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Wild Rice Seed Enumeration Report: 2009-2010

Upper Clam Lake, Lower Clam Lake , Long Lake , and Clam River Flowage

Prepared for SEH – September 2010
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This project was conducted by James A. Johnson (Freshwater Scientific Services, LLC) under contract with Short Elliott Hendrickson Inc. (SEH).

Additional field support was provided by David Blumer (Lake Scientist, SEH) and Tony Havranek (Water Resources Manager, St. Croix Tribal Environmental Department). Additional historical and technical input was provided by Peter David (Great Lakes Indian Fish & Wildlife Commission), and Dr. Anthony Kern (Northland College – Ashland, WI).

Introduction

Background

Over the past 20 years, Upper Clam Lake (Burnett Co., WI) has consistently supported large areas (250 to 300 acres) of northern wild rice (*Zizania palustris*). In 2007, the lake experienced a dramatic decline in both the extent and density of wild rice growth. This decline continued through 2010, with only a few sparse remnant stands of wild rice remaining in isolated shallow bays (less than 80 acres of very sparse rice) after four years of decline. Due to this decline in rice, very little new wild rice seed was produced in Upper Clam Lake from 2007 to 2010. Consequently, the bank of seeds remaining from previous years of rice growth may be severely reduced, possibly limiting a natural recovery of rice beds.

Purpose of Study

This study was initiated to assess the abundance of wild rice seeds remaining in the sediments of Upper Clam Lake prior to the 2010 growing season and to enable comparisons of wild rice seed abundance with two additional lakes that supported moderate to dense stands of wild rice in 2009.

Wild rice beds may experience periodic natural declines (Walker et al. 2006), and high variability in seed production (Moyle 1944). However, even after substantial declines, rice beds are typically able to reestablish from seeds remaining in lake sediments (Moyle 1944). The decline of rice beds in Upper Clam Lake coincided with a documented increase in common carp (*Cyprinus carpio*), suggesting that carp feeding and spawning activities reduced the survival and growth of wild rice in the lake. Furthermore, carp may have reduced the abundance of wild rice seeds by directly consuming them or by uprooting young rice plants before new seeds could be produced.

This study aims to determine the abundance of wild rice seeds remaining in sediments of Upper Clam Lake after multiple consecutive years with little or no production of new wild rice seeds in most of the areas that historically supported rice. If a sufficient abundance of seeds remain, wild rice in the lake may recover naturally if carp are controlled. However, if the seed-bank has been severely depleted, manual seeding with locally harvested seed from remaining sparse rice beds in Upper Clam Lake or nearby lakes may be needed to assist recovery.

Upper Clam Lake

Upper Clam Lake is a large (1350 acres) shallow drainage lake (10 ft max depth) in Burnett County, WI (Figure 1). The lake's hydrology is largely driven by the Clam River, which flows in from the southeast and exits to the north. Upper Clam Lake is connected to Long Lake (directly to the southwest) by a small intermittent stream, and to Lower Clam Lake (immediately downstream) and the Clam River Flowage (15 miles downstream) by the Clam River. Summer total phosphorus in Upper Clam Lake typically ranges from 65 to 100 µg/L, with summer chlorophyll-a ranging from 30 to 60 µg/L. Consequently, water clarity is typically low, ranging from two to four feet (Secchi transparency) during the summer months. Water levels in Upper Clam Lake are controlled by a dam on the Clam River immediately northeast of Lower Clam Lake. Water in Upper and Lower Clam Lake is typically drawn down in the fall (October) of each year to reduce ice heave on shorelines and to provide additional storage capacity to prevent shoreline flooding in the subsequent spring.

Figure 1. Location of study lakes

Wild Rice Growth in Upper Clam Lake

Wild rice harvest records (Figure 2) show that Upper Clam Lake was a consistent high-quality source of wild rice from 1992 through 2006, with anecdotal accounts that this was also typical of most years prior to 1992. Historical images also indicate that the lake supported luxuriant growth of wild rice as recently as 2006 (Figure 3). However, the lake has experienced a dramatic decline in the extent and density of wild rice growth in subsequent years. This decline is also evident in the harvesting records, with no reported harvest of rice from the lake between 2007 and 2009.

Figure 2. Wild rice harvest data from Upper Clam Lake, Long Lake, and Briggs Lake: 1992-2009. Data provided by Peter David, Great Lakes Indian Fish & Wildlife Commission (GLIFWC).

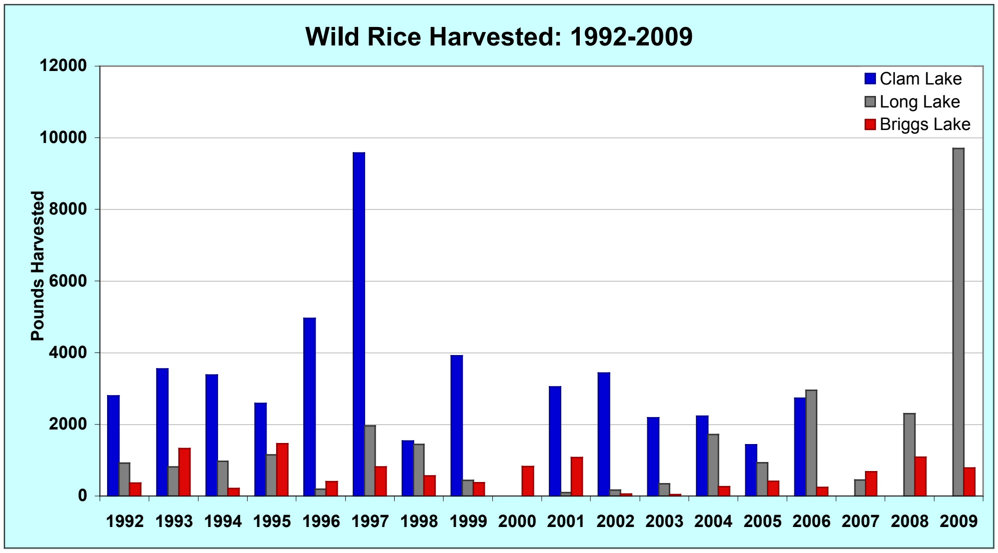
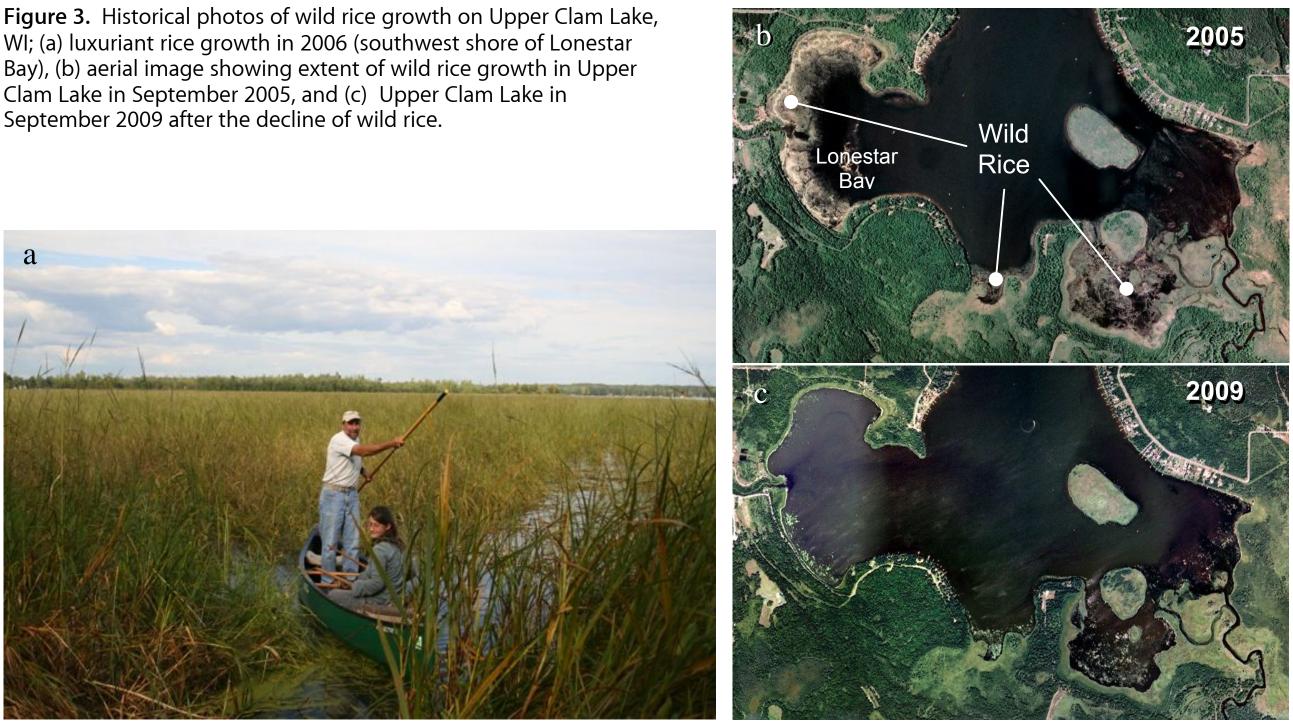


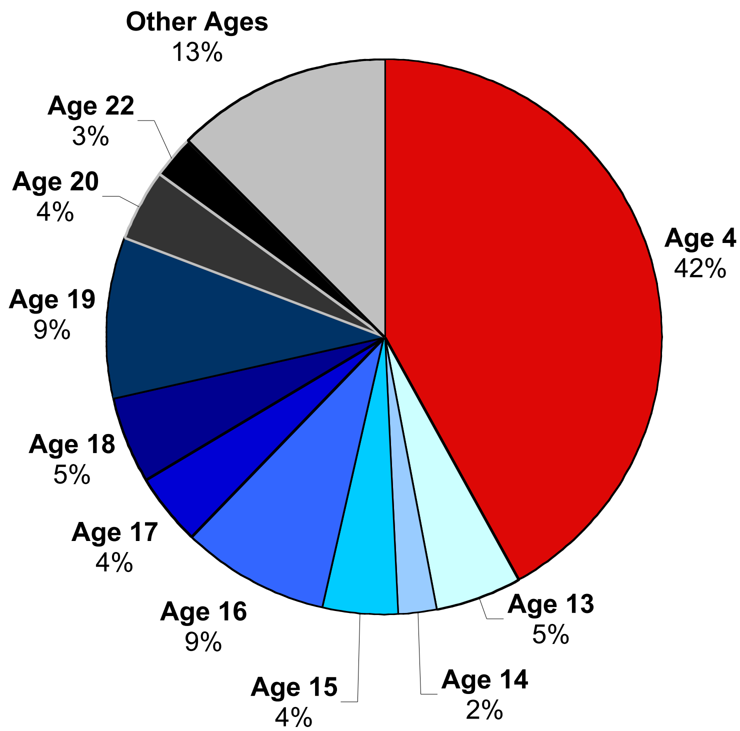
Figure 3. Historical photos of wild rice growth on Upper Clam Lake, WI; (a) luxuriant rice growth in 2006 (southwest shore of Lonestar Bay), (b) aerial image showing extent of wild rice growth in Upper Clam Lake in September 2005, and (c) Upper Clam Lake in September 2009 after the decline of wild rice.



Carp in Upper Clam Lake

Anecdotal reports from local residents suggested that the carp population in Upper Clam Lake had increased noticeably between 2000 and 2009 while the panfish population had declined over the same period. In 2009, staff from the St. Croix Tribal Environmental Department and Wisconsin DNR (Spooner, WI) captured approximately 300 carp in shallow areas of Upper Clam Lake using electrofishing equipment and determined the age of 140 individuals. Results indicated that over 40% of the captured carp were from a single year-class hatched in 2005 (Figure 4). Furthermore, a 2-year old gravid female carp was captured during the survey, suggesting that the large 4+ year-class of carp may have begun spawning in shallow areas of Upper Clam Lake as early as 2007 (the first year of major rice decline).

Figure 4. 2009 carp population age structure in Upper Clam Lake, WI. Age data provided by the Wisconsin DNR and the St. Croix Tribal Environmental Department. Fish age determined by evaluating scale annuli from 140 captured individuals.



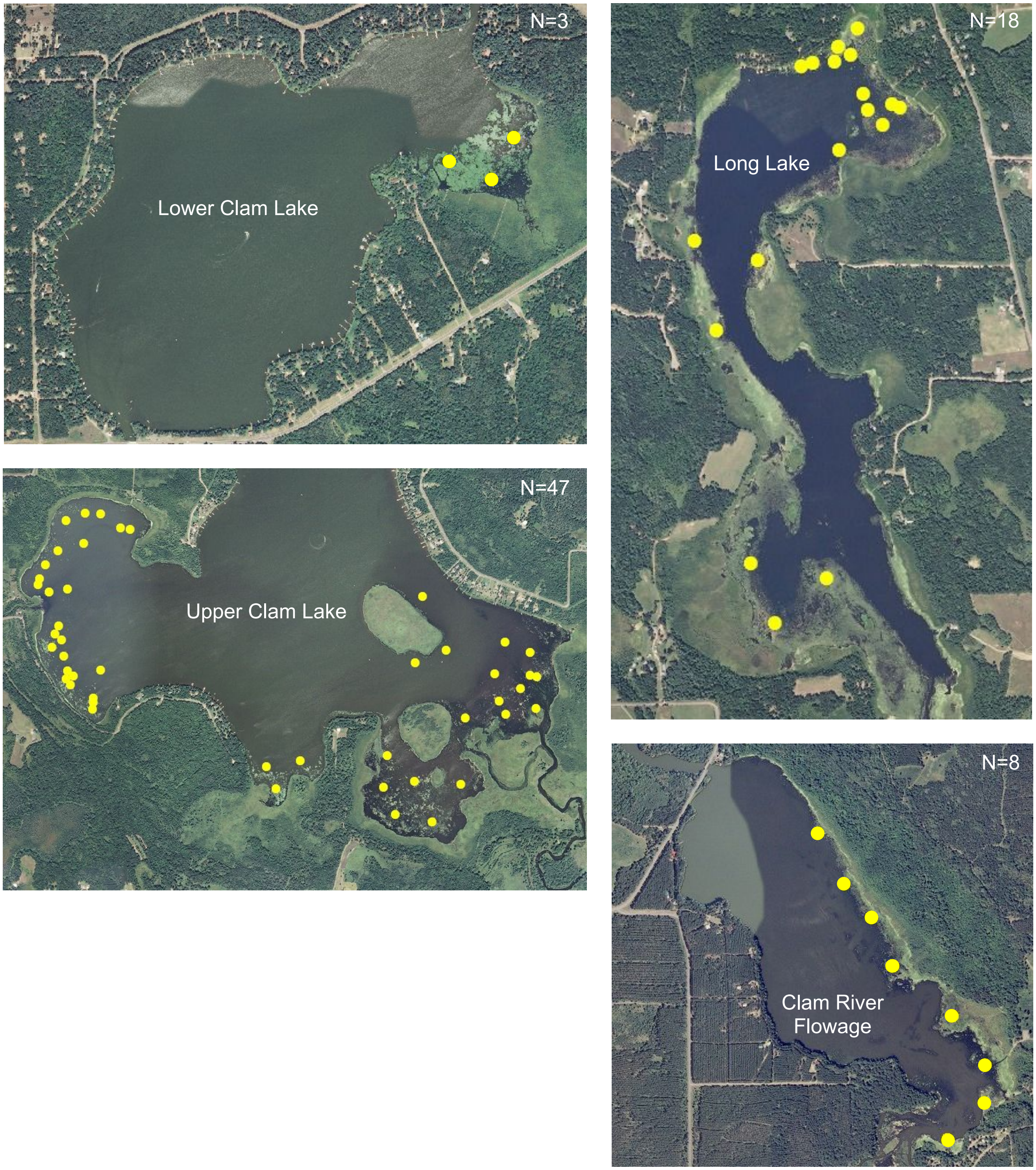
Methods for Seed Enumeration

Sample Collection

In November 2009, we collected sediment samples at 13 locations on Upper Clam Lake and 10 locations on Long Lake. In April 2010, we collected samples at an additional 28 locations on Upper Clam Lake, 3 locations on Lower Clam Lake, 8 location on Long Lake, and 6 locations on the Clam River Flowage. All sample points were generated using desktop GIS software and randomly located within areas that had supported wild rice in previous years (Figure 6). In the field, we navigated to each sample point using a handheld GPS unit (Garmin 76), and collected a single sediment sample with a Ponar dredge (Wildlife Supply Company – Yulee, FL; basal area=225 cm^2) (Figure 5). The dredge consistently sampled the top ten centimeters in the soft sediments of Upper Clam Lake, Lower Clam Lake, and Long Lake, and the top six to eight cm in the firmer sandy sediments of the Clam River Flowage. In addition to these dredge samples, we collected core samples at roughly one-third of the sites using a PVC suction corer (basal area=80 cm^2) to determine the vertical distribution of seeds in lake sediments and to evaluate the abundance of seeds in deeper sediments (Figure 5). Core samples collected from Upper Clam Lake, Lower Clam Lake, and the Clam River Flowage were sectioned by depth stratum (0-5 cm, 5-10 cm, 10-20 cm, and 20-30 cm) while in the field, but core samples collected from Long Lake were extremely flocculent and not amenable to sectioning. Consequently, seed enumerations for Long Lake cores represent core totals and are not broken down into individual strata. Each sediment sample (dredge or core section) was sifted through a 1 mm mesh screen while in the field to remove fine silt. These sifted samples were then stored in sealed plastic bags at 5°C until they could be processed in the lab.

Figure 5. Sediment samplers used to monitor study lakes. Ponar dredge (left) and PVC suction corer with extension for flocculent sediment (right). Core sectioning (below) conducted by placing core tube onto a plunger stand, extruding the core contents, and removing sediment to the desired depth for each stratum.

Figure 6. Locations sampled (yellow dots) in November 2009 and April 2010 in the four study lakes, with aerial imagery (taken in early September of 2009) to show positions of points relative to rice beds in each lake.



Sample Processing

Each sifted sample was manually sorted and all identifiable wild rice seeds and empty seed hulls were enumerated (Figure 7). Seed hulls that were flattened, papery, and easily bent were assumed to be empty and non-viable. After sorting, the total number of identified seeds and empty hulls were recorded for each sample.

Figure 7. Manual processing of sifted sediment sample (left) to identify and enumerate wild rice seeds (top right) and empty seed hulls (bottom right).

Results

Wild rice seed counts from Ponar dredge samples indicated that the abundance of seeds in the top ten centimeters of Upper Clam Lake (0 seeds m^2) was significantly lower (t-test, unequal variances; $P<0.05$) than in Long Lake (250 ±43 seeds/m^2; mean±SE) or the Clam River Flowage (80 ±32 seeds/m^2). Similarly, the abundance of seeds in core samples (full core enumeration) from Upper Clam Lake (11 ±11 seeds/m^2) was lower than in Long Lake (170 ±105 seeds/m^2) or the Clam River Flowage (63 ±63 seeds/m^2). However, given the small number of core samples, these differences were not statistically significant ($P>0.25$). Average seed abundance for each site is presented in Figures 8-10 (average of Ponar dredge and core samples for each site)

In addition to seeds, we found empty seed hulls in the sediment samples. These hulls may be remnants of seeds that had sprouted in previous years, flowers that were not pollinated, seeds that were eaten by insects, or developing seeds that were knocked into the water before reaching maturity. The abundance of these empty hulls was generally much higher than the abundance of seeds in both dredge and core samples from all study lakes (Table 1), with hulls being uniformly distributed throughout the sectioned cores (Table 2). Moreover, the abundance of empty hulls in Upper Clam Lake was not statistically different than the abundance of hulls found in lakes that supported substantial beds of rice in 2009 ($P=0.13$ to 0.31 for Ponar samples; $P=0.27$ to 0.82 for core samples). This suggests that these hulls can persist for years after being deposited.

Table 1. Abundance of wild rice seeds and hulls (#/m^2) in Ponar and core samples collected from study lakes (mean ±SE). Samples collected using

	Ponar Samples* (#/m^2)			Core Samples** (#/m^2)		
	Samples	Seeds/m^2	Hulls/m^2	Samples	Seeds/m^2	Hulls/m^2
Upper Clam Lake	47	0	340 ±56	11	11 ±11	860 ±214
Lower Clam Lake	3	0	60 ±15	1	125	125
Clam River Flowage	8	80 ±32	800 ±264	2	63 ±63	2200 ±563
Long Lake	18	250 ±43	470 ±108	3	170 ±105	960 ±331

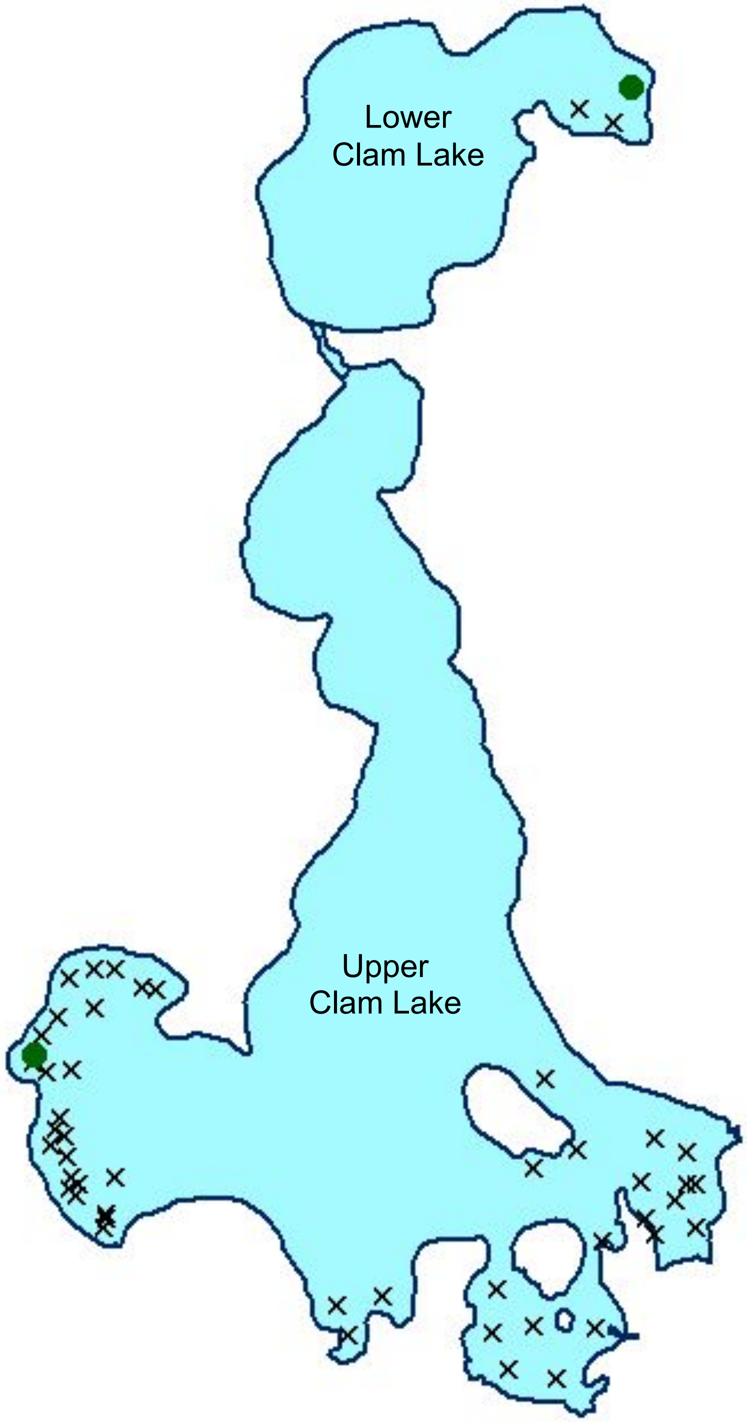
* Petite Ponar, basal area=225 cm^2; sampled sediment depth was ≈10 cm in soft sediment, ≈6 to 8 cm in firmer sediments
** PVC suction corer, basal area=80 cm^2, sampled sediment depth = 0.4 to 1.5m, full core counts (all strata) reported

Table 2. Abundance of wild rice seeds and hulls (#/m^2) in collected sediment core samples (mean ±SE); broken down by depth stratum for sectioned cores. Samples collected using a PVC suction corer; basal area=80 cm^2

	Wild Rice Seeds (#/m^2)				Empty Hulls (#/m^2)			
Sediment Stratum (cm)	Upper Clam *(N=11)*	Lower Clam *(N=1)*	Clam River Flowage *(N=2)*	Long** *(N=3)*	Upper Clam *(N=11)*	Lower Clam *(N=1)*	Clam River Flowage *(N=2)*	Long** *(N=3)*
Full Core	11 ±11	125	63 ±63	170 ±105	860 ±214	125	2200 ±563	960 ±331
0-5	0	0	0	-	130 ±34	0	940 ±63	-
5-10	0	0	0	-	250 ±73	0		-
10-20	11 ±11	125	0	-	300 ±102	125	900 ±375	-
20-30*	0	0	63 ±63	-	400 ±194	0	400 ±250	-

* Strata deeper than 30 cm were not analyzed for lakes with firmer sediments (Upper Clam, Lower Clam, and Clam River Flowage)
** Long Lake sediments were very flocculent and not amenable to sectioning; deeper cores (150 cm) collected to prevent sample loss

Figure 8. Abundance of wild rice seeds (#/m^2) in sediments of Upper and Lower Clam Lake (Ponar dredge (N=47) and core samples (N=11)). Samples collected November 2009 and April 2010. Note that all encountered seeds were found in the 10-20 cm stratum of core samples; no seeds were found in Ponar dredge samples (0-10 cm) collected from Upper or Lower Clam Lake.



Upper and Lower Clam Lakes
2009-2010

Wild Rice Seed Enumeration

- X No seeds found
- < 50 seeds/m^2
- 50-100
- 100-200
- 200-300
- 300-500
- 500-1000

Figure 9. Abundance of wild rice seeds in sediments of Long Lake (combination of Ponar dredge (N=18) and core samples (N=3)). Samples collected November 2009 and April 2010.

Long Lake
2009-2010

Wild Rice Seed Enumeration

- x No seeds found
- < 50 seeds/m^2
- 50-100
- 100-200
- 200-300
- 300-500
- 500-1000

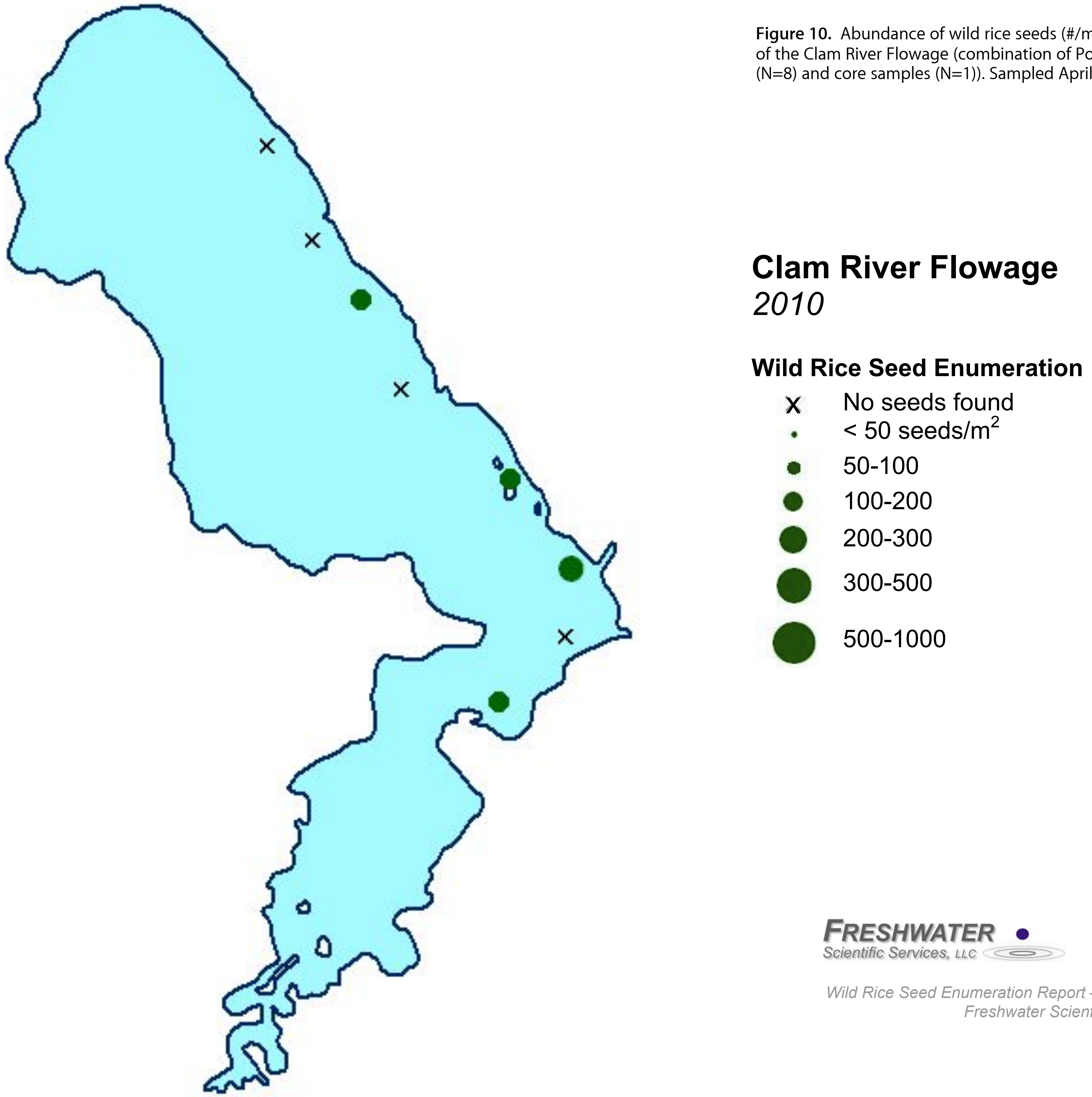


Figure 10. Abundance of wild rice seeds (#/m^2) in sediments of the Clam River Flowage (combination of Ponar dredge (N=8) and core samples (N=1)). Sampled April 2010.

Discussion

The abundance of wild rice seeds in the sediments of Upper Clam Lake appeared to be greatly reduced relative to the seed abundance observed in Long Lake and the Clam River Flowage. The fact that very few seeds were found in the sediments of Upper Clam Lake, with no seeds found in the top ten centimeters of sediment, suggests that reseeding will likely be needed (in addition to carp removal) to restore wild rice growth in Upper Clam Lake. However, any reseeding should use seed collected from a nearby source (ideally from remnant stands in Upper Clam Lake) to preserve the genetic strain of rice that has flourished in Upper Clam Lake in past years. Based upon a personal discussion with Dr. Anthony Kern (Northland College - Ashland, WI), this strain of rice may be uniquely adapted to the conditions in the lake. In 2010, some remnant stands of wild rice grew to maturity in shallow isolated bays of Upper Clam Lake (Figure 11). Although these stands were generally sparse, measures should be taken to protect them from carp so they may serve as founder colonies and a source of seed for future restoration of the rice beds.

Figure 11. Remnant stand of sparse wild rice in the shallow southern bay of Upper Clam Lake (August 2010)

References

Moyle, J. B. 1944. Wild rice in Minnesota. Journal of Wildlife Management. 8: 177-184.

Walker, R. D., J. Pastor, and B. W. Dewey. 2006. Effects of wild rice (*Zizania palustris*) straw on biomass and seed production in northern Minnesota. Canadian Journal of Botany. 84: 1019-1024.