. The *D. polymorpha* sample density range was from 0-11, with the highest observation at one meter. Water chemistry data ranged in its suitability for *D. polymorpha*, and is compared in Table 3.

Table 3. Pine River Flowage Water Chemistry Compared with Mackie and Claudi's Water Parameters Chart						
		Low Potential for Adult Survival	Low Potential for Larval Development	Moderate (survivable, but will not flourish)	High (favorable for optimal growth)	Derived from
Living Conditions	Dissolved oxygen (mg/l)	<3	3 - 7	7 - 8	>8	Mackie and Claudi, 2010
	Temperature (°C)	<10 or >32	26 - 32	10 - 20	20 -26	Mackie and Claudi, 2010
Shell Formation	Calcium mg/l	<8	8 - 15	15 - 30	>30	Mackie and Claudi, 2010
	pH	<7.0 or >9.5	7.0 - 7.8 or 9.0 - 9.8	7.8 - 8.2 or 8.8 - 9.0	8.2 - 8.8	Mackie and Claudi, 2010
	Alkalinity (as mg $CACO_{2/l}$)	<30	30 - 55	55 - 100	100 -280	Mackie and Claudi, 2010
	Conductivity (umhos)	<30	30 - 60	60 - 110	>110	Mackie and Claudi, 2010
Food	Secchi depth (m)	<1 or >8	1 - 2 or 6 - 8	4 - 6	2 - 4	Mackie and Claudi, 2010
	Chlorophyll a (ug/l)	<2.5 or >25	2.0 - 2.5 or 20 -25	8 - 20	2.5 - 8	Mackie and Claudi, 2010
	Total phosphorus (ppb)	<5 or >50	5 - 10 or 35 - 50	10 - 25	25 - 35	Mackie and Claudi, 2010

Table 3. Water chemistry data from the Pine River flowage highlighted in green, entered into Mackie and Claudi's Water Column Parameters chart. The Pine River Flowage presents a complex scenario for habitat suitable for *D. polymorpha* colonization.

Works Cited:

1. Ferry, M., Ginnet, T., Sass, G., Gauthier, K. 2013. *Zebra mussel habitat preference, growth, and mortality in northeast Wisconsin and Upper Michigan.* Unpublished Research.

2. Ram, J.L., Fong, P.P., Garton, D.W. 1996. *Physiological Aspects of Zebra Mussel Reproduction: Maturation, Spawning, and Fertilization* American Zoology 36:326-338

3. U.S. Geological Survey. [2013]. Nonindigenous Aquatic Species Database. Gainesville, Florida. Accessed [6/28/2013].

4. Mackie, G.L., Claudi, R. 2010. Monitoring and control of macrofouling mollusks in fresh water systems. CRC Press, Boca Raton, FL.

5. Invasive Species Interactive Mapping System. Papes, M., Zanden, J.V. Center for Limnology, U.W. Madison. *Lake Suitability for Zebra Mussels.* 2009. Web. 02 July 2013.

Maps:

1. Pine River Flowage Initial Survey. 17 June 2013. Scale undetermined. Robert Richard; "using Google Earth". 27 June 2010.

2. Pine River Flowage Snorkeling Survey. 26 June 2013. Scale undetermined. Robert Richard; "using Google Earth". 27 June 2010.