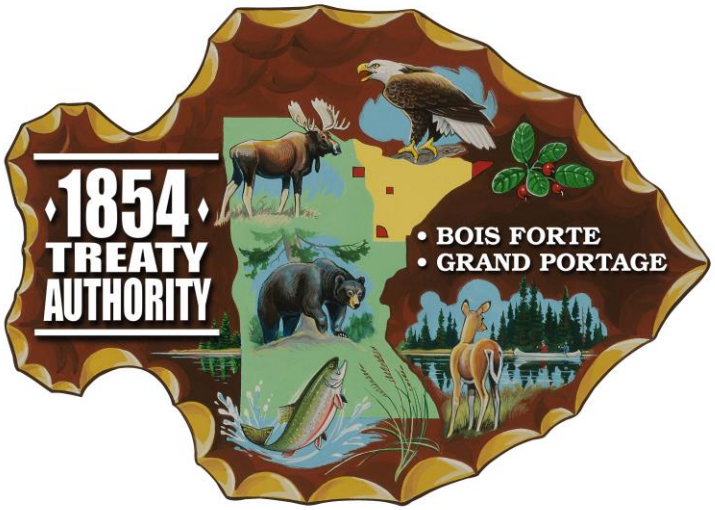

St. Louis River Estuary Wild Rice Restoration Monitoring (2015-2018)

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Introduction

In 2015-2018, 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 2015-2018. The purpose of the monitoring program is to document the success of wild rice restoration.

Wild rice monitoring sites included:

- **2015-2018** Rask Bay, Duck Hunter Bay north, Duck Hunter Bay south, North Bay, Radio Tower Bay
- **2016-2018** Walleye Alley Bay, Landslide Bay, Oliver-Bear Island, Mud Lake northeast, Clough Island east
- **2017-2018** 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 work has begun yet at Foundation, Oliver-Little Pokegama, and Kingsbury bays.

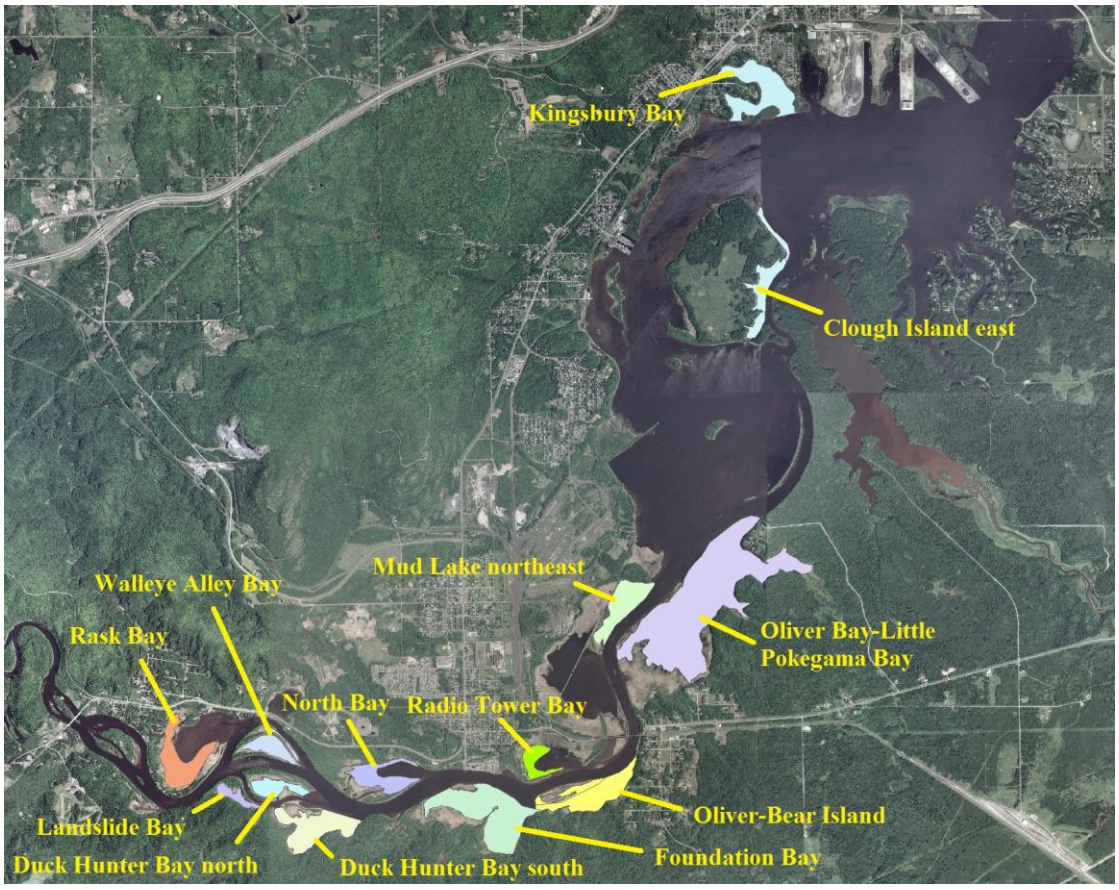

Figure 1: Wild Rice Monitoring in the St. Louis River Estuary

Wild Rice Restoration Overview

Wild rice (*Zizania palustris)* restoration work was implemented in 2015-2017 (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 down 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*

Since 2015, the restoration effort has seeded 31,506 pounds of wild rice (Table 5) over 217 acres. Other efforts have contributed to seeding an additional 1,300-1,450 pounds of wild rice in Clough Island east.

Table 5: Pounds of Wild Rice Seeded in the St. Louis River Estuary, 2015-2018

St. Louis River Estuary	2015	2016	2017	2018	totals
Rask Bay	2085	1650	1647	0	**5,382**
Duck Hunter Bay north	2165	948	953	0	**4,066**
Duck Hunter Bay south	1642	1935	2006	0	**5,583**
North Bay	1666	718	707	0	**3,091**
Radio Tower Bay	946	750	767	0	**2,463**
Walleye Alley Bay	0	1247	850	0	**2,097**
Landslide Bay	0	553	425	0	**978**
Oliver-Bear Island	0	2120	1341	0	**3,461**
Mud Lake northeast	0	2089	1788	0	**3,877**
Clough Island east	0	508	0	0	**508**
totals:	**8,504**	**12,518**	**10,484**	**0**	**31,506**
Clough Island east	*400-500*		*500-550*	*400*	

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 6). 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 21 and September 6 in 2015-2018. 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 has not been initiated to date at Foundation Bay, Oliver-Little Pokegama bays, 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), and 2018 (8/30/2018). 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 6: Wild Rice Density and Biomass, 2018

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	0.6 (0-6)	2.8
Duck Hunter Bay north	21	35	1.2 (0-9)	5.2
Duck Hunter Bay south	60	42	0.6 (0-6)	2.2
North Bay	36	36	0.2 (0-4)	1.2
Radio Tower Bay	18	28	0.2 (0-2)	1.0
Walleye Alley Bay	25	41	0.3 (0-2)	1.1
Landslide Bay	11	29	0.6 (0-4)	2.4
Oliver-Bear Island	62	47	0.1 (0-3)	0.3
Mud Lake northeast	45	41	0.2 (0-2)	1.3
Clough Island east	39	42	0.4 (0-7)	0.4
* Foundation Bay	110	44	0 (0)	0
* Oliver-Little Pokegama bays	300	37	0 (0)	0
* Kingsbury Bay	72	46	0 (0)	0

*no wild rice restoration work initiated to date at these locations

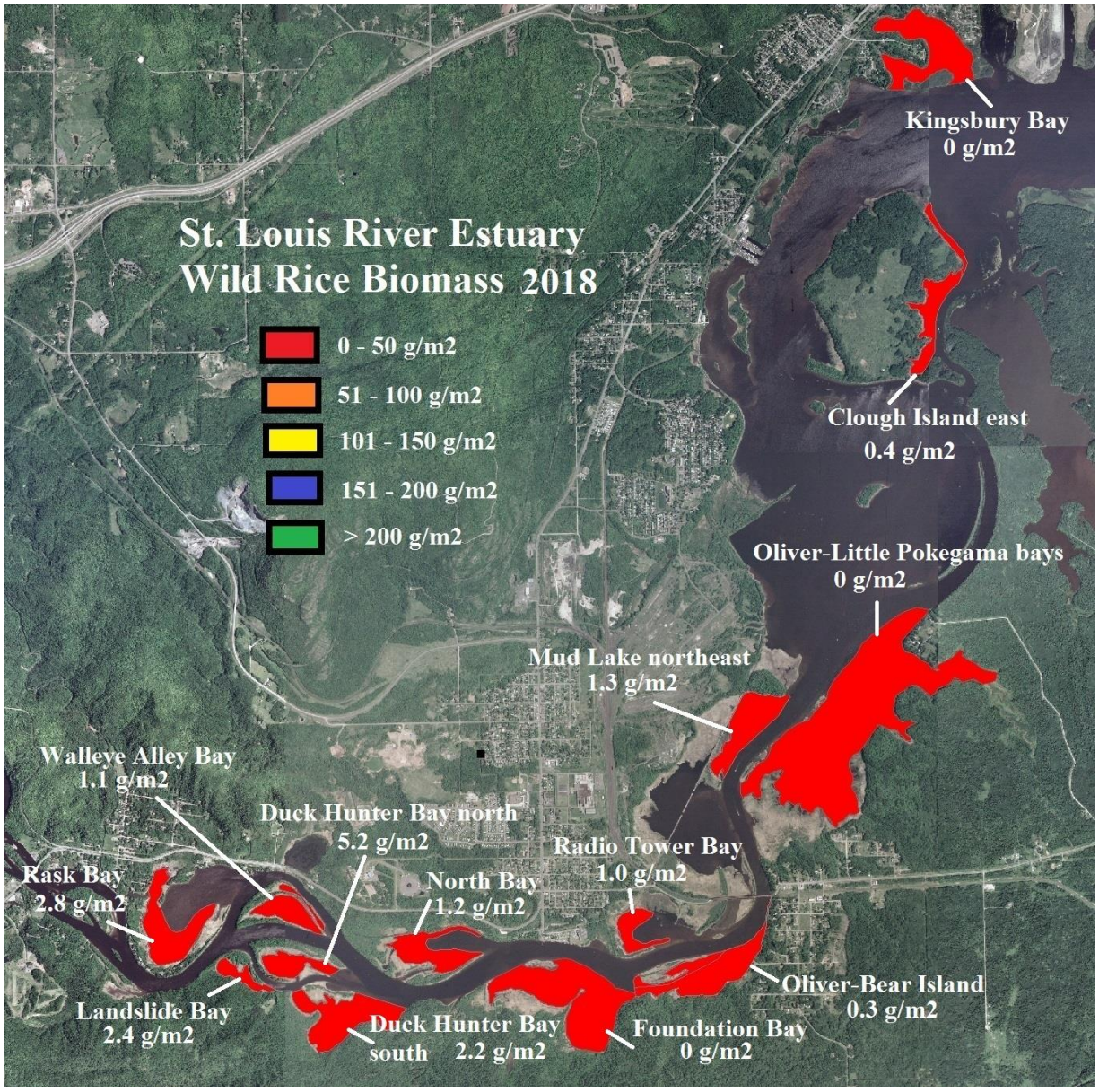

Figure 2: Wild Rice Biomass in Monitored Areas (2018)

Table 7: Average Total Wild Rice Plant Height and Water Depth at Sampling Points, 2018

St. Louis River Estuary	Date	Average Total Plant Height in Inches (range in parentheses)	Average Water Depth in Inches (range in parentheses)
Rask Bay	8/21/2018	51 (44-55)	36 (12-50)
Duck Hunter Bay north	8/22/2018	49 (34-62)	28 (11-45)
Duck Hunter Bay south	8/22/2018	48 (34-68)	38 (10-91)
North Bay	8/28/2018	59 (44-71)	44 (24-72)
Radio Tower Bay	8/23/2018	51 (26-66)	41 (12-73)
Walleye Alley Bay	8/21/2018	49 (37-62)	31 (8-58)
Landslide Bay	8/22/2018	50 (39-64)	36 (10-74)
Oliver-Bear Island	8/23/2018	42 (37-45)	68 (13-217)
Mud Lake northeast	8/29/2018	58 (42-78)	50 (15-216)
Clough Island east	8/30/2018	27 (19-32)	50 (15-101)
* Foundation Bay	8/28/2018	NA	48 (22-80)
* Oliver-Little Pokegama bays	8/29/2018	NA	52 (13-101)
* Kingsbury Bay	8/30/2018	NA	43 (12-66)

*no wild rice restoration work initiated to date at these locations

Table 8: Wild Rice Density and Biomass, 2015-2018

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)
Rask Bay	50	0.6	2.8
Duck Hunter Bay north	21	1.2	5.2
Duck Hunter Bay south	60	0.6	2.2
North Bay	36	0.2	1.2
Radio Tower Bay	18	0.2	1.0
Walleye Alley Bay	25	0.3	1.1
Landslide Bay	11	0.6	2.4
Oliver-Bear Island	62	0.1	0.3
Mud Lake northeast	45	0.2	1.3
Clough Island east	39	0.4	0.4
* Foundation Bay	110	0	0
* Oliver-Little Pokegama bays	300	0	0
* Kingsbury Bay	72	0	0

*no wild rice restoration work initiated to date at these locations

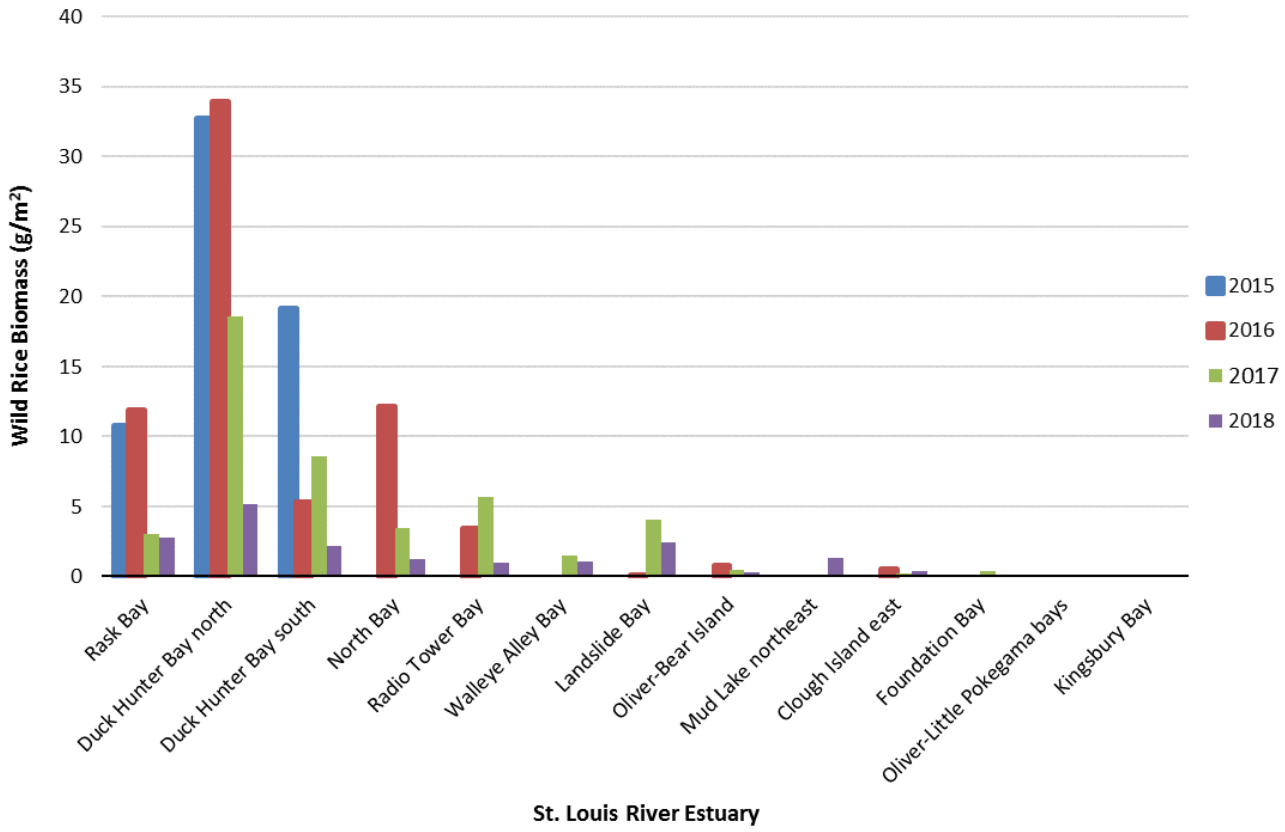

Figure 3: Wild Rice Biomass in Monitored Areas

Discussion

Survey results in 2018 (Table 6, Figure 2) indicate a range of average wild rice biomass from 0.3 grams/m^2 in Oliver-Bear Island, to 5.2 grams/m^2 in Duck Hunter Bay north (not including areas with no restoration work done). A biomass of 5.2 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.

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 2018 were greater than the upper end of this range (Table 7). However, it must be noted that these reported depths were on a single date, and not representative of the entire 2018 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.

In previous years, water elevation information was available at the Oliver bridge courtesy of data from the U.S. Geological Survey (USGS) and Lake Superior National Estuarine Research Reserve (NERR). This location was near the restoration areas and provided a suitable summary of water levels in the upper estuary. However, the USGS gauge was discontinued in October 2017, and the NERR did not have data available for 2018. The next best information for completeness and location is water depth collected (every 15 minutes by data logger) by the NERR in Pokegama Bay. Water depths from 2015 to 2018 (May 1 – October 1 each year) are displayed in Appendix C. Although this does not provide water elevations, it does display relative difference in water depths across years. A comparison of water levels is helpful to understand potential impacts to wild rice growth and restoration success. Water levels in the St. Louis River estuary remained high in 2018, but generally lower than 2017 (perhaps on the order of 8 inches). Higher water levels 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 or 2018.

Annual monitoring results show changes in wild rice density and biomass in each restoration area across years (Table 8, Figure 3). Monitoring completed in 2018 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*[1] was completed in November 2014 through cooperation among numerous partners. Along with identifying possible locations for restoration activities, the plan outlined goals and objectives for wild rice restoration:

[1] Minnesota Department of Natural Resources. 2014. St. Louis River Estuary Wild Rice Restoration Implementation Plan. Division of Ecological and Water Resources. Duluth, Minnesota.

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.

Rask Bay

Wild rice surveys were completed on 8/21/15 (before vegetation cutting that year), 8/25/16, 8/22/17, and 8/21/18. In 2018, sparse wild rice was observed along the west, south, and east shores. Wild rice density and biomass in 2018 was similar to 2017 and declined from levels found in 2015 and 2016. At least one stalk of wild rice was present in 22% of the sampling points. Moderate grazing impact, presumably from geese, was observed during the August 2018 survey. Most leaves and a few wild rice stalks had been nipped off. During a site visit on 7/13/18, sparse to moderate density wild rice was observed along shore in either the floating-leaf stage to standing about one foot. Most standing plants had grazing impact with leaves nipped, but no geese were 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, and 8/22/18. In 2018, sparse areas of wild rice were present across most of the bay. Biomass and density decreased in 2018 and was the lowest observed since surveys beginning in 2015. At least one stalk of wild rice was present in 40% of the sampling points. Moderate to severe grazing impact was observed during the August 2018 survey, with most rice plants nipped (most leaves, some stalks). On the 7/13/18 field visit, sparse wild rice across the bay with moderately dense rice along shore was observed. Rice was floating-leaf to standing about one foot. Most standing plants had been nipped off, but no

geese were observed in the bay. 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. In 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. During the 2016 season, 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). Photo points have been established at four locations.

Duck Hunter Bay south

Wild rice surveys were completed on 8/25/15 (after vegetation cutting that year), 8/23/16, 8/24/17, and 8/22/18. In 2018, 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 decreased from previous years and was the lowest observed since monitoring began in 2015. At least one stalk of wild rice was present in 24% of the sampling points. Grazing impact on wild rice observed during the August 2018 survey was moderate (many leaves and some stalks nipped) and 11 geese were seen in the bay. Impact was high on arrowhead (*Sagittaria sp.*) with most plants nipped off. During the 7/13/18 visit, sparse wild rice was observed with most in the floating-leaf stage and some starting to stand. Some plants had been nipped, and no geese were seen. 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, and 8/28/18. In 2018, sparse wild rice was present along the south and west sides of the bay. Wild rice density and biomass in 2018 declined from the previous two years. At least one stalk of wild rice was present in 11% of the sampling points. Moderate to severe grazing impact was observed during the August 2018 survey, with many rice leaves and stalks nipped. On 7/13/18, sparse wild rice was seen along the south shore and in the northwest corner of the bay, with some plants in floating-leaf stage and others standing about one foot. About half of the leaves had been nipped off, and approximately 42 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, and 8/23/18. In 2018, a few rice plants to sparse areas were found along the south shore, west end, and into the north side. Wild rice density and biomass decreased from the previous two years, and at least one stalk of wild rice was present in 19% of the sampling points. Moderate to severe impacts from grazing were observed during the August 2018 survey, with most wild rice leaves and some stems nipped off. During the 7/13/18 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 about 30 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, and 8/21/18. In 2018, sparse wild rice was found across the bay with similar but slight decline in density and biomass from 2017. At least one stalk of wild rice was present in 22% of the sampling points. Grazing impact on wild rice was moderate (most rice leaves and some stalks nipped) during the August 2018 survey, and eight geese were present in the bay. On 7/13/18, sparse to moderate wild rice was observed across the bay, with some floating-leaf but most standing 12-16 inches. Most wild rice leaves had been nipped, but no 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, and 8/22/18. In 2018, sparse wild rice was present across most of the bay. Wild rice density and biomass declined from 2017, and at least one stalk of wild rice was present in 31% of the sampling points. Moderate to severe grazing impacts on wild rice were observed in August 2018. Most rice leaves and some stalks had been nipped. On 7/13/18, sparse to moderately dense wild rice was observed across most of the bay with some floating-leaf and most standing 12-16 inches. Most plants had been nipped and no 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, and 8/23/18. In 2018, scattered wild rice plants were present across most of the area. Some sparse wild rice was found on the southeast side of Bear Island and along shore. Wild rice density and biomass in 2018 remained low. At least one stalk of wild rice was present in 6% of the sampling points. Grazing impact seen in August 2018 was moderate to severe with most wild rice leaves and some stalks nipped. Seven geese were observed during the August 2018 survey. During a field visit on 7/13/18, sparse wild rice (floating-leaf to standing one foot) was seen across most of the area. Most plants had been clipped and three 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, and 8/29/18. In 2018, scattered wild rice plants were found across most of the restoration area. Wild rice density and biomass remained low, but showed a slight increase from 2016 and 2017 with more rice plants present. At least one stalk of wild rice was present in 15% of the sampling points. Moderate grazing impact was observed in August 2018, and many rice plants had leaves or stems nipped. On the 7/13/18 site visit, sparse wild rice plants (floating-leaf with a few starting to stand) were present across the area. Some plants had been nipped and no 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, and 8/30/18. In 2018, scattered wild rice plants were present along the east side of the island. Wild rice density and biomass remained low, and at least one stalk of wild rice was present in 7% of the sampling points. Moderate grazing impact was observed in August 2018 with many wild rice leaves and stalks nipped. On 7/13/18, sparse wild rice plants were present, with most floating-leaf and a few standing. Some plants had been nipped, and no geese were observed. Photo points have been established at four locations.

Foundation Bay

Wild rice restoration work has not been started in Foundation Bay, but monitoring was initiated in 2017 to track conditions before potential future restoration efforts. Wild rice surveys were completed on 8/29/17 and 8/28/18. In 2018, scattered wild rice plants were found in the northwest portion of the bay, and wild rice was not present in any of the sampling points. Grazing impact seen in August 2018 was minor with leaves nipped and 5 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 and 8/29/18. Some scattered wild rice plants were observed in the inlet/bay on the east side, along the southeast shore, and along the west side of Oliver Bay. Little Pokegama Bay had scattered wild rice plants on the north and east sides. Wild rice was not present in any of the sampling points. Minor grazing impact was observed in August 2018 with some wild rice leaves and stalks nipped. 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 and 8/30/18. Scattered wild rice plants were located near the campground point. Wild rice was not present in any of the sampling points. The existing wild rice plants had moderate grazing impact with some leaves observed to be nipped during the August 2018 survey. 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 2018, 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, most 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 9). 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 9: 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.

Summary

The 1854 Treaty Authority completed a monitoring program in 2015-2018 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 2018. Due to the inability to acquire wild rice seed, no restoration actions were completed in 2018. Monitoring of these restoration areas in 2019 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.

Acknowledgments

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Guy Anderson – Wild Rice Aide, 1854 Treaty Authority
Tony Anselmo – Fish and Wildlife Technician, 1854 Treaty Authority
Saranda Oestreicher – Fish and Wildlife Technician, 1854 Treaty Authority
Charlie Potvin – Cultural Preservation Aide, 1854 Treaty Authority
Jason Stevens – Wild Rice Aide, 1854 Treaty Authority
Jeremy Bloomquist - Land and Water Resources Manager, St. Croix Band
Daryl Peterson – Director of Restoration Programs, Minnesota Land Trust
Joseph Sprenger – Aircraft Pilot, Wisconsin Department of Natural Resources

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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)

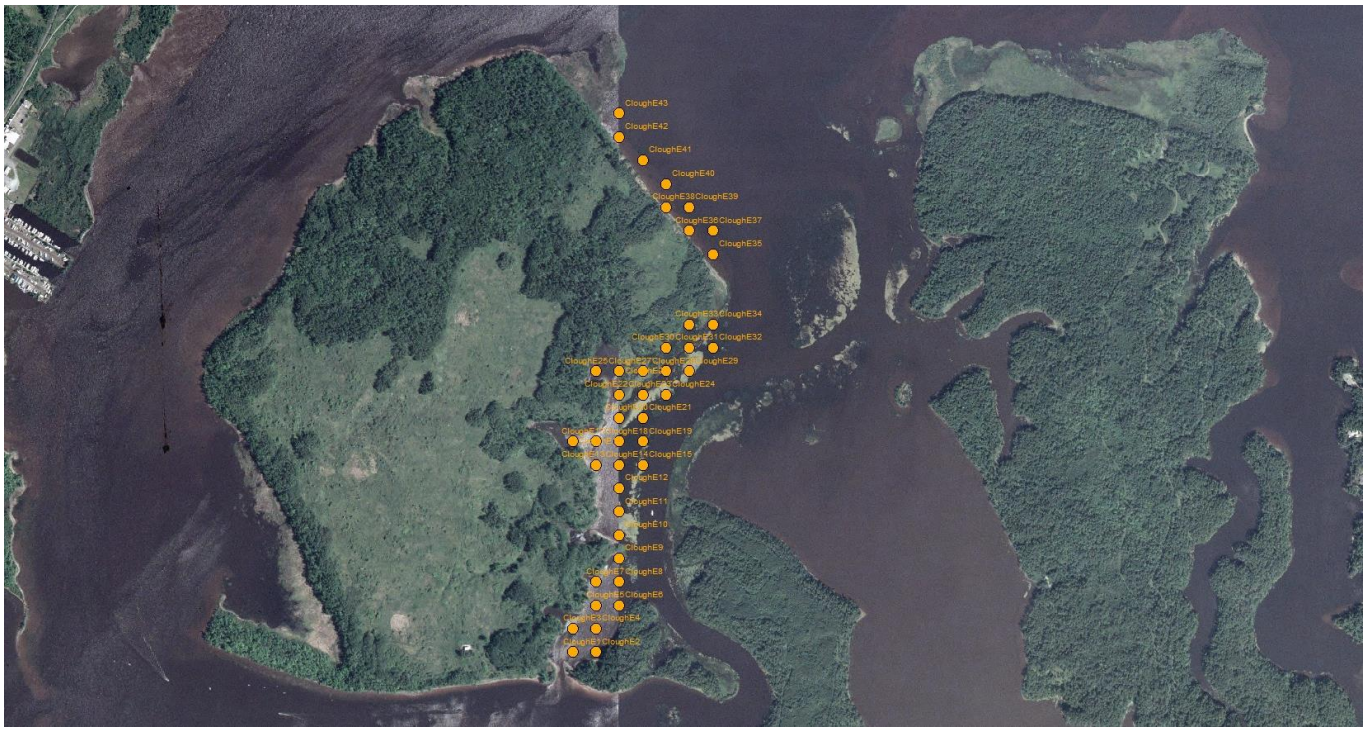


Figure A-10: Monitoring Points in Clough Island east (43 points, 60 m grid)

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)

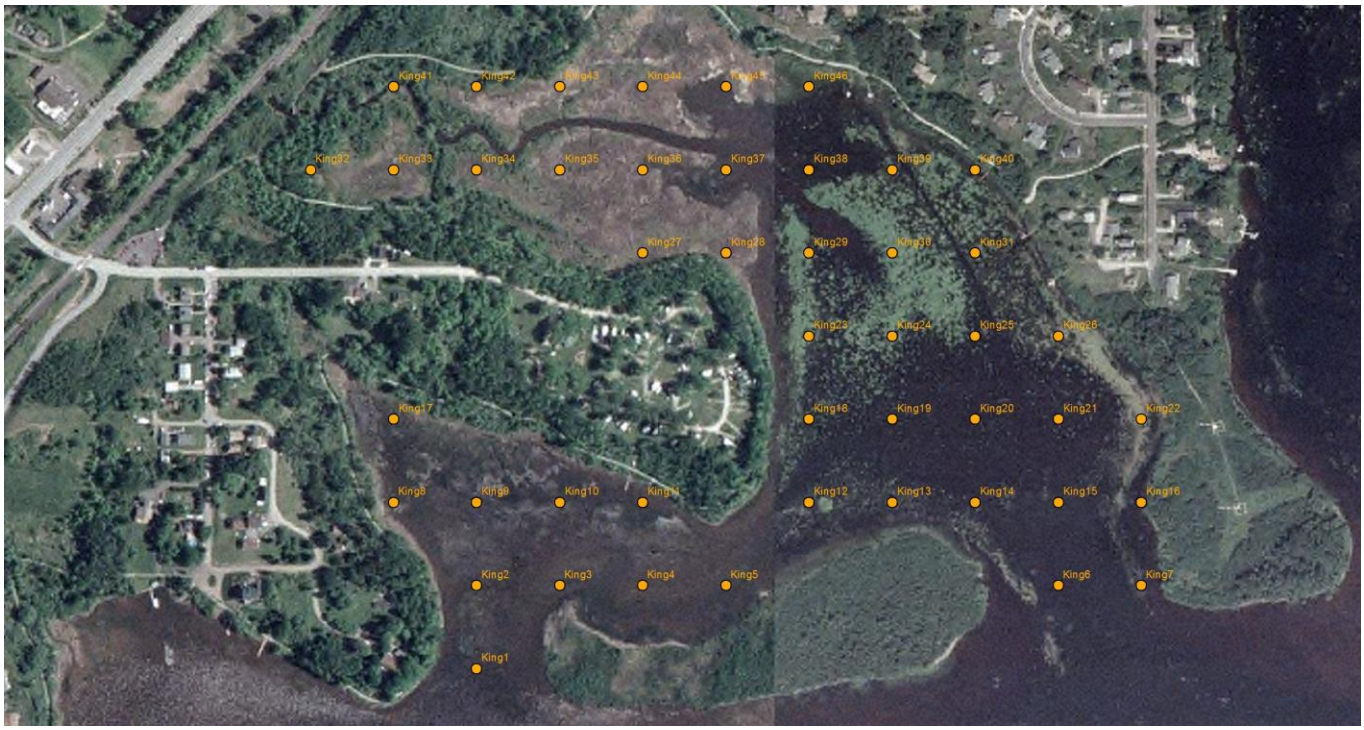
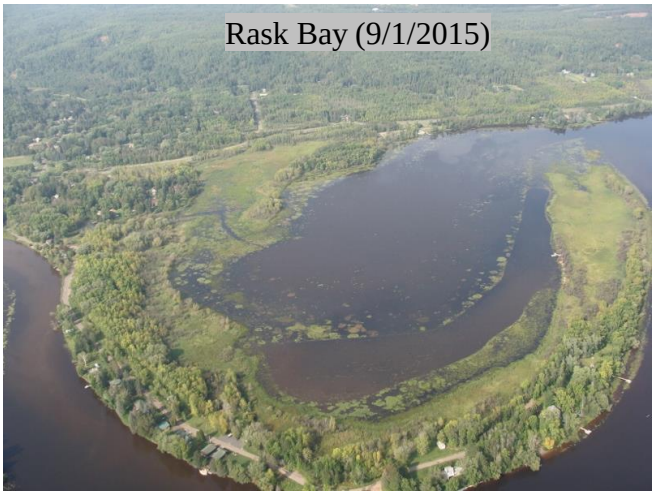


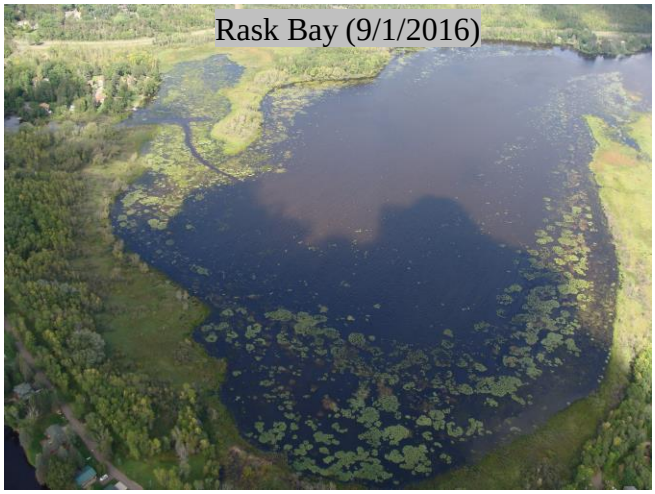
Figure A-13: Monitoring Points in Kingsbury Bay (46 points, 80 m grid)
(several points in north part of bay inaccessible in 2017-2018 due to bog/cattail, potential open water in future after planned restoration work)

Appendix B

Aerial Photographs

Rask Bay (2015-2018)





Duck Hunter Bay north (2015-2018)

Duck Hunter Bay south (2015-2018)


Duck Hunter Bay south (9/1/2015)


Duck Hunter Bay south (9/1/2016)


Duck Hunter Bay south (8/31/2017)


Duck Hunter Bay south (8/30/2018)

North Bay (2015-2018)

Radio Tower Bay (2015-2018)

Walleye Alley Bay (2016-2018)

Walleye Alley Bay (9/1/2016)

Walleye Alley Bay (8/31/2017)

Walleye Alley Bay (8/30/2018)

Landslide Bay (2016-2018)

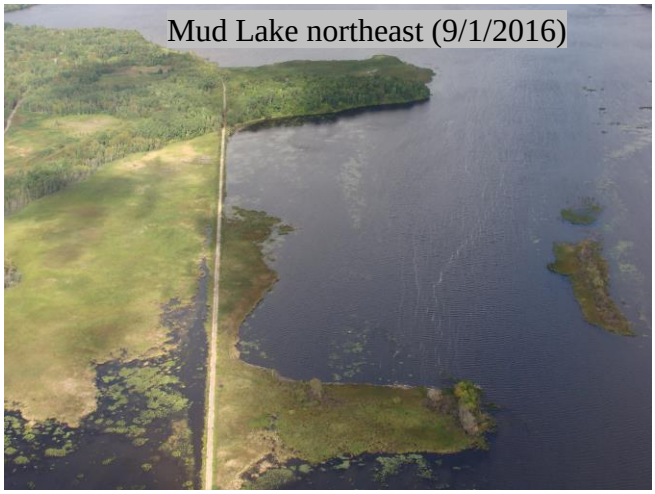

Landslide Bay (9/1/2016)


Landslide Bay (8/31/2017)


Landslide Bay (8/30/2018)

Oliver-Bear Island (2016-2018)

Mud Lake northeast (2016-2018)



Clough Island east (2016-2018)


Clough Island east (9/1/2016)


Clough Island east (8/31/2017)


Clough Island east (8/30/2018)

Foundation Bay (2017-2018)


Foundation Bay (8/31/2017)


Foundation Bay (8/30/2018)

Oliver-Little Pokegama (2017-2018)


Oliver – Little Pokegama (8/31/2017)


Oliver – Little Pokegama (8/30/2018)

Kingsbury Bay (2017-2018)

Appendix C

Water Depth in Pokegama Bay

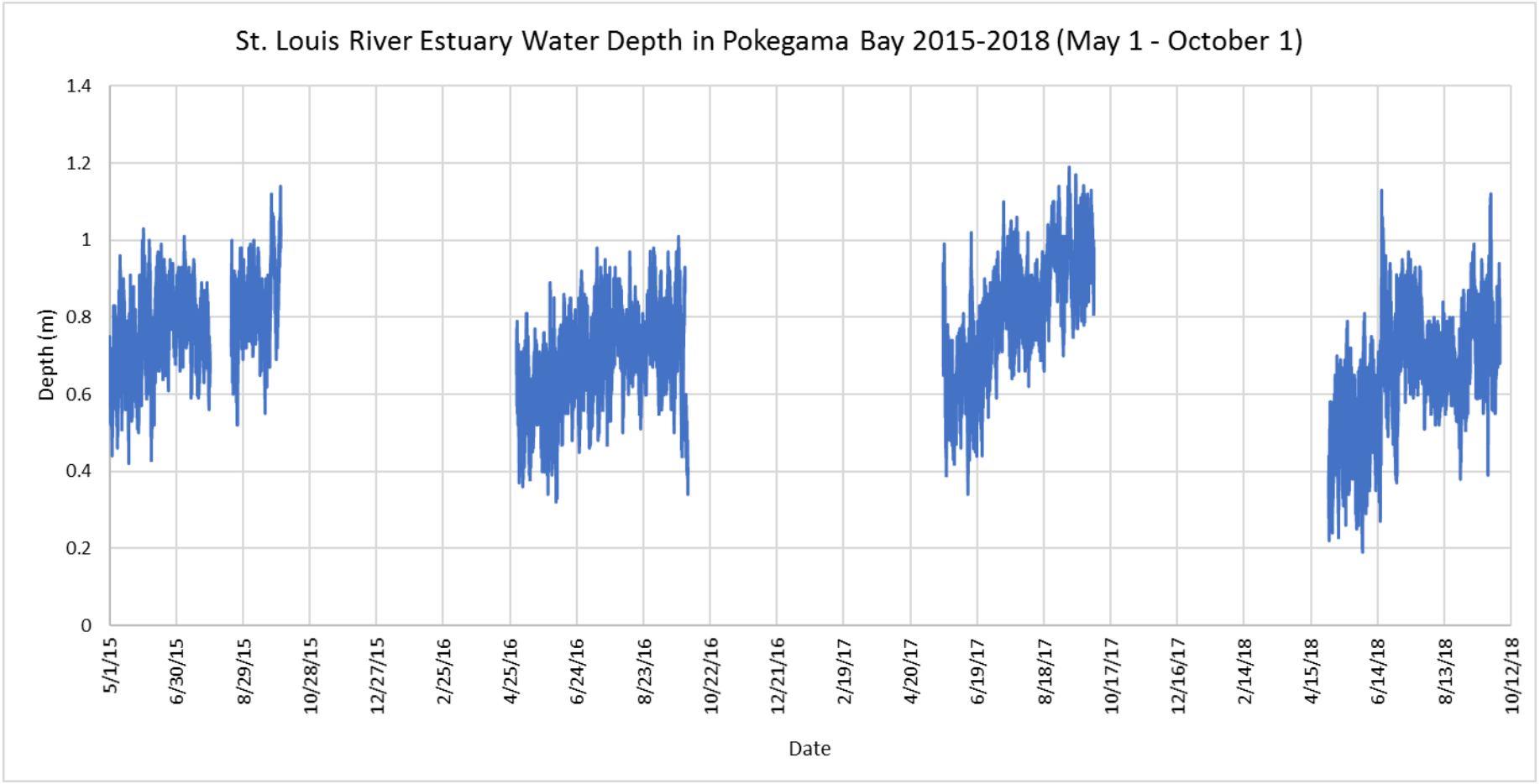


Figure C-1: Water Depth in Pokegama Bay
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program)