St. Louis River Estuary Wild Rice Restoration Monitoring (2015-2020)

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Introduction

In 2015-2020, a coordinated wild rice (manoomin) restoration initiative occurred in the St. Louis River Estuary in Duluth, MN and Superior, WI. Activities were completed through cooperation with partners including the Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, Wisconsin Department of Natural Resources, Minnesota Land Trust, Fond du Lac Band of Lake Superior Chippewa, 1854 Treaty Authority, and Great Lakes Indian Fish & Wildlife Commission. The 1854 Treaty Authority completed wild rice monitoring activities in 2015-2020. The purpose of the monitoring program is to document the success of wild rice restoration.

Wild rice monitoring sites included:

- **2015-2020** Rask Bay, Duck Hunter Bay north, Duck Hunter Bay south, North Bay, Radio Tower Bay
- **2016-2020** Walleye Alley Bay, Landslide Bay, Oliver-Bear Island, Mud Lake northeast, Clough Island east
- **2017-2020** Foundation Bay, Oliver-Little Pokegama Bay, Kingsbury Bay

Figure 1 shows areas monitored for wild rice in the St. Louis River Estuary. Restoration activities were within these areas but may constitute a smaller footprint. No restoration was done through 2019 at Oliver-Little Pokegama and Kingsbury bays.

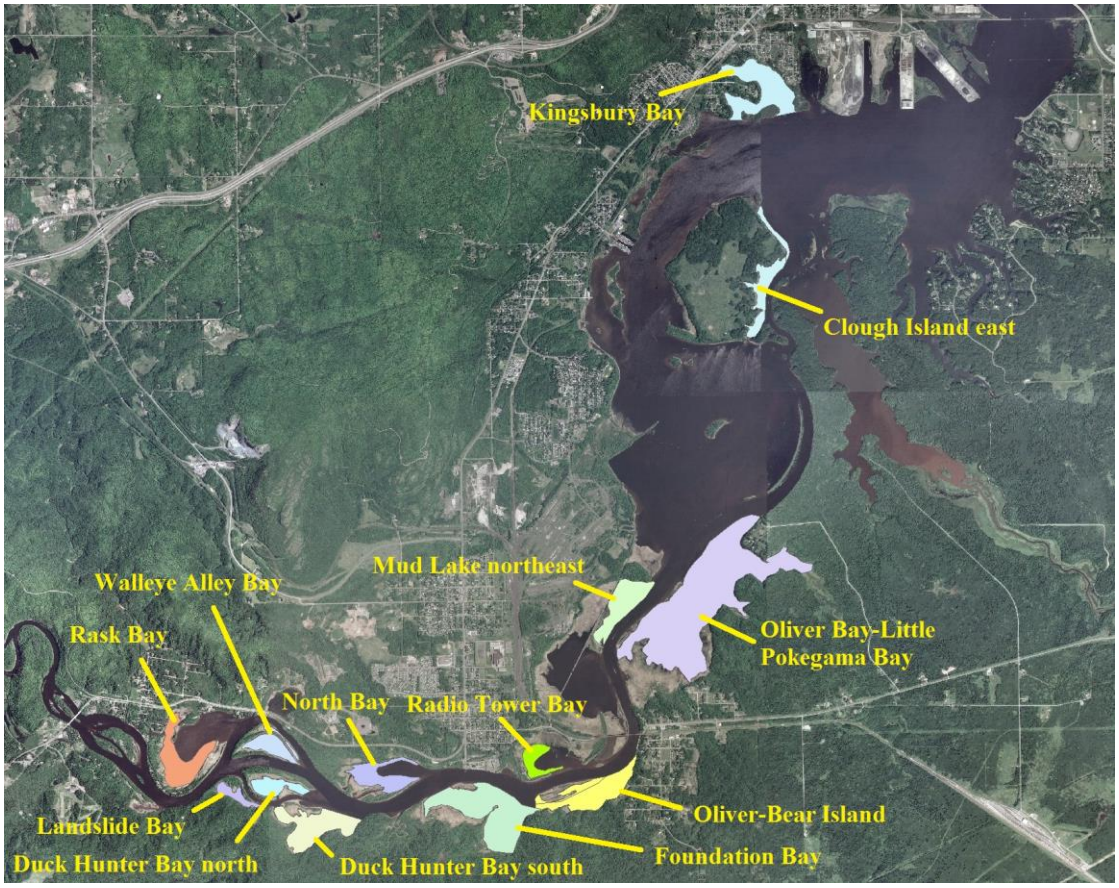

Figure 1: Wild Rice Monitoring in the St. Louis River Estuary

Wild Rice Restoration Overview

Wild rice (*Zizania palustris)* restoration work was implemented in 2015-2020 (none in 2018 due to lack of available rice seed), with the Fond du Lac Band completing restoration activities with grant funding support. In the summer of 2015, site preparation through vegetation cutting was completed. A total of 67 acres of vegetation was mechanically cut in Rask, Duck Hunter north, Duck Hunter south, and North bays. At Radio Tower Bay, aquatic vegetation was removed along with wood waste, which was the focus of a separate restoration project. After vegetation was treated at portions of the restoration sites, 121 acres were seeded with 8,504 pounds of wild rice between 9/2/2015 – 9/13/2015 (Table 1). Clough Island east was seeded in 2015 by another initiative (5-10 acres, 400-500 lbs of wild rice seed). Success of fall seeding in one year (ex. 2015) cannot be determined until observing wild rice growth in the following season (ex. 2016) and future years.

Table 1: Wild Rice Restoration Sites in the St. Louis River Estuary, 2015

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	15	33	2085
Duck Hunter Bay north	14	19	2165
Duck Hunter Bay south	27	40	1642
North Bay	11	14	1666
Radio Tower Bay	0	15	946
totals:	**67**	**121**	**8504**
Clough Island east	*0*	*5-10*	*400-500*

In 2016, site preparation was completed in new wild rice restoration areas. A total of 61 acres of vegetation was mechanically treated by cutting in Walleye Alley Bay, Landslide Bay, Oliver-Bear Island, and Mud Lake northeast. Wild rice seeding occurred between 9/2/2016 – 9/20/2016 in all ten restoration areas (Table 2). A total of 216 acres was seeded with 12,518 pounds of wild rice.

Table 2: Wild Rice Restoration Sites in the St. Louis River Estuary, 2016

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	0	33	1650
Duck Hunter Bay north	0	19	948
Duck Hunter Bay south	0	40	1935
North Bay	0	14	718
Radio Tower Bay	0	15	750
Walleye Alley Bay	17	17	1247
Landslide Bay	9	9	553
Oliver-Bear Island	2	26	2120
Mud Lake northeast	33	33	2089
Clough Island east	0	10	508
totals:	**61**	**216**	**12518**

Wild rice restoration efforts in 2017 were completed at the same locations as in 2016. No additional mechanical treatment of vegetation occurred. Wild rice was seeded on 9/12/2017 in all areas and included 207 acres seeded with 10,484 pounds of wild rice (Table 3). Clough Island east was seeded in 2017 through other efforts (St. Louis River Alliance, Wisconsin DNR, volunteers) with 500-550 pounds over approximately 10 acres.

Table 3: Wild Rice Restoration Sites in the St. Louis River Estuary, 2017

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	0	33	1647
Duck Hunter Bay north	0	19	953
Duck Hunter Bay south	0	40	2006
North Bay	0	14	707
Radio Tower Bay	0	15	767
Walleye Alley Bay	0	17	850
Landslide Bay	0	9	425
Oliver-Bear Island	0	27	1341
Mud Lake northeast	0	33	1788
Clough Island east	0	0	0
totals:	**0**	**207**	**10484**
Clough Island east	*0*	*about 10*	*500-550*

Additional wild rice seeding was planned for 2018 but was not completed due to the inability to acquire seed (Table 4). Sellers were unable to provide seed due to other needs and a poor production year for wild rice. Clough Island east was seeded on 9/18/2018 through other efforts (St. Louis River Alliance, Wisconsin DNR, volunteers) with 400 pounds over approximately 10 acres.

Table 4: Wild Rice Restoration Sites in the St. Louis River Estuary, 2018

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	0	0	0
Duck Hunter Bay north	0	0	0
Duck Hunter Bay south	0	0	0
North Bay	0	0	0
Radio Tower Bay	0	0	0
Walleye Alley Bay	0	0	0
Landslide Bay	0	0	0
Oliver-Bear Island	0	0	0
Mud Lake northeast	0	0	0
Clough Island east	0	0	0
totals:	**0**	**0**	**0**
Clough Island east	*0*	*about 10*	*400*

In 2019, approximately 84 acres were seeded with 7,622 pounds of wild rice on 9/24/2019 (Table 5). Two new areas, parts of Foundation Bay and near the Red River outlet, were seeded for the first time under this initiative. Clough Island east was seeded

on 9/19/2019 through other efforts (St. Louis River Alliance, Wisconsin DNR, volunteers) with 1,500 pounds over approximately 10 acres.

Table 5: Wild Rice Restoration Sites in the St. Louis River Estuary, 2019

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	0	18	1530
Duck Hunter Bay north	0	7	1642
Duck Hunter Bay south	0	8	1151
North Bay	0	6	379
Radio Tower Bay	0	13	701
Walleye Alley Bay	0	18	592
Landslide Bay	0	7	419
Oliver-Bear Island	0	5	743
Mud Lake northeast	0	0	0
Clough Island east	0	0	0
Foundation Bay	0	1	285
Red River	0	1	180
totals:	**0**	**84**	**7622**
Clough Island east	*0*	*10*	*1500*

Seeding in 2020 began on 9/4/2020 and included 13,816 pounds of wild rice over 126 acres (Table 6). Clough Island east was seeded on 9/1/2020 and 9/6/2020 through other efforts (St. Louis River Alliance, Wisconsin DNR) with 500 pounds over approximately 10 acres.

Table 6: Wild Rice Restoration Sites in the St. Louis River Estuary, 2020

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	0	33	3349
Duck Hunter Bay north	0	19	2805
Duck Hunter Bay south	0	23	2306
North Bay	0	14	1534
Radio Tower Bay	0	15	1499
Walleye Alley Bay	0	11	1105
Landslide Bay	0	8	812
Oliver-Bear Island	0	1	130
Mud Lake northeast	0	0	0
Clough Island east	0	0	0
Foundation Bay	0	1	101
Red River	0	1	175
totals:	**0**	**126**	**13816**
Clough Island east	*0*	*10*	*500*

Since 2015, the restoration effort has seeded 52,944 pounds of wild rice (Table 7) over about 219 acres. Other efforts have contributed to seeding an additional 3,300-3,450 pounds of wild rice in Clough Island east.

Table 7: Pounds of Wild Rice Seeded in the St. Louis River Estuary, 2015-2020

St. Louis River Estuary	2015	2016	2017	2018	2019	2020	totals
Rask Bay	2085	1650	1647	0	1530	3349	**10,261**
Duck Hunter Bay north	2165	948	953	0	1642	2805	**8,513**
Duck Hunter Bay south	1642	1935	2006	0	1151	2306	**9,040**
North Bay	1666	718	707	0	379	1534	**5,004**
Radio Tower Bay	946	750	767	0	701	1499	**4,663**
Walleye Alley Bay	0	1247	850	0	592	1105	**3,794**
Landslide Bay	0	553	425	0	419	812	**2,209**
Oliver-Bear Island	0	2120	1341	0	743	130	**4,334**
Mud Lake northeast	0	2089	1788	0	0	0	**3,877**
Clough Island east	0	508	0	0	0	0	**508**
Foundation Bay	0	0	0	0	285	101	**386**
Red River	0	0	0	0	180	175	**355**
totals:	**8,504**	**12,518**	**10,484**	**0**	**7,622**	**13,816**	**52,944**
Clough Island east	*400-500*		*500-550*	*400*	*1500*	*500*	

Monitoring Methods

Survey Points

Monitoring areas were outlined to encompass restoration sites, and a grid of monitoring GPS points was established. A total of 40 points is targeted when setting up a sampling grid to achieve suitable statistical precision, regardless of the size of the area monitored (Kjerland, T. 2015. Wild Rice Monitoring Handbook). A point grid was established for each area monitored, focusing on portions of the bays containing suitable wild rice habitat and targeted for restoration work. Points ranged from 40 m to 175 m apart depending upon the size and shape of the monitored area. The number of sampling points ranged from 28 to 47 based upon the best fit for a grid of points across the monitored area (Table 8). Maps showing sampling points in each bay are included in Appendix A (Figures A1-A13).

Density and Biomass

The best time to complete wild rice monitoring is late August or early September when plants are standing and reaching maturity. This aids with plant observation and identification, and provides for plant measurements to be taken (versus early in the season when plants are submerged or in floating-leaf stage). Surveys to estimate wild rice density were completed between August 20 and September 6 in 2015-2020. Some aspects of this timing in relation to site preparation work should be noted. Wild rice presence in 2015 is likely under-reported in Duck Hunter north, Duck Hunter south, and North bays because the survey work was completed after vegetation cutting (and potential removal of existing wild rice plants) that year. In Rask Bay, the wild rice survey was completed before cutting, and therefore provided a more accurate representation of the 2015 season. Vegetation in Radio Tower Bay was already impacted through removal of wood debris under another restoration project. Similarly, 2016 wild rice presence may be under-reported in Walleye Alley Bay, Landslide Bay, Oliver-Bear Island, and Mud Lake northeast because the survey was completed after vegetation cutting that season. No vegetation treatment was conducted around Clough Island. Ideally, survey work should have started in 2014 or earlier to get better long-term

information on wild rice presence before restoration activities. Wild rice restoration was not initiated through 2019 at Oliver-Little Pokegama Bay and Kingsbury Bay. Monitoring of these areas began in 2017 in anticipation of planned future restoration work.

Wild rice density is determined from sample plots with an area of 0.5 m^2 each. A floating square constructed from PVC piping (~0.71 m on a side) is used as a sampling plot. The plot is placed over a portion of the rice bed and the number of rice stalks within it is counted and recorded. The stalk nearest to a corner of the plot is selected, and its height above the water is first recorded. The plant is then pulled and the distance from the top of the root to the water level is measured, enabling total plant height to be calculated. Density plots are completed at sampling points based on a grid established for each area. A GPS unit is used to navigate to all sampling points on the grid.

Equations have been developed to calculate wild rice biomass from measurements such as plant height or potential number of seeds. The equations provide a way to estimate biomass without collecting plants. Options for wild rice biomass equations (Kjerland, T. 2015. Wild Rice Monitoring Handbook) include:

1. Plant weight/stalk = $(9.03 \times 10^{-6}) \times (\text{total plant height in cm})^{2.55}$

2. Plant weight/stalk = $(0.137) \times (\text{number of female pedicels per stalk})^{0.917}$

For monitoring on the St. Louis River Estuary, the total plant height equation was utilized to estimate wild rice biomass. Recording total plant height is more efficient in the field than counting the number of pedicels per stalk. Wild rice biomass was calculated for each point based on total height recorded from a sample plant, with average biomass per square meter (grams/m^2) reported for each area monitored.

Water Depths

Water depths were recorded at each sampling point during wild rice density surveys. In plots with a wild rice plant present, the distance from top of the root to the water surface was recorded as water depth. When no wild rice plants were present, water depth was measured either with a marked PVC pipe used as a staff gauge or a hand-held depth finder at deeper locations.

Photography

Photo points were established on the water in each bay to demonstrate views from the water surface. Aerial photos were taken by helicopter in 2015 (6/10/15 before vegetation treatment activities, 9/1/2015 after treatment activities), 2016 (9/1/2016), 2017 (8/31/2017), 2018 (8/30/2018), 2019 (8/29/2019), and 2020 (8/27/2020). Photographs will help to further document wild rice restoration work and changes to the system moving forward. Aerial photographs of each area are included in Appendix B.

Results

Table 8: Wild Rice Density and Biomass, 2020

St. Louis River Estuary	Area Monitored in Acres	Number of Sample Points	Average # Stalks per 1/2 m² (range in parentheses)	Average Biomass per m² (g/m2)
Rask Bay	50	36	0.3 (0-5)	2.3
Duck Hunter Bay north	21	35	2.5 (0-13)	17.3
Duck Hunter Bay south	60	42	0.5 (0-4)	2.8
North Bay	36	36	0.4 (0-6)	1.2
Radio Tower Bay	18	28	0.5 (0-5)	3.5
Walleye Alley Bay	25	41	0.3 (0-5)	1.0
Landslide Bay	11	29	0.7 (0-8)	4.6
Oliver-Bear Island	62	47	0.2 (0-2)	0.9
Mud Lake northeast	45	41	0.05 (0-1)	0.3
Clough Island east	39	43	0.4 (0-7)	1.9
Foundation Bay	110	44	0.3 (0-14)	2.7
* Oliver-Little Pokegama bays	300	37	0 (0)	0
* Kingsbury Bay	NA	NA	NA	NA

*no wild rice restoration work initiated through 2019 at these locations

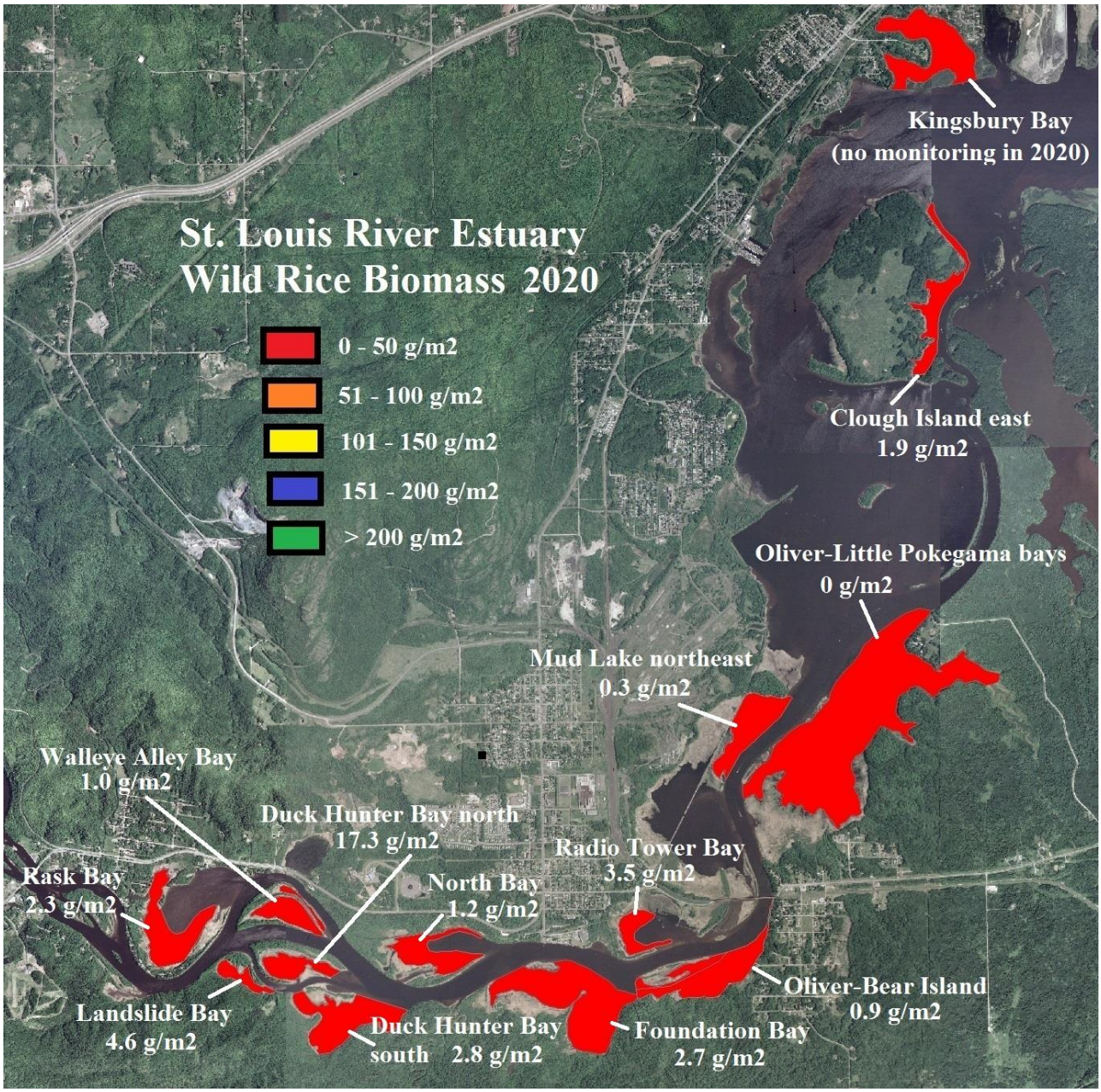

Figure 2: Wild Rice Biomass in Monitored Areas (2020)

Table 9: Average Total Wild Rice Plant Height and Water Depth at Sampling Points, 2020

St. Louis River Estuary	Date	Average Total Plant Height in Inches (range in parentheses)	Average Water Depth in Inches (range in parentheses)
Rask Bay	8/20/2020	54 (35-76)	46 (22-60)
Duck Hunter Bay north	8/25/2020	61 (43-77)	40 (29-56)
Duck Hunter Bay south	8/25/2020	59 (46-69)	50 (28-82)
North Bay	8/27/2020	49 (25-61)	46 (12-73)
Radio Tower Bay	8/21/2020	62 (36-87)	53 (24-75)
Walleye Alley Bay	8/20/2020	47 (33-63)	37 (13-53)
Landslide Bay	8/20/2020	60 (48-72)	45 (16-76)
Oliver-Bear Island	8/21/2020	53 (43-65)	77 (22-282)
Mud Lake northeast	8/26/2020	55 (54-56)	60 (39-136)
Clough Island east	8/28/2020	55 (37-80)	60 (22-112)
Foundation Bay	8/28/2020	66 (66)	60 (29-90)
* Oliver-Little Pokegama bays	8/26/2020	NA	63 (34-115)
* Kingsbury Bay	NA	NA	NA

*no wild rice restoration work initiated through 2019 at these locations

Table 10: Wild Rice Density and Biomass, 2015-2020

St. Louis River Estuary	Acres Monitored	2015 Avg # stalks per 1/2 m²	2015 Biomass (g/m²)	2016 Avg # stalks per 1/2 m²	2016 Biomass (g/m²)	2017 Avg # stalks per 1/2 m²	2017 Biomass (g/m²)
Rask Bay	50	2.0	10.8	1.6	11.9	0.7	3.0
Duck Hunter Bay north	21	4.6	32.7	6.1	33.9	4.3	18.6
Duck Hunter Bay south	60	2.6	19.1	0.8	5.3	1.7	8.6
North Bay	36	0	0	2.9	12.1	0.5	3.5
Radio Tower Bay	18	0	0	0.7	3.4	1.0	5.7
Walleye Alley Bay	25			0	0	0.5	1.5
Landslide Bay	11			0.03	0.1	1.2	4.1
Oliver-Bear Island	62			0.1	0.8	0.1	0.5
Mud Lake northeast	45			0	0	0.1	0.1
Clough Island east	39			0.1	0.5	0.02	0.2
* Foundation Bay	110					0.1	0.4
* Oliver-Little Pokegama bays	300					0.03	0.1
* Kingsbury Bay	72					0	0

St. Louis River Estuary	Acres Monitored	2018 Avg # stalks per 1/2 m²	2018 Biomass (g/m²)	2019 Avg # stalks per 1/2 m²	2019 Biomass (g/m²)	2020 Avg # stalks per 1/2 m²	2020 Biomass (g/m²)
Rask Bay	50	0.6	2.8	0.3	2.0	0.3	2.3
Duck Hunter Bay north	21	1.2	5.2	1.2	6.0	2.5	17.3
Duck Hunter Bay south	60	0.6	2.2	0.4	2.2	0.5	2.8
North Bay	36	0.2	1.2	0.2	1.2	0.4	1.2
Radio Tower Bay	18	0.2	1.0	0.2	1.4	0.5	3.5
Walleye Alley Bay	25	0.3	1.1	0.1	0.3	0.3	1.0
Landslide Bay	11	0.6	2.4	0.8	4.9	0.7	4.6
Oliver-Bear Island	62	0.1	0.3	0.04	0.3	0.2	0.9
Mud Lake northeast	45	0.2	1.3	0.1	0.5	0.05	0.3
Clough Island east	39	0.4	0.4	0.1	0.4	0.4	1.9
* Foundation Bay	110	0	0	0	0	0.3	2.7
* Oliver-Little Pokegama bays	300	0	0	0.05	0.3	0	0
* Kingsbury Bay	72	0	0	0	0	NA	NA

*no wild rice restoration work initiated through 2019 at these locations

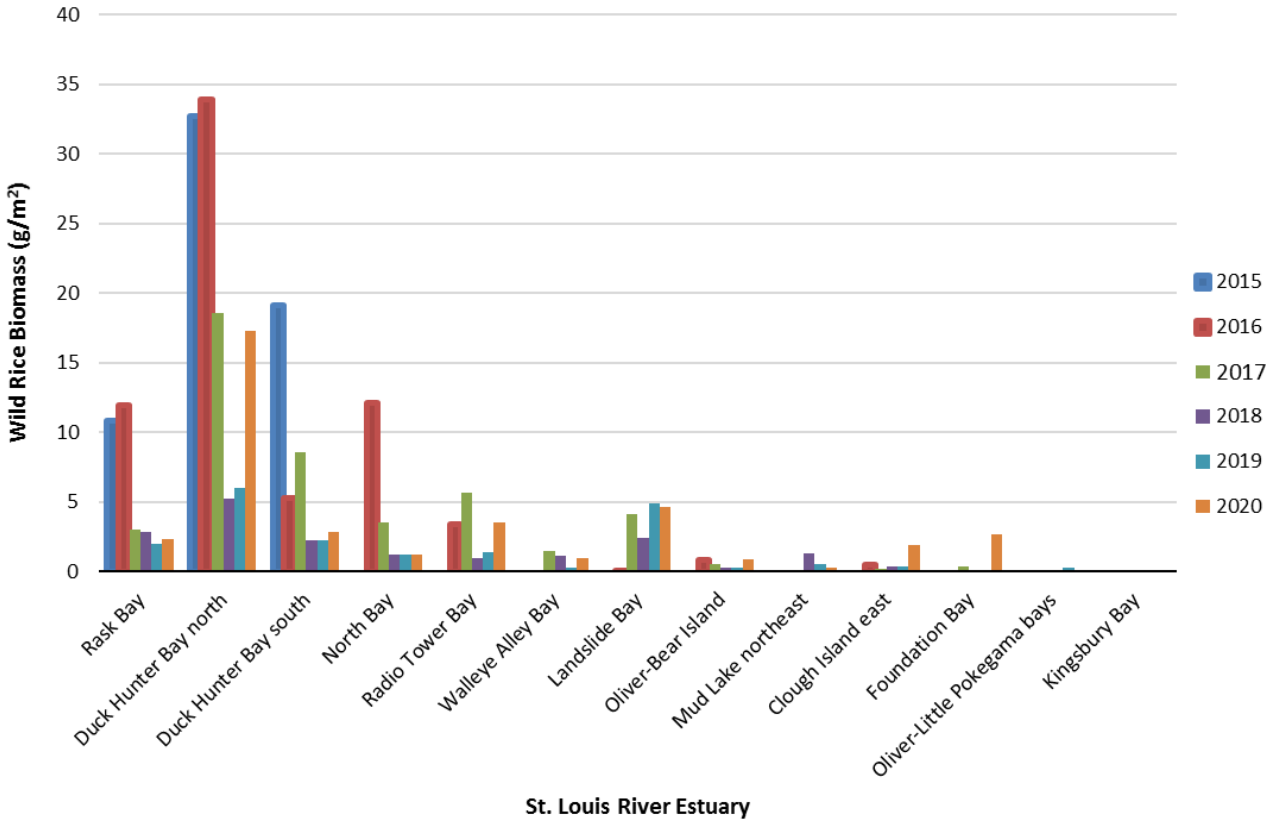

Figure 3: Wild Rice Biomass in Monitored Areas

Discussion

Survey results in 2020 (Table 8, Figure 2) indicate a range of average wild rice biomass from 0.3 grams/m^2 in Mud Lake northeast, to 17.3 grams/m^2 in Duck Hunter Bay north (not including areas with no restoration work done). A biomass of 17.3 grams/m^2 is low when compared to other wild rice waters in the region. Wild rice lakes and rivers in the 1854 Treaty Authority monitoring program typically range in the 100-300 grams/m^2 on a fair to good year, and have exceeded 700 grams/m^2 for average biomass during an excellent year. Monitoring was not completed in Kingsbury Bay in 2020 due to equipment (dredges, barges) working on other restoration efforts. The small area seeded just to the west of the mouth of the Red River was not included in the monitoring program.

Water depth is an important factor in wild rice growth, with 12-36 inches typically considered as ideal conditions. Average water depths at the time of sampling in late August to early September 2020 were generally greater than the upper end of this range (Table 9). However, it must be noted that these reported depths were on a single date, and not representative of the entire 2020 season. Monitored areas may also be larger than the current restoration footprint, resulting in some sampling points (and water depths) on the edge or outside of expected wild rice growth.

A comparison of water levels across years is helpful to understand potential impacts to wild rice growth and restoration success. Water depth is collected (every 15 minutes by data logger) by the Lake Superior National Estuarine Research Reserve (NERR) at the Oliver Bridge. This location is near the restoration areas and provides a suitable summary of water levels in the upper estuary. Water depths from 2015 to 2020 (May 1 – October 1 each year) are displayed in Appendix C. Water elevation data collected by the U.S. Geological Survey in 2017 can be paired with the NERR water level data to calculate water elevations at the Oliver Bridge, also shown in Appendix C. However, some differences in data logger readings and the two datasets make this calculation a close estimate of water elevations but perhaps not completely accurate. The water depths and elevations display relative difference in water depths across years. Water levels in the St. Louis River estuary remained high in 2020, but a drier season kept levels below those seen in 2019 (Lake Superior set monthly record highs in summer 2019 and neared the all-time record high level). In 2020, Lake Superior water levels on June 1 were 6 inches lower than on June 1 in 2019, but still more than 10 inches above long-term average. October 2020 was similar, with the lake 4 inches lower than October 1 in 2019, but still about 10 inches above normal (Duluth News Tribune). Higher water levels in the estuary likely affect wild rice growth and restoration success.

The timing of wild rice surveys in 2015 and 2016 must again be understood. Surveys are completed in late August or early September to target the time when wild rice is standing and reaching maturity. However, these surveys were done after mechanical cutting was completed in Duck Hunter north, Duck Hunter south, and North bays in 2015. In these areas, some wild rice was likely impacted by vegetation cutting, resulting in an under representation of wild rice presence. Radio Tower Bay was in a similar situation, with other restoration work to remove wood debris completed in 2015 which likely impacted vegetation presence and wild rice monitoring results. In contrast, the 2015 Rask Bay survey was completed before vegetation treatment and provided a more accurate representation of wild rice presence. In 2016, similar circumstances occurred. Monitoring surveys were completed after mechanical treatment in Walleye Alley Bay, Landslide Bay, Oliver-Bear Island, and Mud Lake northeast. Monitoring results in these areas likely under-reported rice presence compared to what may have been found prior to cutting. No vegetation treatment was conducted around Clough Island. Vegetation treatment did not occur in any sites in 2017-2020.

Annual monitoring results show changes in wild rice density and biomass in each restoration area across years (Table 10, Figure 3). Monitoring completed in 2020 and future years will allow for wild rice to be tracked moving forward in all monitored areas.

The *Wild Rice Restoration Implementation Plan for the St. Louis River Estuary* (Minnesota Department of Natural Resources. 2014. St. Louis River Estuary Wild Rice Restoration Implementation Plan. Division of Ecological and Water Resources. Duluth, Minnesota) was completed through cooperation among numerous partners. Along with identifying possible locations for restoration activities, the plan outlined goals and objectives for wild rice restoration:

The objective for wild restoration in the St. Louis River estuary is:

By 2025, at least 275 acres of wild rice will be restored or enhanced in approximately 15 locations where habitat conditions are suitable for wild rice, to benefit fish and wildlife resources and provide opportunities for harvest, including a minimum of one wild rice stand greater than 50 acres in size. Restored or enhanced wild rice stands will comprise the following characteristics:

1. *Wild rice is present with an average density of greater than 1 stem/0.5 m2 in 50% of the sampling points within the defined site in three of every five years and not absent in 60% or more of the sampling points for more than three straight years.*
2. *Stands targeted to provide harvest opportunities have an average stand density that can be identified through standard aerial photography methodology in late summer (August 7 through Sept 15) in two of every five years.*

In 2016, one year after restoration was initiated in five locations, only Duck Hunter Bay north (with at least one stalk of wild rice present in 77% of the sampling points) met the density threshold described in the plan. In 2017, once more only Duck Hunter Bay north (wild rice again in 77% of the sampling points) met this threshold. No restoration areas met this density in 2018 or 2019. In 2020, Duck Hunter Bay north (wild rice present in 71% of the sampling points) met this density.

Rask Bay

Wild rice surveys were completed on 8/21/15 (before vegetation cutting that year), 8/25/16, 8/22/17, 8/21/18, 8/23/19, and 8/20/20. In 2020, very sparse wild rice was observed along the west, south, and east shores. A small area of moderate density was present in the north arm of bay. Wild rice density and biomass in 2020 were similar to 2017-2019 and declined from levels found in 2015 and 2016. At least one stalk of wild rice was present in 17% of the sampling points. Moderate to severe grazing impact, presumably from geese, was observed during the August 2020 survey and 16 geese were present. Most leaves and many wild rice stalks had been nipped off. During a site visit on 7/9/20, sparse density wild rice was observed along shore with most in the floating-leaf stage and some plants beginning to stand. Almost all standing plants had grazing impact, and five geese were observed in the bay. Photo points have been established at six sampling locations and will be useful in showing changes across years.

Duck Hunter Bay north

Wild rice surveys were completed on 8/25/15 (after vegetation cutting that year), 8/23/16, 8/24/17, 8/22/18, 8/27/19, and 8/25/20. In 2020, moderate density areas of wild rice were present across most of the bay. Biomass and density showed improvement and were increased compared to 2018 and 2019. At least one stalk of wild rice was present in 71% of the sampling points. Moderate grazing impact was observed during the August 2020 survey, with most rice plants nipped (most leaves, some stalks) but no geese present. On the 7/9/20 field visit, moderate to good density wild rice was found along the south and west sides of the bay. Rice was floating-leaf to standing about one foot. Nearly all

standing plants had been nipped off, but no geese were observed in the bay. Photo points have been established at four locations.

Exclosures and other efforts in Duck Hunter Bay north

- 2016: Nets were strung across the two openings into the bay to act as a carp barrier, and three exclosures were installed to fence off areas from geese (and potentially carp).
- 2017: Nine sets of poles with ribbon (installed by the Fond du Lac Band earlier in the season to act as a goose deterrent) were present, but most were not operational by August with ribbons gone likely from wind.
- 2018: Two exclosures were installed on 7/17/18 by the Fond du Lac Band with assistance from the 1854 Treaty Authority. During the August 2018 survey, no apparent difference in wild rice growth was observed inside the exclosures (with some leaves inside appearing nipped) versus outside.
- 2020: Eight exclosures were installed in early May by the Fond du Lac Band with limited assistance from the 1854 Treaty Authority. During a site visit on 7/9/20, rice within the exclosures was taller (observation of 24-30 inches) than rice outside (floating-leaf to standing 12 inches). This difference was again apparent during the survey on 8/25/20. Rice within the exclosures (or areas where exclosures had been present) was taller, thicker, and more robust. Two exclosures along the south side of the bay were still present on August 25th, while the other six had been removed for the season. Four sampling points were completed in each of the two existing exclosures. A comparison of wild rice within these two exclosures versus the summary for the other portion of the bay is included in Table 11. Photos of the exclosures in 2020 can be found in Appendix D.

Table 11: Wild Rice Height, Density, and Biomass in Duck Hunter North Bay, 2020

Duck Hunter North Bay	Number of Sample Points	Average Total Plant Height in Inches (range in parentheses)	Average # Stalks per 1/2 m² (range in parentheses)	Average Biomass per m² (g/m2)
entire bay	35	61 (43-77)	2.5 (0-13)	17.3
2 exclosures	8	86 (73-100)	16.9 (7-30)	295.6

Duck Hunter Bay south

Wild rice surveys were completed on 8/25/15 (after vegetation cutting that year), 8/23/16, 8/24/17, 8/22/18, 8/29/19, and 8/25/20. In 2020, sparse wild rice was observed around most of the bay, with some areas containing no rice or only a few plants. Wild rice density and biomass were similar to 2018 and 2019. At least one stalk of wild rice was present in 29% of the sampling points. Grazing impact on wild rice observed during the August 2020 survey was moderate (most leaves and some stalks nipped) and 20 geese were seen in the bay. During the 7/9/20 visit, sparse to moderate density wild rice was observed with plants in the floating-leaf stage to standing about one foot. Almost all standing plants had been nipped, and 15 geese were present. Photo points have been established at 11 locations.

North Bay

Wild rice surveys were completed on 8/24/15 (after vegetation cutting that year), 8/25/16, 8/28/17, 8/28/18, 8/27/19, and 8/27/20. In 2020, very sparse wild rice was present along the south and west sides of the bay. Wild rice density and biomass in 2020 were similar to 2018 and 2019, declining from the previous two years. At least one stalk of wild rice was present in 14% of the sampling points. Moderate to severe grazing impact was observed during the August 2020 survey, with most rice leaves and many stalks nipped. Five geese were observed in the bay during the survey. On 7/9/20, sparse wild rice was seen along the south shore with some moderate density on the northwest end of the bay. Most wild rice was floating-leaf with some starting to stand, but almost all standing plants had been nipped. Five geese were present in the bay. Photo points have been established at four locations.

Radio Tower Bay

Wild rice surveys were completed on 8/24/15 (after wood removal work that year), 8/29/16, 8/30/17, 8/23/18, 8/30/19, and 8/21/20. In 2020, sparse areas of wild rice were found along the south shore, west end, and into the north side. Wild rice density and biomass were increased from 2018 and 2019, and at least one stalk of wild rice was present in 31% of the sampling points. Moderate to severe impacts from grazing were observed during the August 2020 survey, with most wild rice leaves and many stems nipped. Six geese were observed during the survey. During the 7/9/20 site visit, sparse floating-leaf wild rice (with a few plants starting to stand) was found in the restoration area. Some plants had been nipped, and no geese were present in the bay. Photo points have been established at five locations.

Walleye Alley Bay

Wild rice surveys were completed on 8/30/16 (after vegetation cutting that year), 8/28/17, 8/21/18, 8/22/19, and 8/20/20. In 2020, sparse wild rice was found across the bay with density and biomass increased from 2019 and similar to 2017 and 2018. At least one stalk of wild rice was present in 15% of the sampling points. Grazing impact on wild rice was moderate to severe (most rice leaves and many stalks nipped) during the August 2020 survey, but no geese were present in the bay. On 7/9/20, sparse to moderate density wild rice was observed across the bay, with most floating-leaf and some starting to stand. Most standing plants had been nipped, and 12 geese were observed in the bay. Photo points have been established at six locations.

Landslide Bay

Wild rice surveys were completed on 8/30/16 (after vegetation cutting that year), 8/22/17, 8/22/18, 8/27/19, and 8/20/20. In 2020, sparse wild rice was present across most of the bay. Wild rice density and biomass were similar to 2019, and at least one stalk of wild rice was present in 24% of the sampling points. Moderate to severe grazing impacts on wild rice were observed during the August 2020 survey, and two geese were observed in the bay. Most rice leaves and many stalks had been nipped or broken. On 7/9/20, moderately dense wild rice was observed in parts of the bay, with plants floating-leaf to standing one foot. All standing plants had been nipped and 15 geese were observed. During the August 2017 survey, eight sets of poles with ribbon were present to act as a

goose deterrent, but most were not operational with ribbons gone. Photo points have been established at three locations.

Oliver-Bear Island

Wild rice surveys were completed on 8/29/16 (after vegetation cutting that year), 8/29/17, 8/23/18, 8/30/19, and 8/21/20. In 2020, sparse wild rice was found along the south shore and the southeast side of Bear Island. Scattered wild rice plants were present across most of the other area. Wild rice density and biomass in 2020 remained low but increased from previous years. At least one stalk of wild rice was present in 15% of the sampling points. Grazing impact seen in August 2020 was moderate to severe with most wild rice leaves and many stalks nipped, and 22 geese were observed during the survey. During a field visit on 7/9/20, sparse to moderate density wild rice was seen across much of the area, with moderate to good density along the south shore. Wild rice was floating-leaf to standing 12-16 inches. Most standing plants had been nipped, and no geese were present. Photo points have been established at six locations.

Mud Lake northeast

Wild rice surveys were completed on 8/31/16 (after vegetation cutting that year), 8/30/17, 8/29/18, 8/30/19, and 8/26/20. In 2020, scattered wild rice plants were found across most of the restoration area. Wild rice density and biomass remained low. At least one stalk of wild rice was present in 5% of the sampling points. Moderate grazing impact was observed in August 2020 with most leaves nipped but no geese observed during the survey. On the 7/9/20 site visit, areas of sparse to moderate density floating-leaf wild rice were present and 12 geese were observed. Photo points have been established at three locations.

Clough Island east

Wild rice surveys were completed on 8/31/16, 9/6/17, 8/30/18, 9/4/19, and 8/28/20. In 2020, sparse wild rice was present in areas along the east side of the island. Wild rice density and biomass increased from previous years, and at least one stalk of wild rice was present in 14% of the sampling points. Moderate to severe grazing impact was observed in August 2020 with most wild rice leaves and many stalks nipped. No geese were observed during the survey. During a visit on 7/9/20, moderate to good density wild rice was found along portions of shore. Plants were floating-leaf to standing about one foot, and all plants had been nipped. Sixteen geese were observed, and some seen (and recorded with video) actively grazing on wild rice plants. Photo points have been established at four locations.

Foundation Bay

Wild rice monitoring in Foundation Bay was initiated in 2017 to track conditions before restoration efforts. Seeding of wild rice in portions of the area began in fall 2019, meaning restoration work showed in monitoring results starting in 2020. Wild rice surveys were completed on 8/29/17, 8/28/18, 8/27/19, and 8/28/2020. In 2020, moderate to good density wild rice was found in a small patch in the northwest portion of the monitored area, and moderate density wild rice was present along the southwest shore of the bay (which coincided with the areas that were seeded). Scattered wild rice plants were found in other areas of the monitored area. Wild rice was present in one of the sampling

points (equating to about 2% of the points). Grazing impact seen in August 2020 was moderate with most leaves and some stalks nipped, but no geese observed during the survey. Photo points have been established at 11 locations.

Oliver – Little Pokegama bays

Wild rice restoration work has not been started at Oliver-Little Pokegama bays, but monitoring was initiated in 2017 to track conditions before potential future restoration efforts. Wild rice surveys were completed on 8/30/17, 8/29/18, 8/26/19, and 8/26/20. Some scattered wild rice plants were observed in the inlet/bay on the east side, along the south shore, and along the west side of Oliver Bay. Little Pokegama Bay had sparse wild rice along portions of shore. However, wild rice was not present in any of the sampling points in 2020. Moderate grazing impact was observed in August 2020 with most wild rice leaves and some stalks nipped, and 18 geese observed during the survey. Photo points have been established at seven locations.

Kingsbury Bay

Wild rice restoration work has not been started at Kingsbury Bay, but monitoring was initiated in 2017 to track conditions before potential future restoration efforts. Wild rice surveys were completed on 8/31/17, 8/30/18, and 9/4/19. Monitoring was not completed in Kingsbury Bay in 2020 due to equipment working on other restoration efforts. Photo points have been established at five locations.

Goose Impacts and Evaluation

Impacts from geese on wild rice restoration are a concern in the St. Louis River Estuary. In July 2020, staff from the 1854 Treaty Authority visited most of the restoration sites to observe wild rice growth and possible impacts from geese. In many areas, rice had germinated and reached the floating-leaf stage or was beginning to stand. In general, many standing wild rice plants had been nipped off, likely by geese. Further observations of impacts from geese are included in discussions above on each restoration area. Impacts from geese are difficult to quantify, but likely affect monitoring results and restoration success. In 2018, a cooperative effort was initiated to document geese presence in wild rice restoration areas. The St. Croix Band of Lake Superior Chippewa contracted with the Wisconsin Department of Natural Resources to conduct weekly flights to count geese in Allouez Bay. With additional grant support managed by the MN Land Trust and coordination from the 1854 Treaty Authority, flights were expanded to include the other wild rice restoration areas. Flights by fixed-wing aircraft were completed approximately weekly from June through September 2018 to count geese (Table 12). Total geese observed on a given day peaked on 7/9/18 and 7/17/18 flights. This time period coincides with the emergence of wild rice from the floating-leaf stage to beginning to stand. The total number of geese observed in each bay varied, with a higher number seen in Rask Bay.

Table 12: Number of Geese Counted During Aerial Survey (2018)

St. Louis River	6/1	6/8	6/14	6/22	7/2	7/9	7/17	7/23	7/30	8/9	8/13	8/22	8/28	9/5	9/13	9/17	9/24	totals
Rask Bay	0	15	4	0	18	23	36	5	8	6	7	7	0	2	0	4	0	135
Duck Hunter north	2	0	17	10	0	0	3	0	0	6	17	0	0	0	2	4	0	61
Duck Hunter south	4	7	0	4	3	11	19	0	0	2	2	0	0	0	0	0	0	52
North Bay	2	2	0	0	0	16	4	0	20	4	0	27	0	0	3	0	0	78
Radio Tower Bay	0	0	7	0	16	11	6	6	6	0	2	0	2	2	0	0	0	58
Walleye Alley Bay	3	1	0	0	0	12	12	0	12	14	6	0	0	0	0	0	0	60
Landslide Bay	4	2	4	0	0	0	0	0	0	6	0	9	7	0	0	0	0	32
Oliver-Bear Island	0	0	0	0	5	0	5	0	0	10	6	9	0	0	0	0	0	35
Mud Lake northeast	2	0	0	0	13	7	0	9	2	12	7	2	0	0	0	0	8	62
Clough Island east	0	0	7	2	0	0	0	0	4	2	4	0	0	0	0	0	0	19
totals	17	27	39	16	55	80	85	20	52	62	51	54	9	4	5	8	8	592

A graduate student from the University of Wisconsin Superior conducted additional work on geese in the St. Louis River estuary. Kayak paddling was conducted most days in different portions of the river (Rask, Duck Hunter north, North, Radio Tower, Walleye Alley, Clough Island, Pokegama bays) in summer 2018 to move geese. Trail cameras were also set in numerous locations to capture goose presence. In 2019, the St. Louis River Alliance hired paddlers to deter geese in wild rice areas. In 2020, additional student work in coordination with the Lake Superior National Estuarine Research Reserve tracked geese/waterfowl and water levels in several locations.

Summary

The 1854 Treaty Authority completed a monitoring program in 2015-2020 on wild rice restoration areas in the St. Louis River Estuary. The purpose of the program is to document the success of wild rice restoration. High water levels and impacts from grazing (likely geese) appeared detrimental to wild rice success in 2020. In 2020, 13,816 pounds of wild rice was seeded in several locations. Monitoring of these restoration areas in 2021 and into the future will demonstrate changes to wild rice presence and abundance. Long-term monitoring is a critical component of restoration work, especially given the variability of wild rice biomass across years and variety of factors involved.

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Nick Bogyo – Fisheries Biologist, 1854 Treaty Authority
Jeffrey Flory – Invasive Species Specialist, 1854 Treaty Authority
Tyler Kaspar – Environmental Biologist, 1854 Treaty Authority
Matt Santo – Invasive Species Technician, 1854 Treaty Authority

Monitoring activities in 2020 were supported by contract with the Wisconsin Department of Natural Resources (thank you to Matt Steiger) through funding from the Great Lakes Restoration Initiative administered by the U.S Environmental Protection Agency.

Appendix A

Maps of Monitoring Points

Figure A-1: Monitoring Points in Rask Bay (36 points, 75 m grid)

Figure A-2: Monitoring Points in Duck Hunter Bay north (35 points, 50 m grid)

Figure A-3: Monitoring Points in Duck Hunter Bay south (42 points, 75 m grid)

Figure A-4: Monitoring Points in North Bay (36 points, 60 m grid)

Figure A-5: Monitoring Points in Radio Tower Bay (28 points, 50 m grid)
(aerial photograph taken before open water habitat created in north portion of bay)

Figure A-6: Monitoring Points in Walleye Alley Bay (41 points, 50 m grid)

Figure A-7: Monitoring Points in Landslide Bay (29 points, 40 m grid)

Figure A-8: Monitoring Points in Oliver-Bear Island (47 points, 75 m grid)

Figure A-9: Monitoring Points in Mud Lake northeast (41 points, 65 m grid)

Figure A-10: Monitoring Points in Clough Island east (43 points, 60 m grid)

Figure A-11: Monitoring Points in Foundation Bay (44 points, 100 m grid)

Figure A-12: Monitoring Points in Oliver-Little Pokegama (37 points, 175 m grid)

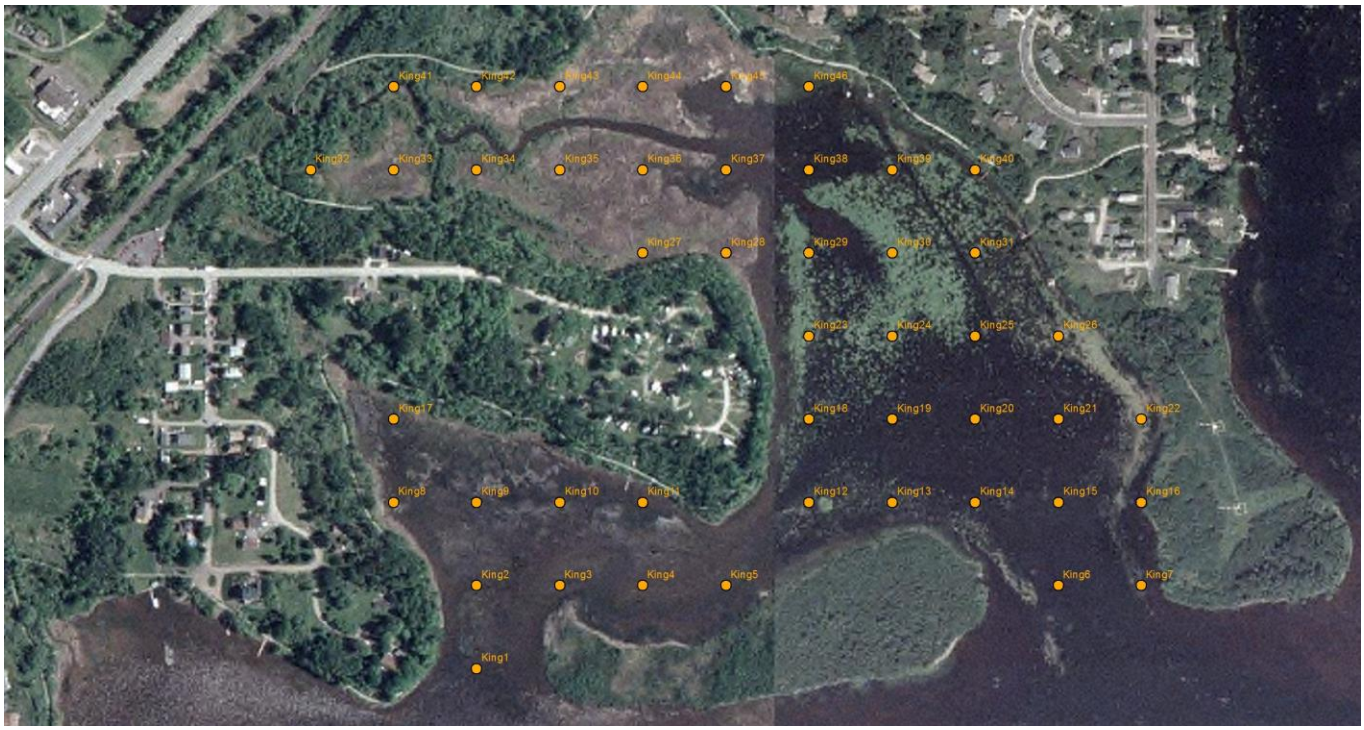
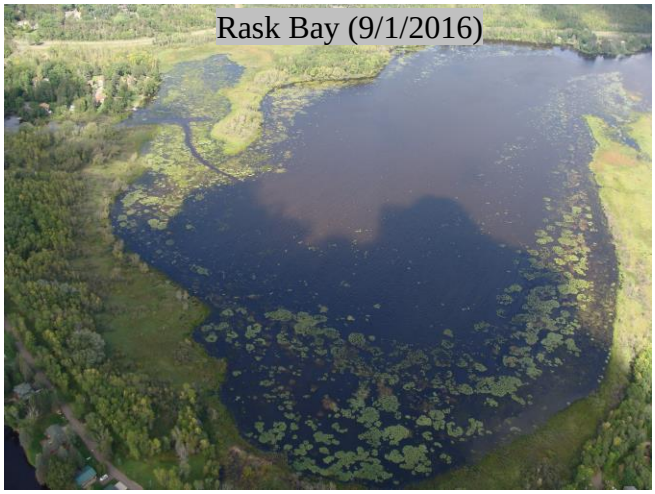


Figure A-13: Monitoring Points in Kingsbury Bay (46 points, 80 m grid)
(several points in north part of bay inaccessible in 2017-2019 due to bog/cattail, potential open water in future after planned restoration work)

Appendix B

Aerial Photographs

Rask Bay (2015-2020)



Duck Hunter Bay north (2015-2020)


Duck Hunter Bay north (9/1/2015)


Duck Hunter Bay north (9/1/2016)


Duck Hunter Bay north (8/31/2017)

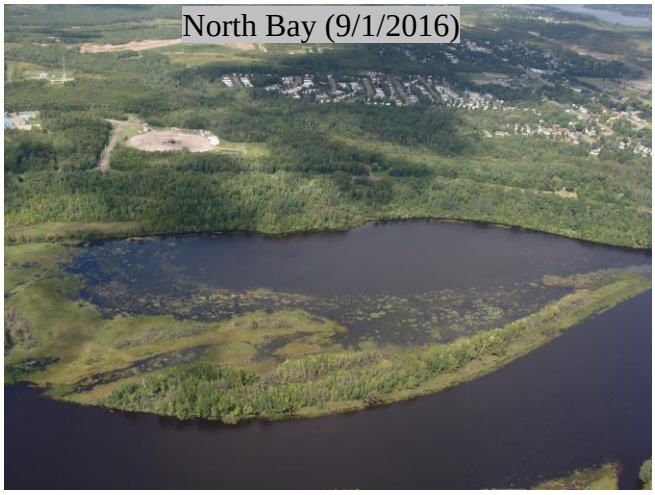

Duck Hunter Bay north (8/30/2018)


Duck Hunter Bay north (8/29/2019)


Duck Hunter Bay north (8/27/2020)

Duck Hunter Bay south (2015-2020)

North Bay (2015-2020)



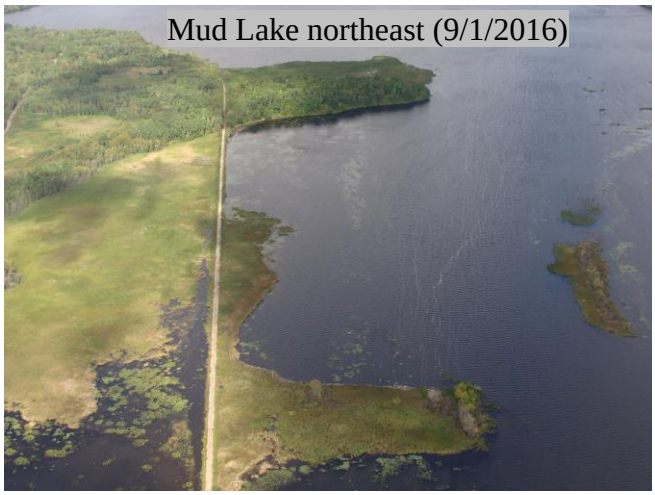
Radio Tower Bay (2015-2020)

Walleye Alley Bay (2016-2020)

Landslide Bay (2016-2020)

Oliver-Bear Island (2016-2020)

Mud Lake northeast (2016-2020)


Mud Lake northeast (9/1/2016)


Mud Lake northeast (8/31/2017)


Mud Lake northeast (8/30/2018)


Mud Lake northeast (8/29/2019)


Mud Lake northeast (8/27/2020)

Clough Island east (2016-2020)


Clough Island east (9/1/2016)


Clough Island east (8/31/2017)


Clough Island east (8/30/2018)


Clough Island east (8/29/2019)


Clough Island east (8/27/2020)

Foundation Bay (2017-2020)


Foundation Bay (8/31/2017)


Foundation Bay (8/30/2018)


Foundation Bay (8/29/2019)


Foundation Bay (8/27/2020)

Oliver-Little Pokegama (2017-2020)


Oliver – Little Pokegama (8/31/2017)


Oliver – Little Pokegama (8/30/2018)


Oliver – Little Pokegama (8/29/2019)


Oliver – Little Pokegama (8/27/2020)

Kingsbury Bay (2017-2020)


Kingsbury Bay (8/31/2017)


Kingsbury Bay (8/30/2018)


Kingsbury Bay (8/29/2019)


Kingsbury Bay (8/27/2020)

Appendix C

Water Depth and Elevation at Oliver Bridge

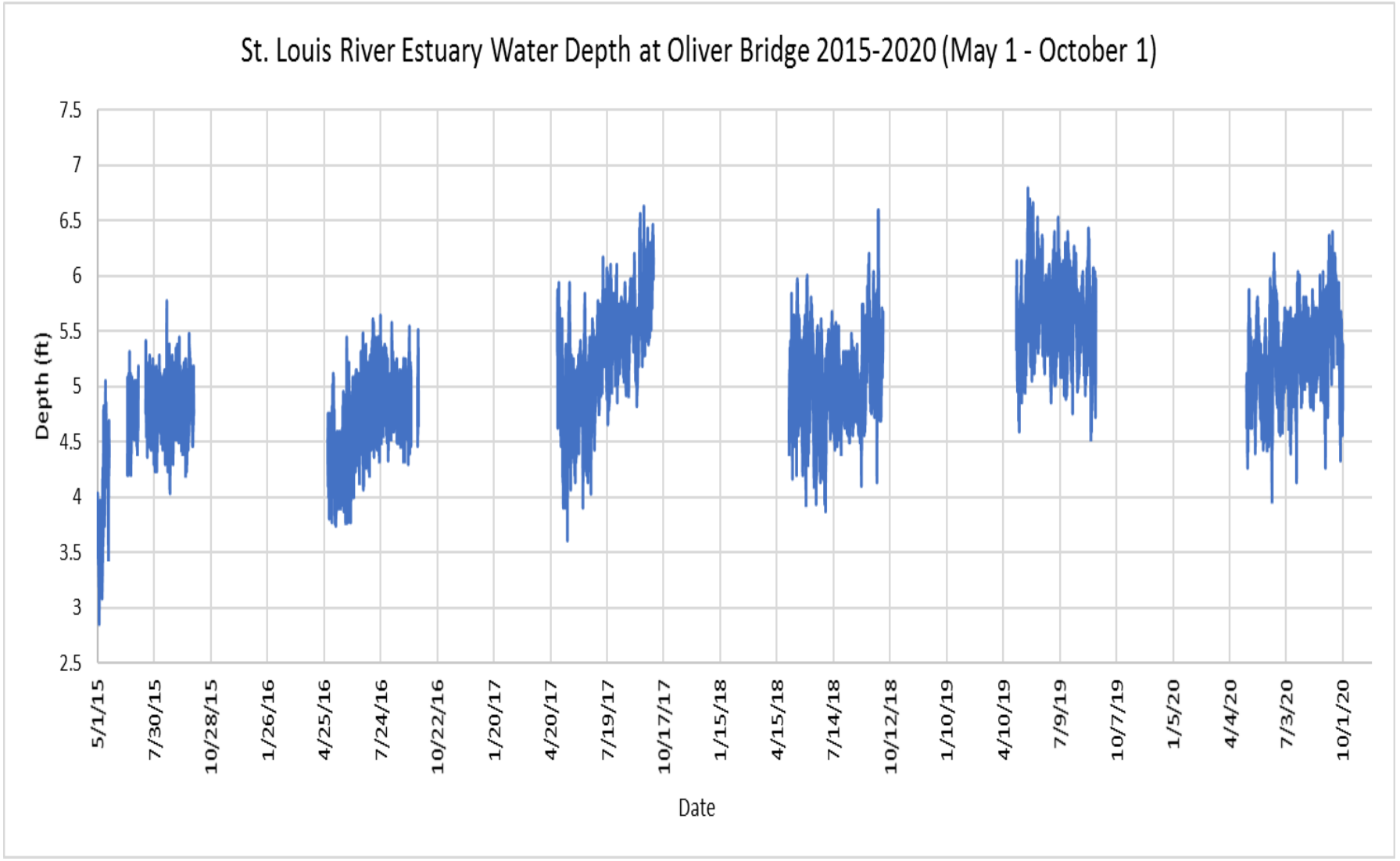


Figure C-1: Water Depth at Oliver Bridge
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program)

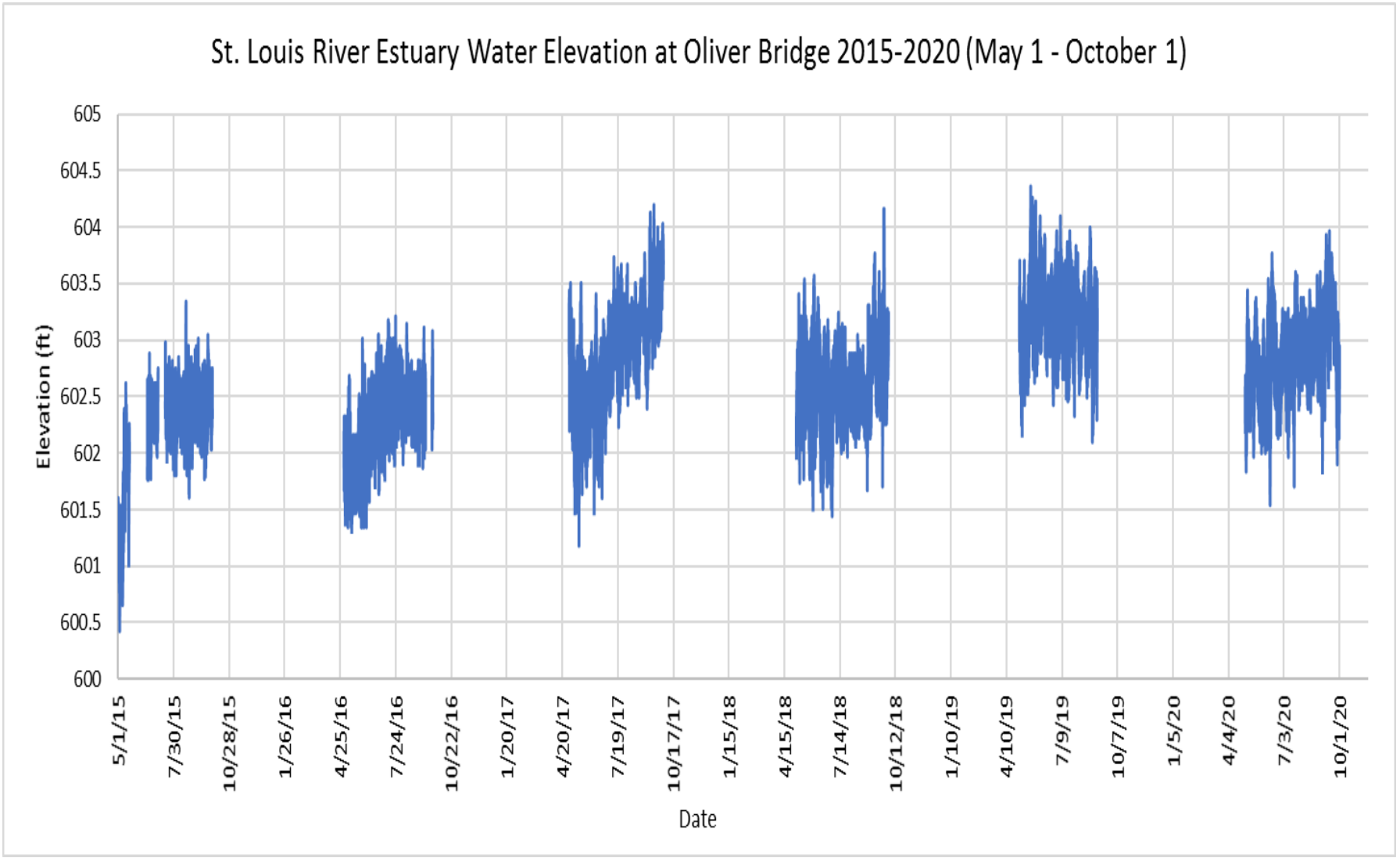


Figure C-2: Water Elevation at Oliver Bridge (estimated from combining two data sources)
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program) and U.S. Geological Survey

Appendix D

Photographs of Exclosures in Duck Hunter Bay North

5/14/2020

5/14/2020

5/14/2020

7/9/2020

7/9/2020

7/9/20020

8/25/2020

8/25/2020

8/25/2020

8/25/2020

8/27/2020

8/27/2020