

**2009 St. Croix National Scenic Riverway
Zebra Mussel and
Federally Listed Endangered
Native Mussel Species Monitoring**



Report Prepared by:

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Report Prepare for:

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Introduction:

The St. Croix National Scenic Riverway was the first unit of the National Park System included in the Wild and Scenic Rivers Act of 1968. The Riverway is considered a nationally significant resource for its richness and abundance of freshwater mussels (~40 species, the greatest in the Upper Mississippi watershed) and is recognized for its outstanding recreational and biological assets. The diversity of unionids within the Riverway is well documented and many threats to that diversity have been identified. This faunal group could be severely impacted by a zebra mussel (*Dreissena polymorpha*) infestation and from other invasive species. Freshwater mollusks are a keystone faunal group of freshwater systems and their potential loss is unacceptable.

In order to understand the invasion of zebra mussels into the St. Croix, measurements of density have been taken since 2004 within the known infestation zone (the last 21 miles of river). Anecdotal evidence from the Upper Mississippi River suggests zebra mussel colonization predominates on native mussel beds, especially when substrates are less favorable for recruitment (e.g., sand, silt, etc.). Therefore, sample locations were chosen based on native mussel bed survey work previously conducted by the Minnesota Department of Natural Resources (MN DNR). Six locations were identified from Stillwater, MN, to Prescott, WI, reflecting the range of habitats and hydrology found in the infestation zone. In addition, the two Essential Habitat Areas of Hudson and Prescott were included. Thirty 1/8-meter quadrat samples were collected by divers at each of the locations. These samples were processed on site, frozen and examined under magnification. Data collected continues to aid managers who are creating policy based on the spread and intensity of the invasion.

In addition to understanding relative abundance of zebra mussels in Lake St. Croix, other St. Croix Basin activities for 2009 related to zebra mussels and work with endangered native mussels follows.

Qualitative zebra mussel sampling was performed in 2009 using two methods. First, throughout the watershed, including 14 locations on the main stem of the St. Croix and Namekagon and several area lakes, plate samplers with glass slides were placed in the water to encourage initial settlement of any floating veligers in the system. A second, more active sampling method involves timed SCUBA searches in areas of the river with higher probability of zebra mussel colonization, but where none, to date, have been found. These dives occurred from approximately river mile 70 to 22. During 2009, these activities were supported by the U.S. Fish and Wildlife Service (Fisheries Resources Office, Onalaska, WI) and the Minnesota Department of Natural Resources.

Associated veliger collection continued this year as part of a broader determination of reproduction of zebra mussels throughout the Upper Mississippi River System. This monitoring is critical as a compliment to other projects in the basin in determining effects of the infestation.

In an effort to assess the water quality and health of Upper St. Croix Basin, the St. Croix National Scenic Riverway aided a multi-year USACE study by data gathering/sample collection near the river's headwaters (Gordon Flowage, Eau Claire River confluence, and in 2008 main stem of the St. Croix). Results will be reflected in a pending USACE report.

Gaining insight from work done over the past several years, a larger sampling attempt was completed in 2009 for common carp and drum, to determine diet. Evidence had suggested that these fish, exposed to easily accessible quantities of zebra mussels, would prefer this food source. We collected specimens in areas of high, low and no zebra mussel-foraging opportunities, as well as relatively high areas of juvenile native mussels. Stomach contents of these fish are currently being analyzed.

Finally, the St. Croix Riverway Scuba Dive Team participated in several activities related to the propagation and recovery of the Higgins eye pearly mussel and the winged mapleleaf mussel (both federally listed as endangered). These activities included propagation (fish cages and lab infestations), developing mussel caches and gravid female recovery, placing and checking juvenile rearing cages, and relocation habitat assessment. Also in 2009, a mussel community analysis was performed at the two Essential Habitat Areas of Interstate Park and the Hudson Narrows.

Lake St. Croix Zebra Mussel Densities

Quantitative samples were collected at eight locations (established native mussel beds) to determine zebra mussel densities at various places within the last 21 miles of the river. The locations included the Essential Habitat Areas designated for the Higgins eye mussel and representative of each of the pools and narrows of Lake St. Croix. From the confluence with Mississippi River, upstream:

- 1) Prescott Higgins eye Essential Habitat Area (EHA) (River Mile Right 0.2),
- 2) St. Croix Bluffs (RM R5)
- 3) Kinnickinnic Narrows (RM L6)
- 4) Black Bass Bar (RM L10)
- 5) Lake St. Croix Beach (RM R14)
- 6) Hudson Higgins' eye Essential Habitat Area (RM R17)
- 7) South Highline Beach (RM L21)
- 8) Stillwater Mussel Relocation Site (RM L23).

These same eight sites were sampled in 2005 -08 by NPS/FWS. In 2004, the EHAs were sampled by the USACE and WI DNR.

At each site, 30 1/8th meter-squared quadrates were sampled by haphazardly tossing the metal squares from the boat. A test dive was performed to mark suitable habitat and native mussel densities. Within the location perimeter, the boat was moved to ensure full coverage of the native mussel bed. The dive boat was positioned in as close proximity as possible to previously sampled sub-sites locations via GPS. After all samples from the location were collected, an appropriate shore site was determined and a crew of 4-6 staff

and volunteers (Fig. 1) processed each sample through 3mm screen mesh using a low pressure pump of river water. This technique (though potentially labor intensive) allowed for completion of time consuming flushing of sand, mud and small organic matter on site, without tedious transport. On site processing reduces off-site storage and contamination, aids in sample preservation, and improves efficiency. Data recovery is quickened and reporting becomes timelier.

In the laboratory, sample material was thawed and removed from the one gallon zip-locked baggies and spread onto a sorting tray. Larger debris was checked under handheld magnification and zebra mussels (if any) removed by hand or forceps. Next, the remaining material was rewashed in a 250 μm sieve then spread evenly throughout a dissecting scope and analyzed. If abundance is high, sub-samples have been used to obtain density estimates in previous years. This year's material used for density estimates was fully counted unless animals were $>1\text{mm}$, however. Zebra mussels were not otherwise measured for length in the 2009. In 2010, a USGS predator/competition study will assess growth patterns in the Lake.

Figure 1. Shore land processing of substrate samples and low pressure water pump.



Only zebra mussels that were alive or considered living during collection were counted. All mussels were placed into 4 groups: zebra mussels found attached to living native mussels were categorized for infestation rates and included for density, live zebra mussels found elsewhere in the sample quadrat were added for total density, live native mussels (identified to species) and dead native shells (without attached tissue) were used to calculate bed densities.

The results for 2009 reflect similar results found since data collection began in 2004. However, the comparisons for all 8 locations since that time suggest two interesting recent trends (Fig. 3). While zebra mussels remain in very low numbers in the samples from Stillwater and Bayport, and have increased slightly in Hudson, the increase south of the I-94 Bridge in 2009 is significant (Fig 2). Secondly while densities ballooned dramatically within the mid-reaches of the Prescott Pool in 2007 (over $12,000\text{m}^2$ at St. Croix Buffs), there has been a significant decrease in numbers collected in 2008 and 2009. Hydrological conditions probably drove the settlement within this pool in the past,

it is possible that ecological factors, such as predation, account for the recent lower densities.

Figure 1. Quantitative assessment of zebra mussel populations at 8 long term monitoring sites from Stillwater to Prescott in 2009.

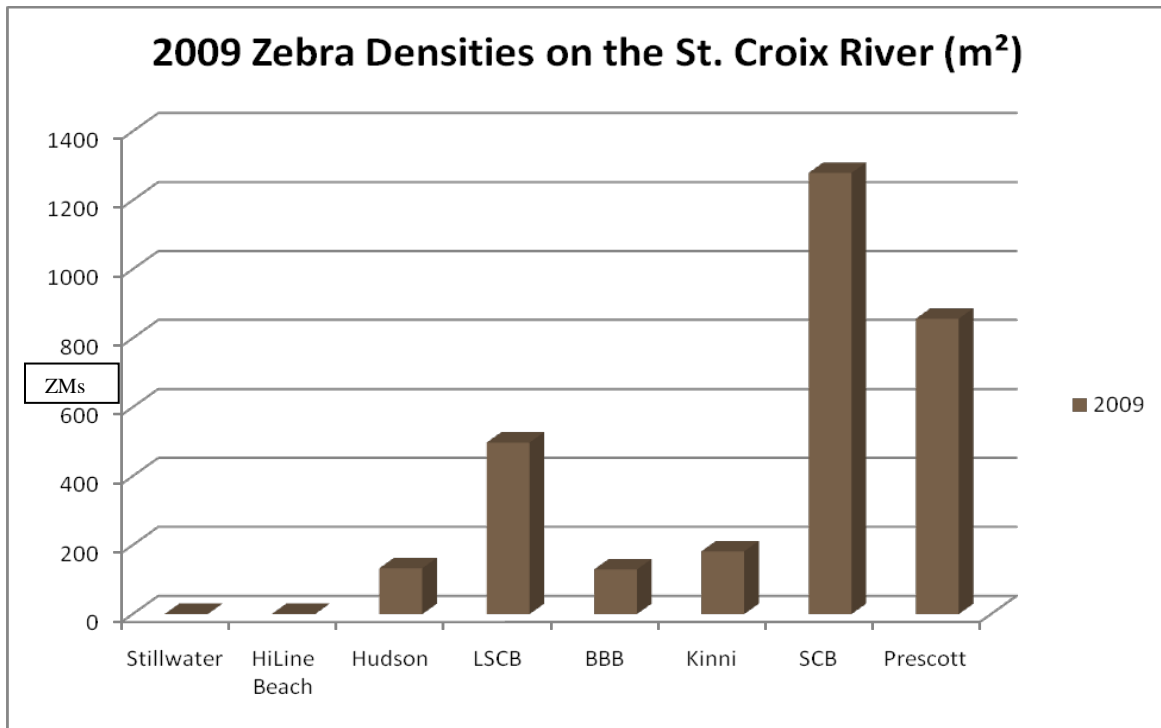
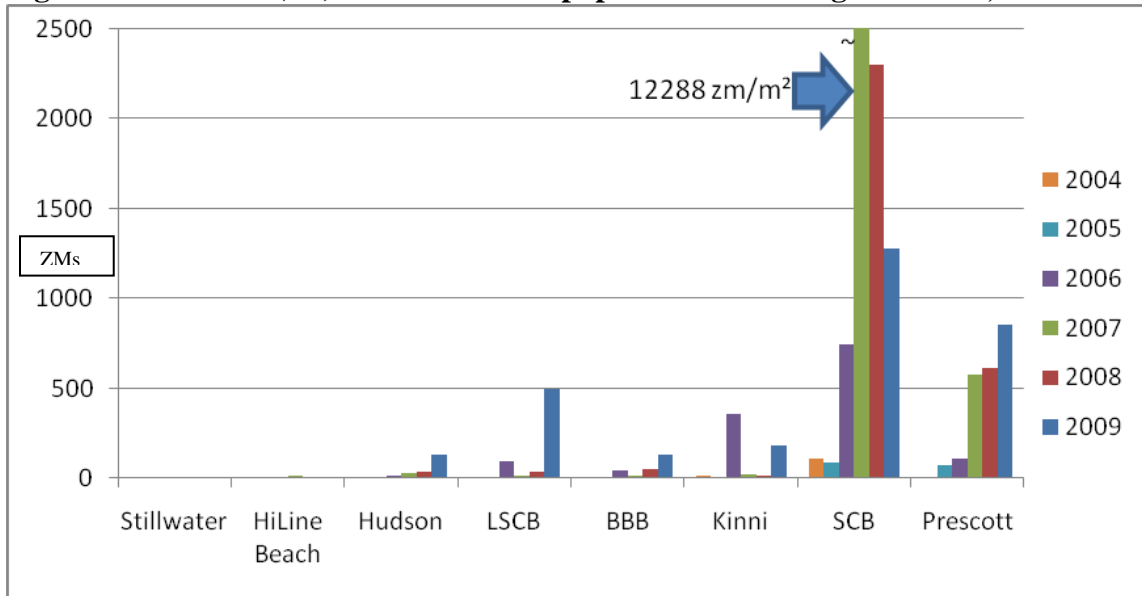
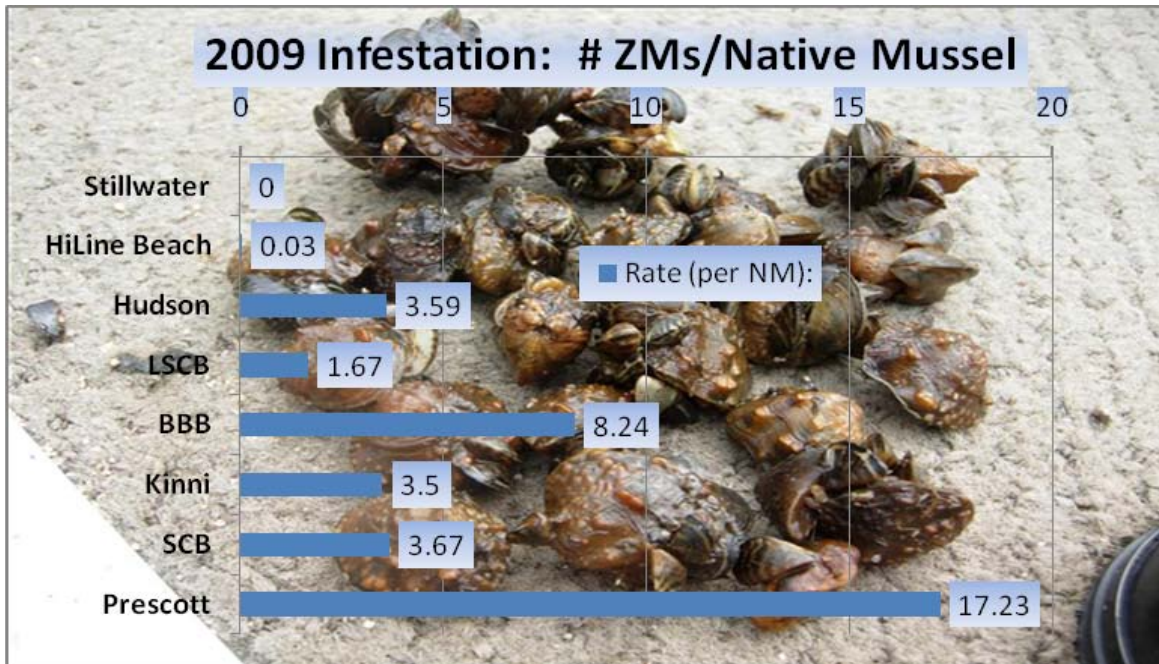


Figure 3. Densities (m²) of zebra mussel populations at 8 long term sites, 2004-2009.



Additional data was collected as zebra mussel densities were determined. These included Asian clams (*Corbicula fluminea*), any species of snails and dead mussels or their shells. The results of the clam, snail and shell enumeration can be found in the appendix (Fig. 1). The ratio of zebra mussels to the native mussels we collected (Fig 4) during our sampling suggests that density and infestation are not directly linked. At least at Prescott and Black Bass Bar, sites where densities were not the highest found in the pool, native mussels were collected with higher numbers of zebra mussels. In Prescott, the zebra mussels were generally very small (field notes suggest too small to individually count, in some cases) and this may be an under count at this location. It could also be related to predation and “grazing” of exposed zebra mussels less of an issue with a non-moving /living substrate. Again, this year’s start of a three year predation study by the USGS may help answer these questions.

Figure 4. Ratio of zebra mussels to live collected native mussels at each of the eight Lake St. Croix Sites, 2009. [Errata in key: *Ratio*, not *Rate*]



Veliger Sampling in the St. Croix and Tributaries

In July and August of 2009, the NPS, USACE and WI DNR continued to support the Upper Mississippi Basin veliger “snapshot” sampling. Dozens of sites throughout the upper river and tributaries are long term monitoring locations, sampled during a single event to provide an instant picture of reproduction in the river system. Veliger collection is done with a manual diaphragm pump of a single composite (90 liters) water sample from high, mid and low in the column, and taken across channel at left, center and right. Sampled material is poured through a 53 μ m mesh nylon filter. Filtered material is washed into a sample container and preserved using either a 10% sugar-buffered formalin

solution or a 10% acetate-buffered formalin solution. After the August sampling event, the containers are mailed to the Vicksburg Research Center for processing and analysis.

Table 1. Veliger density results for the St. Croix River and tributaries using fixed volume stratified sampling - 2009

Sample ID	Location	Date	# Live/L
St. Croix R. - Prescott	St. Croix R. Mouth at Prescott	7/08/09	34.44
St. Croix R. - Hudson	St. Croix R. at Hudson.	7/08/09	26.33
St. Croix River - Stillwater	Mile Long Island - Boomsite	7/08/09	0.00
St. Croix River -St. Croix Falls	Below Falls - Interstate SP	7/08/09	0.02
Snake River	Cross Lake	7/17/09	0.00
Sunrise River	Kost Dam	7/11/09	0.02
St. Croix R. - Prescott	St. Croix R. Mouth at Prescott	8/12/09	4.96
St. Croix R. - Hudson	St. Croix R. at Hudson.	8/12/09	11.25
St. Croix River - Stillwater	Mile Long Island - Boomsite	8/12/09	0.02
St. Croix River -St. Croix Falls	Below Falls - Interstate SP	8/12/09	0.06
Snake River	Cross Lake	8/12/09	0.20
Sunrise River	Kost Dam	8/12/09	0.00

As the results from this summer were analyzed, it became apparent that veligers had been collected at locations on the St. Croix River and its tributaries previously free of the evidence of reproduction (Table 1). In July, along with the typical detections in the lower river at Hudson and Prescott, a very small presence was detected in the Sunrise River and in the main stem of the St. Croix at Interstate. In August, again very few, but detectable amounts of veligers were found in samples from the Snake River, Interstate and the St. Croix north of Stillwater. While disturbing, no adults were discovered during usual qualitative monitoring. In 2010, increased monitoring using the above method, plankton tows, shore searches, plate samplers and divers will be employed to confirm these detections. Until physical evidence of adult zebra mussels are discovered, the St. Croix and its tributaries upstream of Stillwater will still be considered non-infested.

Zebra Mussel Monitoring

During 2009, several methods of presence/absence monitoring were used throughout the Riverway in order to detect the presence of zebra mussels. While not the focus of this report, these efforts are of note and are briefly shown below.

The U.S. Fish and Wildlife Office in Onalaska has provided support with diving and plate samplers for many years and 2009 was no exception. Divers assisted with qualitative diving in the upper river in the St. Croix Falls Flowage and on several occasions from Interstate to Stillwater. Dive support was also provided by FWS at the TCFO, Macalester College and by park volunteers. During these dives, only a single adult mussel was

Zebra Mussel and T&E mussel Monitoring on the St. Croix NSR

found – at the causeway of the Stillwater Lift Bridge. This was notable, only in that the mussel was on rip-rap on the upstream side of the bridge. This was a first, though mussels have been found on the side and—as shown below—in Houlton.

- Wild River State Park*
- Sunrise River*
- Nevers Dam*
- St. Croix Falls Flowage*
- Osceola*
- Franconia*
- Marine*
- North of High Bridge*
- South of High Bridge*
- Stillwater*
- Houlton [ZM = ~
10m²]**

*known zm location

A total of 33 hours and 40 minutes of diver time underwater was expended towards this active monitoring effort. The FWS also added to the efforts of the NPS again in 2009 by providing Masonite or PVC samplers with glass slides at locations on the river and at Wisconsin lakes at high risk to the river (Table 2). These samplers are in addition to the fourteen PVC samplers deployed by the NPS during the summer season. None of these samplers had a positive detection in 2009.

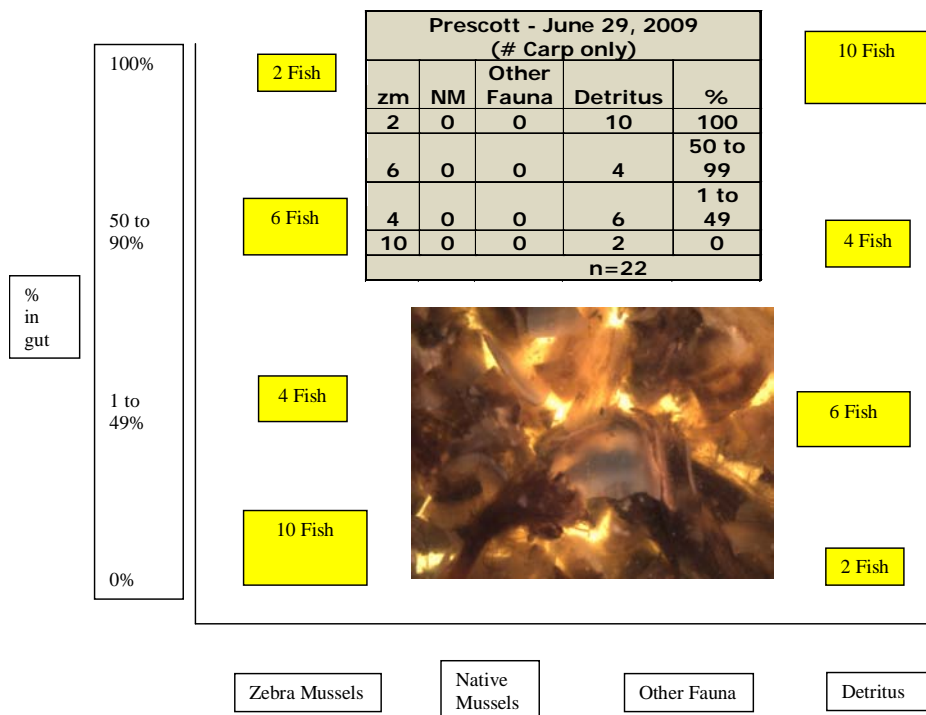
Table 2. U. S. Fish and Wildlife Samplers on the St. Croix and Area Lakes in 2009

FWS 2009 Samplers on WI Lakes and St. Croix	County	Slides Yes	Takeout-Install Month	PVC/Masonite
Balsam, 1	Polk	x	May/Nov	Masonite
Balsam, 2	Polk	x	May/Nov	Masonite
Balsam, 3	Polk	x	May/Nov	Masonite
Bone,	Polk	x	May/Nov	Masonite
Wapagasset 2	Polk	x	May/Nov	Masonite
Wapagasset	Polk	x	May/Nov	Masonite
Half Moon	Polk	x	May/Nov	Masonite
Half Moon	Polk	x	May/Nov	Masonite
Big Round	Polk	x	May/Nov	Masonite
Cedar Lake,	St. Croix/Polk	x	May/Nov	Masonite
Lake Mallalieu	St. Croix	x	May/Nov	Masonite
Lake Mallalieu	St. Croix	x	May/Nov	Masonite
St. Croix Yacht Club	Washington	x	ALL Year	PVC
Wolfe's Marine	Washington	x	ALL Year	PVC

Fish Predation on Zebra Mussels

In order to continue to understand the population dynamics of zebra mussels within Lake St. Croix (esp. the lowest pool (Prescott Pool), and selective predation pressure on native unionids as well as zebra mussels, we collected fish (carp and drum) specimens at a mid and late summer event and from locations reflective of heavy, light and no zebra mussel infestations. The sampling (aided by FWS) occurred near established native mussel beds to determine whether fish predation on natives is significant. Attempts were made to collect at least 25 carp and 5 drum from each site during both event. Gut analysis was performed in the laboratory and a complete summary of the results will be provided to the USACE as the results become available. To date, most of the carp from the June sampling date have been processed. Those data are summarized in Appendix A (Fig. 2-4) and suggest that this species will use zebra mussels where this prey is readily available. There is also evidence that carp will eat native mussel fauna, though it is not clear if this is only occurs where large numbers of juvenile native mussels are present.

Figure 5. Gut Contents of Common Carp Collected at Prescott 2009.



Prescott – 6/29/09

In Prescott (Fig. 5), the June samples of carp, suggest that fish foraged on plant material and zebra mussels exclusively. Of the 22 specimens examined, 10 stomachs contained no zebra mussels, but 6 contained more than 50%. Another 10 fish had 100% of their guts filled with plant material.

Because approximately 50% of the samples have been processed and analyzed as of this report, a separate discussion will follow with the results when they are completed later this season.

The above work is a lead in to a 2010-12 USGS study of zebra mussel competition and predation seeks to quantify the effects of the zebra mussel invasion in the St. Croix by assessing:

- 1) the mechanisms of impact on native adult and juvenile mussels (e.g., direct impact via encrustation, indirect via competition for seston food resources);
- 2) the extent of ingestion and assimilation of zebra mussel and native juveniles by local populations of benthivorous fish; and
- 3) effects of zebra mussels removal by hand-scrubbing on native mussels.

Native Mussel Community Assessment

During July 2009, NPS dive team members aided in the periodic (~5 years) native mussel community assessment performed on the St. Croix River at the Interstate and Hudson Essential Habitat Areas. Over the course of 10 days, divers assisted sampling that employed randomized substrate collections within these mussel beds. Nearly 200 one meter quadrates were analyzed. Results of this project are contained in a separate Wisconsin Department of Natural Resources report to the USACE.

Endangered Native Mussel Propagation

The St. Croix River contains reproducing populations of two federally-listed endangered native mussels. For both species, the NPS joined many other organizations in various propagation efforts. Efforts included aiding in cage and river site maintenance, and protection buoy installation, removal and maintenance. Periodic site visits during the season allowed for micro habitat temperature monitoring, fish placement and removal, and assessment of juvenile transformation, survival, growth success, etc. At Interstate State Parks, scuba team members and support staff searched for, and cached, winged mapleleaf in July. These groups of mussels were revisited in September in order to collect gravid females for propagation efforts. During June and October, NPS dive team members aided in checking two juvenile rearing “silos” at Hidden Falls. Silos were checked to assure their safety and the winged mapleleaf inside were checked to ensure viability and growth. During the April Higgins eye/fish infestation procedures performed at the rearing facility at the Genoa NFH, NPS staff provided help and aided in outreach.

Water Quality in the Headwaters

In support of a multi-year study of water quality in the headwaters region of the St. Croix River, park staff aided by collecting biweekly data and water samples for processing and analysis by the Aquatic Ecology Lab of the USACE, in Eau Galle, WI. In 2009, three sites were sampled—within a channel of the Gordon Flowage, mid lake in the Flowage, and at a riverine site below the confluence with the Eau Claire River. Sampling included

an on-site measurement for standard water quality parameters (e.g., secchi, temperature, dissolved oxygen, pH, conductivity, etc) and collection of an integrated water sample.

Winged mapleleaf reintroduction in the Upper St. Croix River

In order to determine suitable winged mapleleaf refugia/re-introduction sites on the Upper St. Croix National Scenic Riverway, the National Park Service, Fish and Wildlife Service and Macalester College performed various tasks to judge feasibility.

The results of this study can be found in a separate report to the USACE by Macalester College (see Appendix B).

APPENDIX A

Table 1. Number of Native Mussels Collected Live at Each of the Long Term Monitoring Locations. Includes the Number of Zebra Mussels Attached to Any Live Mussel.

2009 # of Attached Zebra Mussels and Live Native Mussels by Location								
ZM Att.	0	1	244	15	140	70	22	517
Natives	17	33	68	9	17	20	6	30
Rate (per NM):	0	0.03	3.59	1.67	8.24	3.5	3.67	17.23
Locations	Stillwater	HiLine Beach	Hudson	LSCB	BBB	Kinni	SCB	Prescott

Table 2. Number of Zebra Mussel (by square meter) at All Locations Since 2004.

St. Croix River Zebra Mussel Densities - Stillwater to Prescott 2004-09 (m ²)								
Stillwater	HiLine Beach	Hudson	LSCB	BBB	Kinni	SCB	Prescott	
0.53	1.07	133.07	497.6	129.33	181.87	1279.47	856.8	2009
1.6	0.8	34.13	38.4	53.6	12.54	2295	612	2008
1.3	12.8	32.2	13.7	16.5	24.4	12288	574	2007
1.87	1.33	17.07	94.67	44	358.67	742	111	2006
0.01	0.27	0.8	1.87	1.06	8.5	89.33	71.73	2005
0.01	1.6		5.33	0.8	12.27	107.73		2004

Figure 1. Number of Specimens Collected by Location, 2009

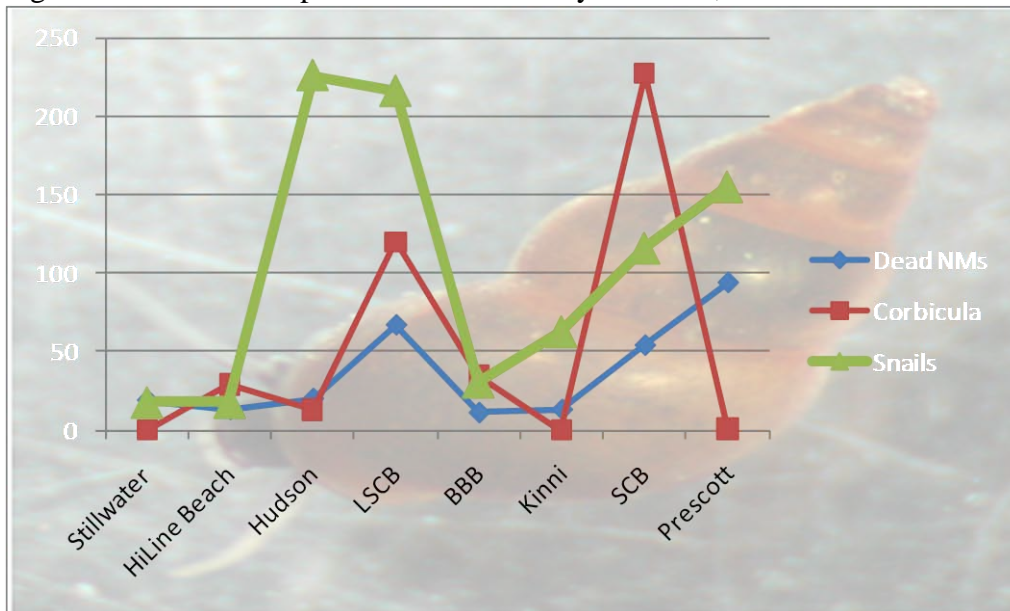


Figure 2. Common Carp Stomach Contents (by category—percentage grouping), Interstate 2009

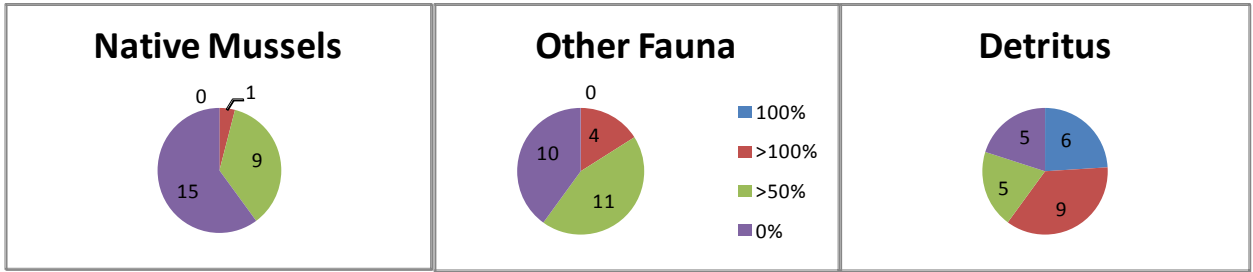


Figure 3. Stillwater 2009

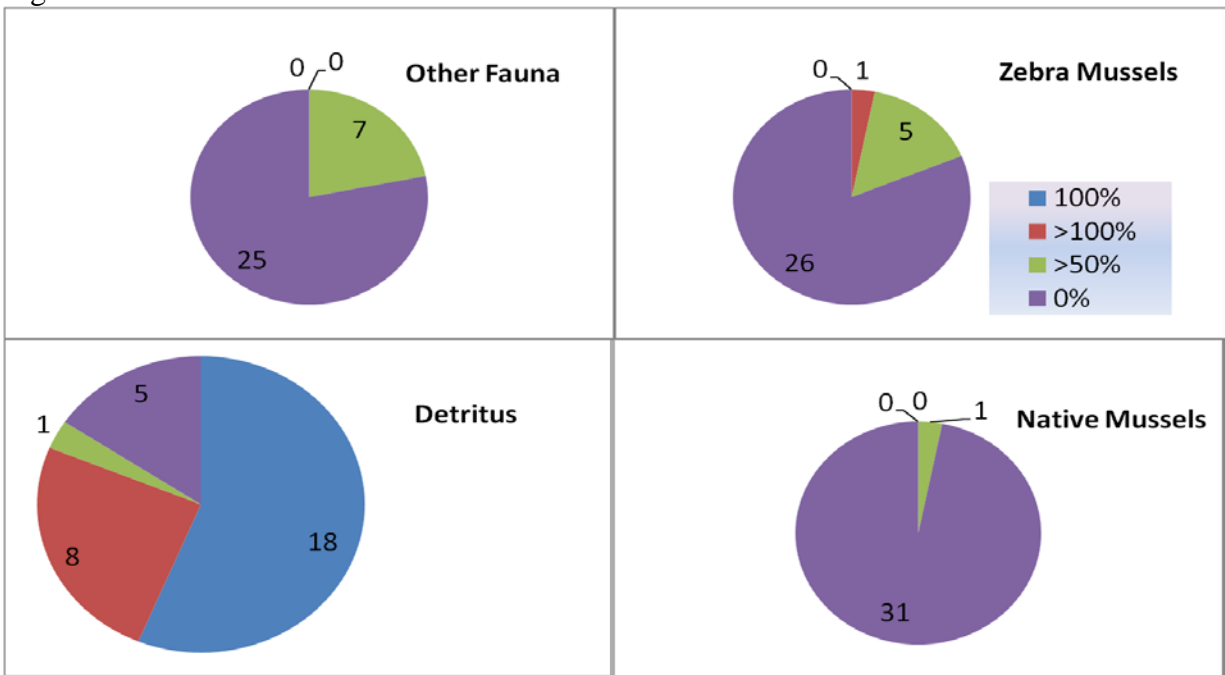
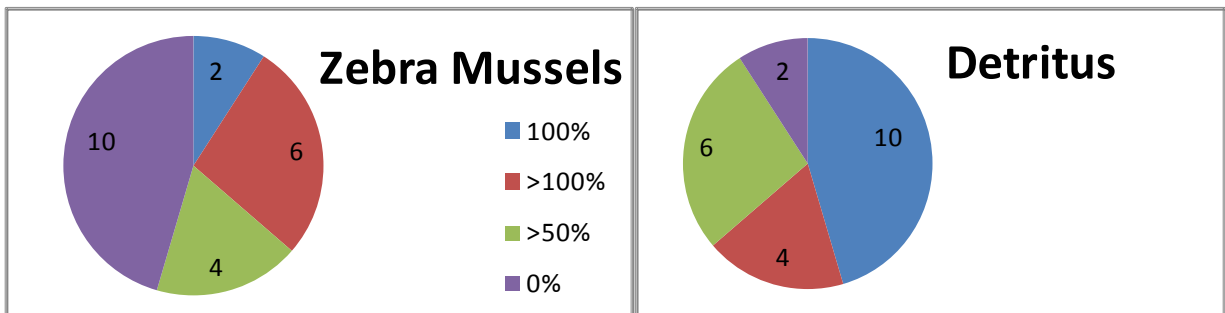


Figure 4. Prescott 2009



APPENDIX B.

Please see separate report:

Upper St. Croix River Winged Mapleleaf Reintroduction Site Selection and Monitoring – 2009 Final Report

Submitted to:

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1.0 Executive Summary

The federally endangered winged mapleleaf mussel (*Quadrula fragosa*) has become extirpated throughout most of its historic range and is in need of conservation efforts. One threat to winged mapleleaf is the explosive spread and population growth of the invasive zebra mussel (*Dreissena polymorpha*) that may encrust and smother native mussels and compete with them for food. The U.S. Army Corps of Engineers, St. Paul District, as part of their St. Croix River Endangered Mussel Conservation and Zebra Mussel Control Feasibility Study is interested in the potential of re-establishing winged mapleleaf into areas within the species historic range with no or very little threat to zebra mussels. One potential area of interest is the St. Croix River mainstem above St. Croix Falls and the current population at Interstate State Park. The goal of this project was to identify and monitor at least two potential winged mapleleaf reintroduction sites in the upper St. Croix River. We identified potential winged mapleleaf reintroduction sites by reviewing published and grey literature and consulted with malacologists familiar with St. Croix River mussel communities. Local malacologists reviewed characteristics of the highest quality mussel beds and selected the top four sites for reconnaissance. Divers used SCUBA to survey the four sites and the top three sites were selected for monitoring work; the two small sites near Nevers Dam were combined to create one of two potential relocation sites. At least 180 quadrat samples were randomly distributed and collected at each

of the two potential reintroduction sites (Sunrise River and Nevers Dam). Mussels were identified to species and length, age and sex (for sexually dimorphic species) were recorded for each individual collected and visual, qualitative estimates of substrate composition were recorded. Additionally, 120 person-minutes of qualitative searches were conducted at each site with the goal of observing as wide a variety of mussel species as possible. At each site a combined total of 100 *Quadrula pustulosa* and *Cyclonaias tuberculata* were marked as surrogate species representing potential reintroduced *Q. fragosa* for use in future recollection and monitoring. *Quadrula pustulosa* and *C. tuberculata* are useful *Q. fragosa* surrogates as the glochidia of all three species metamorphose on channel catfish and these three species often live together in St. Croix River winged mapleleaf beds. The upstream study site (Sunrise River) holds a large, diverse mussel bed (17 species) with fairly coarse substrata although more sand occurs

1

at this site than downstream at Nevers Dam. Mussel density, diversity, habitat and density of *C. tuberculata* and *Q. pustulosa* are similar between Sunrise River and upstream Nevers Dam study sites and Interstate State Park (Hornbach 2009), where largest known St. Croix River *Q. fragosa* population occurs. These observations lead us to believe that the site upstream of the confluence of the Sunrise River and the small reach just downstream of Nevers Dam would be the two strongest candidate sites for reintroducing winged mapleleaf among known mussel beds in the upper St. Croix River.