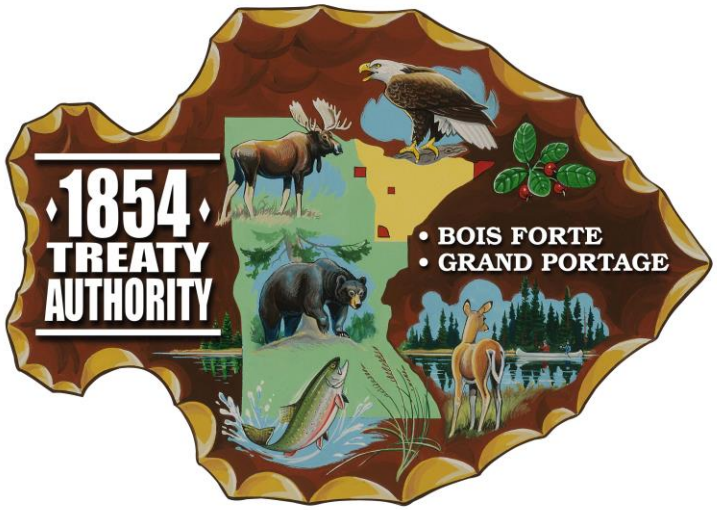

St. Louis River Estuary Wild Rice Restoration Monitoring (2015-2017)

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Technical Report 17-09
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Introduction

In 2015-2017, 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 2015-2017. The purpose of the monitoring program is to document the success of wild rice restoration.

Wild rice monitoring sites included:

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

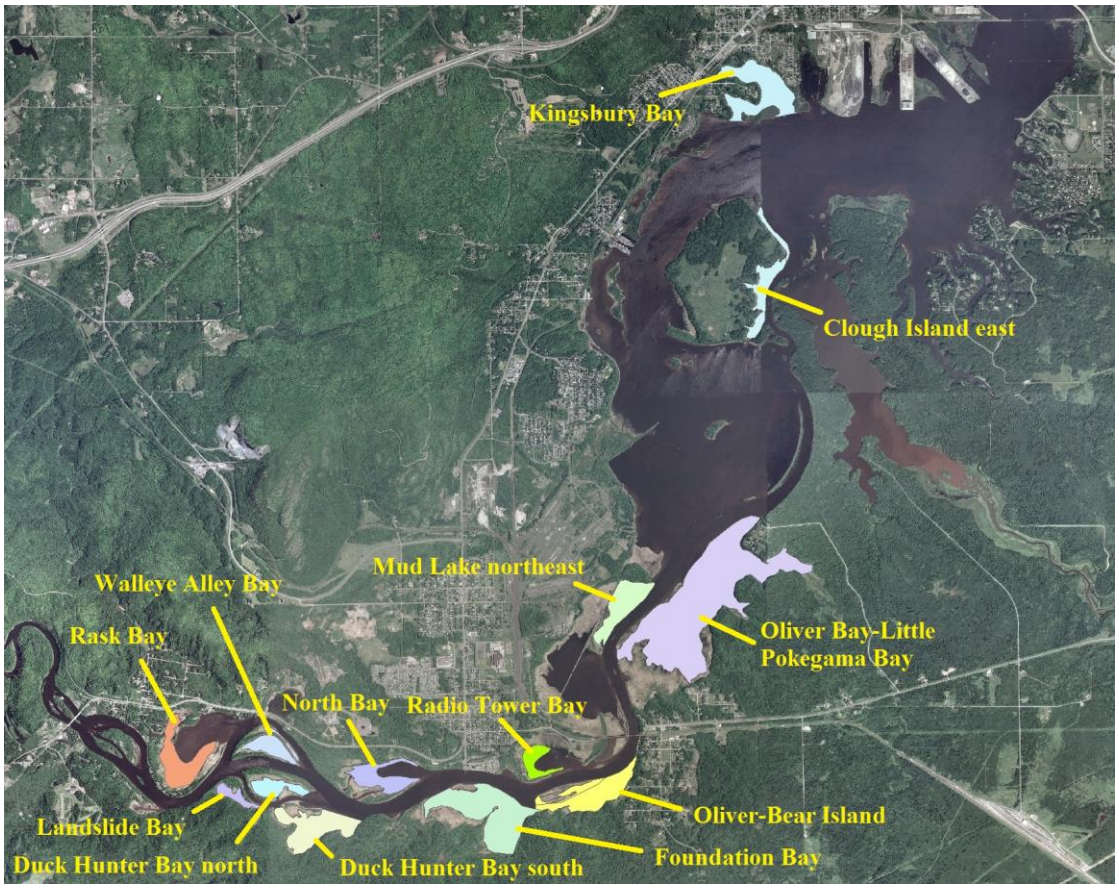

Figure 1: Wild Rice Monitoring in the St. Louis River Estuary

Wild Rice Restoration Overview

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

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 4). 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 2015-2017. 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), and 2017 (8/31/2017). 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 4: Wild Rice Density and Biomass, 2017

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	0.7 (0-5)	3.0
Duck Hunter Bay north	21	35	4.3 (0-15)	18.6
Duck Hunter Bay south	60	42	1.7 (0-20)	8.6
North Bay	36	36	0.5 (0-3)	3.5
Radio Tower Bay	18	28	1.0 (0-6)	5.7
Walleye Alley Bay	25	41	0.5 (0-2)	1.5
Landslide Bay	11	29	1.2 (0-5)	4.1
Oliver-Bear Island	62	47	0.1 (0-2)	0.5
Mud Lake northeast	45	41	0.05 (0-1)	0.1
Clough Island east	39	42	0.02 (0-1)	0.2
* Foundation Bay	110	44	0.1 (0-2)	0.4
* Oliver-Little Pokegama bays	300	37	0.03 (0-1)	0.1
* Kingsbury Bay	72	46	0 (0)	0

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

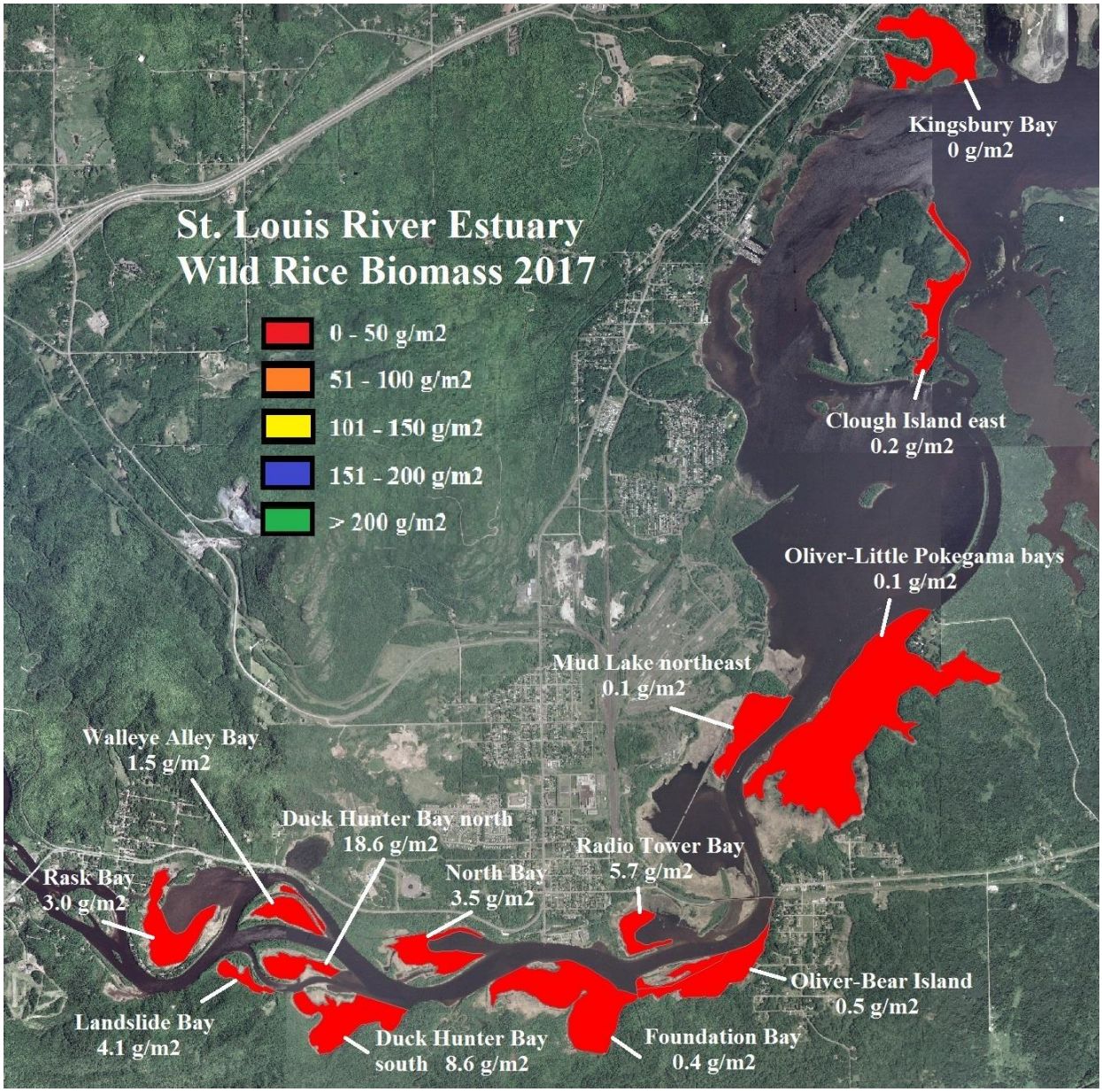

Figure 2: Wild Rice Biomass in Monitored Areas (2017)

Table 5: Average Total Wild Rice Plant Height and Water Depth at Sampling Points, 2017

St. Louis River Estuary	Date	Average Total Plant Height in Inches (range in parentheses)	Average Water Depth in Inches (range in parentheses)
Rask Bay	8/22/2017	50 (34-69)	39 (25-54)
Duck Hunter Bay north	8/24/2017	51 (38-67)	37 (20-54)
Duck Hunter Bay south	8/24/2017	58 (44-76)	47 (22-91)
North Bay	8/28/2017	60 (41-73)	49 (30-82)
Radio Tower Bay	8/30/2017	58 (25-82)	59 (13-104)
Walleye Alley Bay	8/28/2017	45 (37-58)	41 (16-57)
Landslide Bay	8/22/2017	45 (24-60)	41 (16-85)
Oliver-Bear Island	8/29/2017	48 (39-61)	75 (24-320)
Mud Lake northeast	8/30/2017	40 (32-48)	64 (32-294)
Clough Island east	9/6/2017	63 (63)	53 (18-102)
* Foundation Bay	8/29/2017	55 (48-61)	56 (35-92)
* Oliver-Little Pokegama bays	8/30/2017	47 (47)	62 (30-114)
* Kingsbury Bay	8/31/2017	NA	52 (24-80)

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

Table 6: Wild Rice Density and Biomass, 2015-2017

		2015		2016		2017	
St. Louis River Estuary	Acres Monitored	Avg # stalks per 1/2 m²	Biomass (g/m²)	Avg # stalks per 1/2 m²	Biomass (g/m²)	Avg # stalks per 1/2 m²	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

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

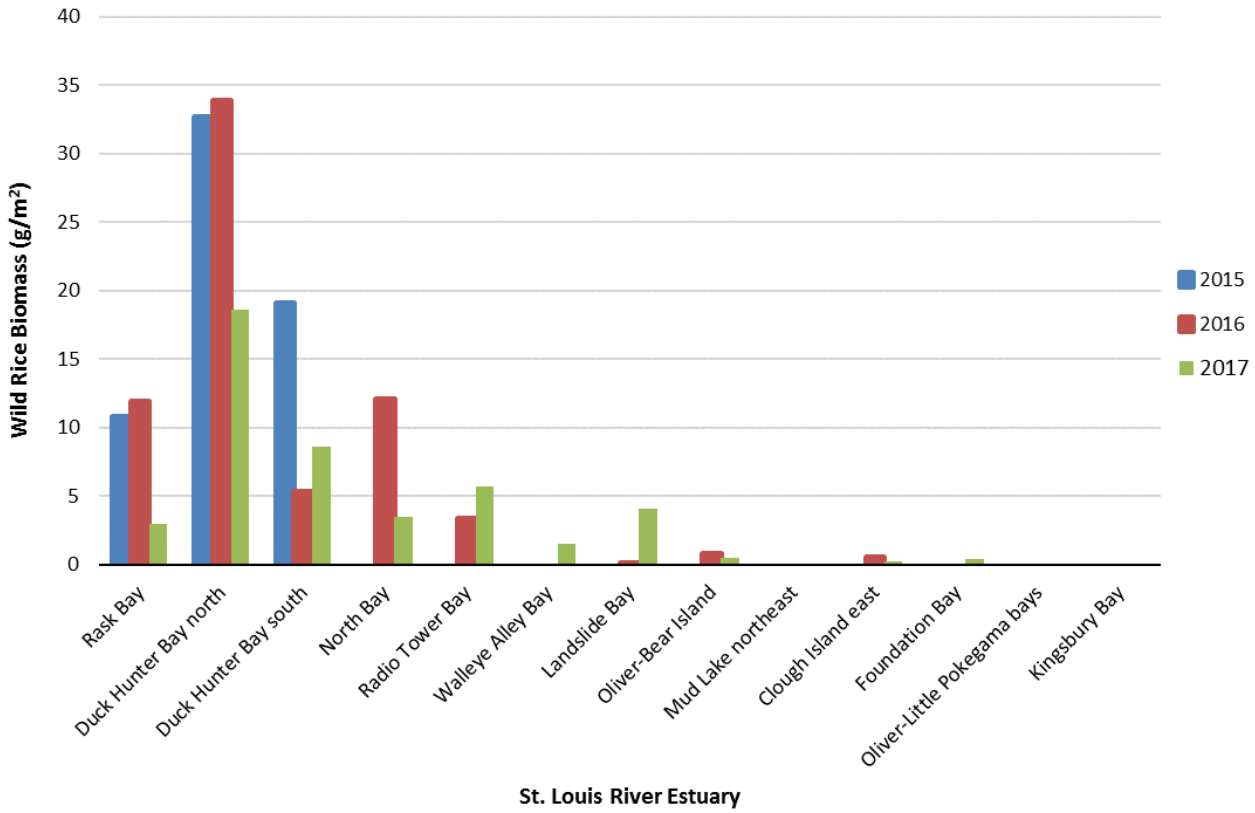

Figure 3: Wild Rice Biomass in Monitored Areas

Discussion

Survey results in 2017 (Table 4, Figure 2) indicate a range of average wild rice biomass from 0.1 grams/m^2 in Mud Lake northeast, to 18.6 grams/m^2 in Duck Hunter Bay north (not including areas with no restoration work done). A biomass of 18.6 grams/m^2 is still 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 2017 were greater than the upper end of this range (Table 5). However, it must be noted that these reported depths were on a single date, and not representative of the entire 2017 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. Water levels in the St. Louis River estuary were high in 2017, and likely affected wild rice growth and restoration success. Water elevation at the Oliver bridge courtesy of data from the U.S. Geological Survey (Figure 4)

is available for July 31 – October 1, 2017. This location is near the restoration areas and provides a suitable summary of water levels in the upper estuary.

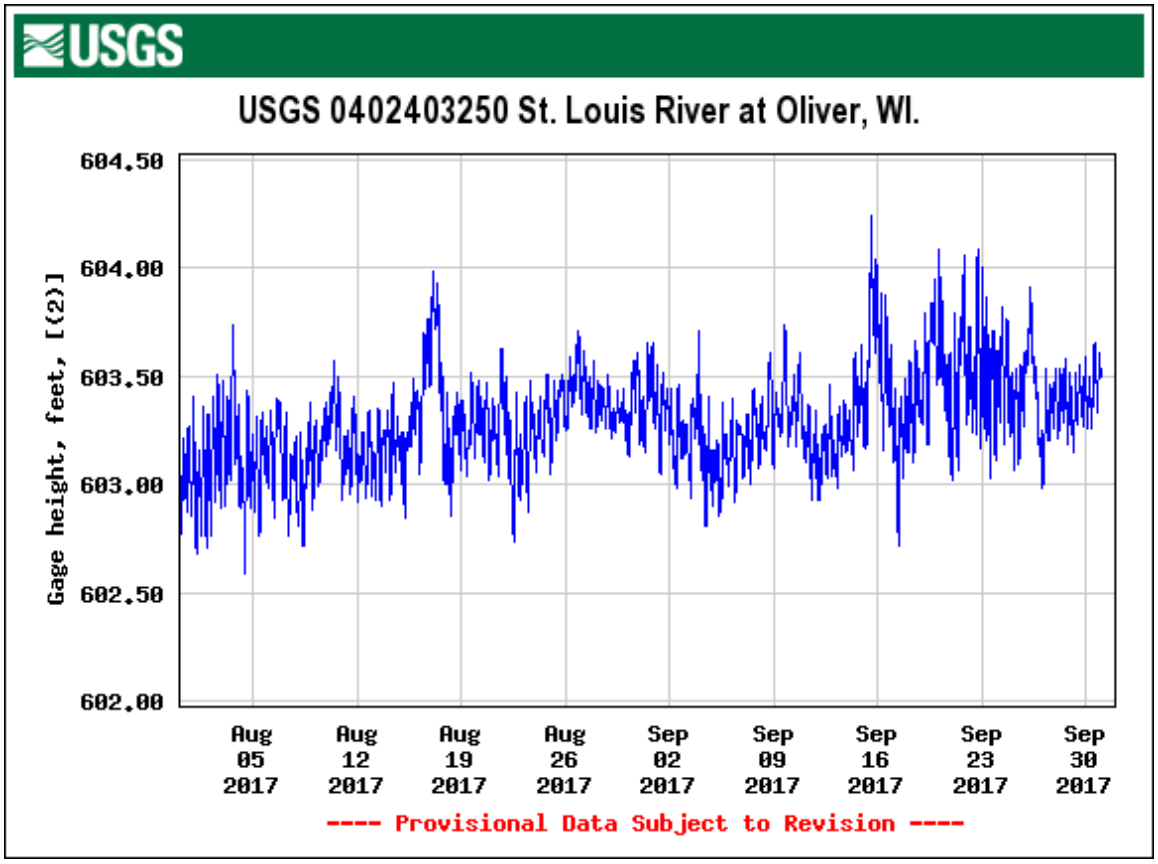

Figure 4: Water Elevation in St. Louis River Estuary 2017 (Oliver Bridge), USGS

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 at the Oliver bridge, and depths from 2015 to 2017 (May 1 – October 1 each year) are displayed in Appendix C. Pairing this information with the USGS data can allow for a calculation of water elevations over this time, 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 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.

Annual monitoring results show changes in wild rice density and biomass in each restoration area across years (Table 6, Figure 3). Monitoring completed in 2017 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:

> *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.

Impacts from geese on wild rice are a concern in the St. Louis River Estuary. In July 2017, 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. Most or all standing wild

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

rice plants had been nipped off, likely by geese. Further observations of impacts from geese are included in discussion below on each restoration area. These impacts are difficult to quantify, but likely affect monitoring results and restoration success.

Rask Bay

Wild rice surveys were completed on 8/21/15 (before vegetation cutting that year), 8/25/16, and 8/22/17. In 2017, sparse wild rice was observed along the west, south, and east shores. Some small areas of moderate density rice were present in the north arm and near shore on the south end. Wild rice density and biomass in 2017 declined from similar levels found in 2015 and 2016. At least one stalk of wild rice was present in 33% of the sampling points. Moderate to severe grazing impact, presumably from geese, was observed during the August 2017 survey. Most wild rice plants, either the leaves or the stalk, had been nipped off along with most arrowhead (*Sagittaria sp.*) plants. Plants were generally short and still developing seeds. During a site visit on 7/19/17, moderate density wild rice was observed in either the floating-leaf stage to standing about one foot. Most or all standing plants had grazing impact, and about 10 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, and 8/24/17. In 2017, sparse to moderate areas of wild rice were present across most of the bay. Although biomass and density decreased in 2017, at least one stalk of wild rice was present in 77% of the sampling points. Moderate to severe grazing impact was observed during the August 2017 survey, with most rice plants nipped off (many just the leaves, some stalks). Many rice plants were short with seeds still developing. On the 7/19/17 field visit, moderately dense wild rice was observed across most of the bay. Most rice was still floating-leaf, with some standing about one foot. Most standing plants had been nipped off, and eight geese were observed in the bay with another five at the mouth of the bay. 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 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, and 8/24/17. In 2017, sparse wild rice was observed around most of the bay, with some moderate density rice near shore on the southwest side and in the northwestern end. Wild rice density and biomass in 2017 increased from 2016. At least one stalk of wild rice was present in 39% of the sampling points. Grazing impact on wild rice observed during the August 2017 survey was moderate, and 16 geese were seen in the bay. Rice plants were standing 1-2 feet and developing seeds. Impact was high on arrowhead with most plants nipped off. During the 7/19/17 visit, sparse wild rice was observed with some areas of moderate density. Most rice was in the floating-leaf stage, with some starting to stand.

Nearly all arrowhead plants had been nipped off. 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, and 8/28/17. In 2017, sparse wild rice was present along the south and west sides of the bay. Wild rice density and biomass in 2017 declined from 2016. At least one stalk of wild rice was present in 25% of the sampling points. Moderate to severe grazing impact was observed during the August 2017 survey, with most rice plants nipped (leaves, stems, broken stems). Almost all arrowhead plants were nipped off. Many rice plants were short and still developing seeds. On 7/19/17, sparse to moderate wild rice was seen in the restoration areas. Rice was floating-leaf to standing 12-16 inches, with many of the standing plants nipped off. About 12 geese were observed 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, and 8/30/17. In 2017, sparse wild rice was found along the south shore, west end, and into the north side. Wild rice biomass increased from 2016, and at least one stalk of wild rice was present in 41% of the sampling points. Moderate to severe impacts from grazing were observed during the August 2017 survey, with many leaves and some stems nipped off. Many areas contained sparse wild rice, but much was short, laying in water, or nipped off. Some rice was still in floating-leaf stage. During the 7/19/17 site visit, sparse floating-leaf wild rice was found in the restoration area. 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) and 8/28/17. In 2017, sparse wild rice was found across the bay and showed an increase biomass from 2016. At least one stalk of wild rice was present in 34% of the sampling points. Grazing impact on wild rice was moderate to severe, with most rice plants nipped (leaves, some stems) during the August 2017 survey. Not much arrowhead was present in the bay, but any plants present were nipped off. Rice plants were short and late developing. On 7/19/17, many areas of the bay were observed to contain moderately dense wild rice. Rice was floating-leaf to standing about one foot, and most standing plants were nipped off. Photo points have been established at six locations.

Landslide Bay

Wild rice surveys were completed on 8/30/16 (after vegetation cutting that year) and 8/22/17. In 2017, sparse wild rice was present across most of the bay, with some areas of moderate density on the west end and in the northern arm. Wild rice biomass increased from 2016, and at least one stalk of wild rice was present in 41% of the sampling points. Moderate to severe grazing impacts on wild rice were observed in August 2017. Most rice plants had been nipped, either leaves or the stalks. Existing rice plants were short. On 7/19/17, moderately dense wild rice was observed in the north half of the bay. Rice was floating-leaf stage to standing about one foot, and most standing rice plants had been

nipped off. Six geese were seen in the bay. 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) and 8/29/17. In 2017, scattered wild rice plants were present across most of the area. Some sparse to moderately dense wild rice was found on the southeast side of Bear Island. Wild rice biomass in 2017 was similar to 2016 and remained low. At least one stalk of wild rice was present in 11% of the sampling points. Grazing impact seen in August 2017 was moderate to severe with many plants having leaves or stalks nipped. Many plants present were late in developing (short, just out of floating-leaf stage, underwater). During a field visit on 7/19/17, a few floating-leaf plants were found in the Oliver area and sparse floating-leaf plants near Bear Island. About 30 geese were observed. 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) and 8/30/17. No wild rice was observed in 2016, but scattered wild rice plants were found across most of the restoration area in 2017. At least one stalk of wild rice was present in 5% of the sampling points. Moderate grazing impact was observed in August 2017, and many rice plants had leaves or stems nipped. Many wild rice plants were short or still in floating-leaf stage. On the 7/19/17 site visit, sparse floating-leaf wild rice plants were present across the area. Photo points have been established at three locations.

Clough Island east

Wild rice surveys were completed on 8/31/16 and 9/6/17. No vegetation treatment has occurred in this area, and seeding was completed each fall 2015-2017. In 2017, scattered wild rice plants were present along the east side of the island. Wild rice biomass decreased slightly from 2016, and at least one stalk of wild rice was present in 2% of the sampling points. Only minor grazing impact was observed in September 2017 with some wild rice leaves nipped. Existing plants were generally taller in this restoration area than most others. 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. A wild rice survey was completed on 8/29/17. Scattered wild rice plants were located along the south shore of the bay, and at least one stalk of wild rice was present in 5% of the sampling points. Grazing impact seen in August 2017 was minor. Many wild plants had leaves nipped but not stalks. Wild rice plants were generally taller in this area than most other restoration sites. 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. A wild rice survey was completed on 8/30/17. Some scattered wild rice plants were observed in the inlet/bay on the east side, along the south shore, and along the northeast side of Oliver Bay. Little Pokegama Bay had sparse wild rice plants across the eastern end. At least one stalk of wild rice was present in 3% of the sampling points. Minor grazing impact was observed in August 2017 in Little Pokegama Bay, with some wild rice leaves 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. A wild rice survey was completed on 8/31/17. Scattered wild rice plants were located around the campground point, and along the north side of the island. Wild rice was not present in any of the sampling points. The existing wild rice plants had moderate grazing impact with some observed to be nipped during the August 2017 survey. Photo points have been established at five locations.

Summary

The 1854 Treaty Authority completed a monitoring program in 2015-2017 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 2017. Many rice plants were short and late in developing when observed in August. Several possible explanations exist for the condition of wild rice plants: these were later germinating plants and earlier plants were removed/impacted by geese; plants were recovering from geese impacts earlier in season; impacts from high water. Restoration actions completed in 2017 included wild rice seeding in ten restoration areas. Success will be determined by wild rice growth in subsequent years. Monitoring of these restoration areas in 2018 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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Jeffrey Flory - Invasive Species Technician, 1854 Treaty Authority
Josh Mutchler - Fish and Wildlife Aide, 1854 Treaty Authority
Cassie Taplin - Invasive Species Aide, 1854 Treaty Authority
Kelsey Wenner - Invasive Species Technician, 1854 Treaty Authority

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)

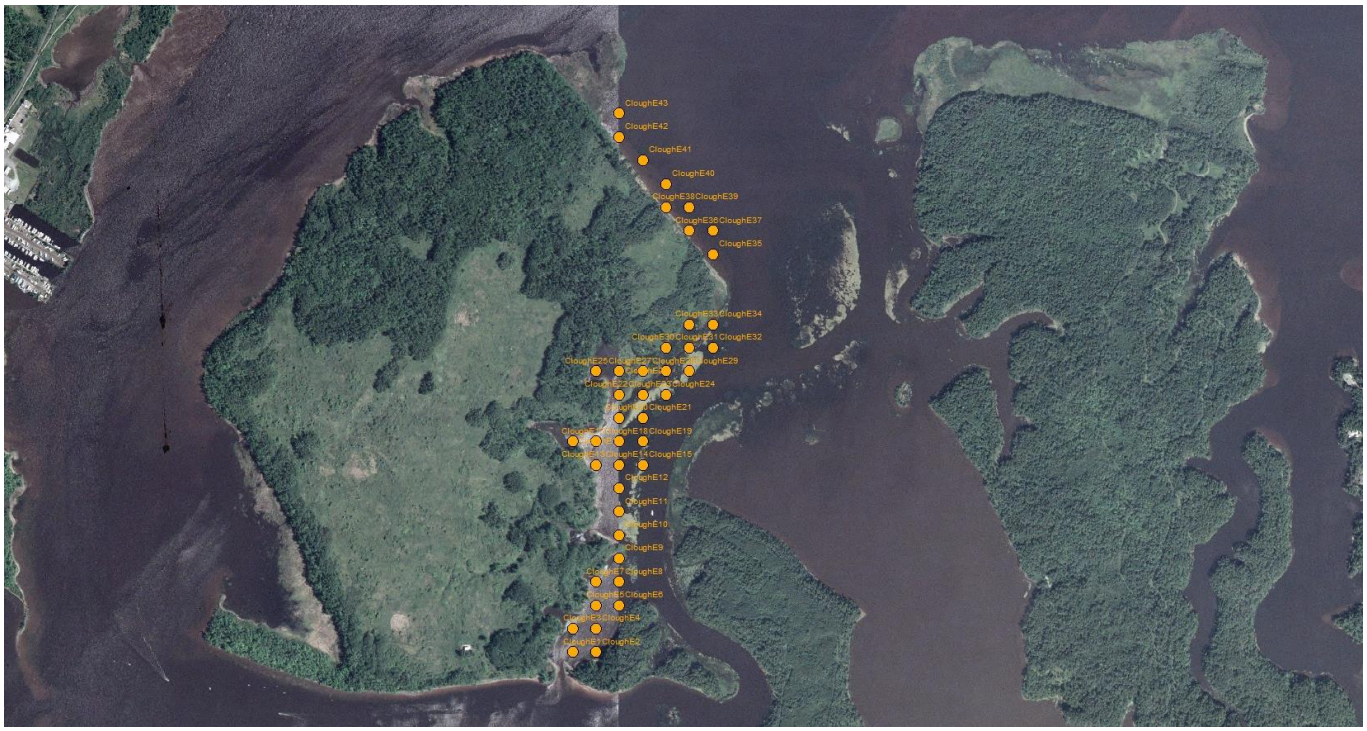


Figure A-10: Monitoring Points in Clough Island east (43 points, 60 m grid)

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)

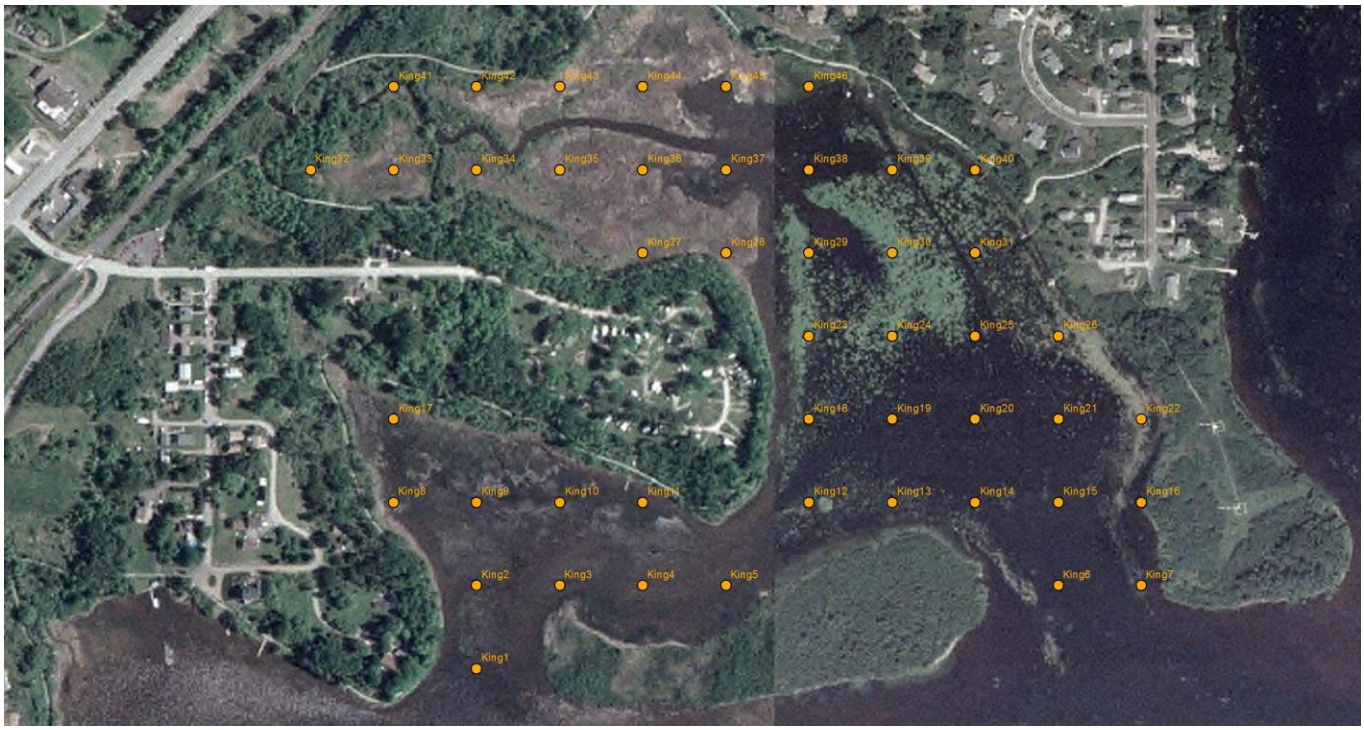
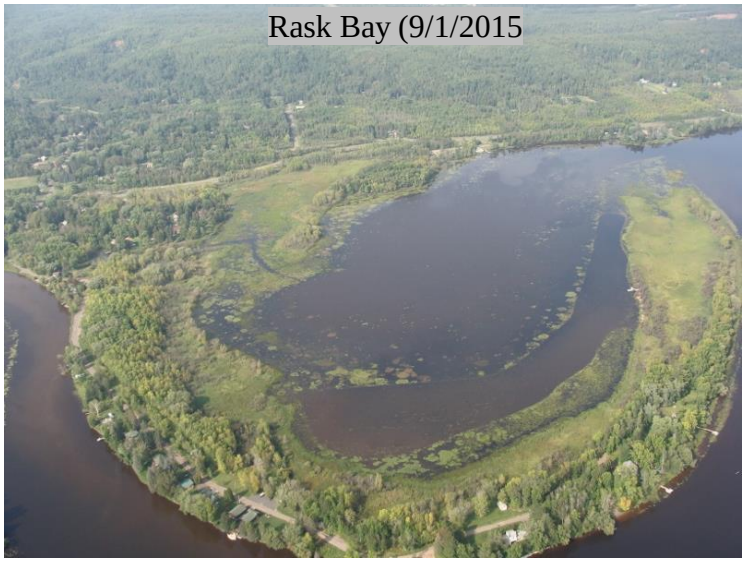


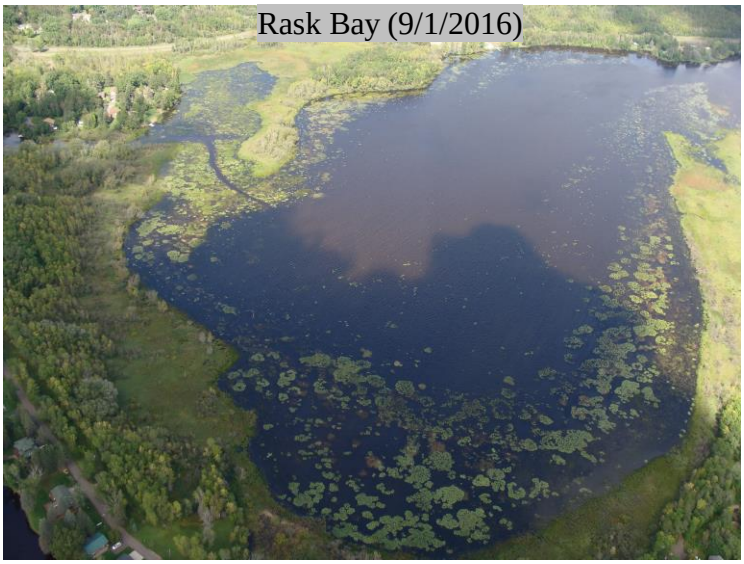
Figure A-13: Monitoring Points in Kingsbury Bay (46 points, 80 m grid)
(several points in north part of bay inaccessible in 2017 due to bog/cattail, potential open water in future after planned restoration work)

Appendix B

Aerial Photographs



Rask Bay (9/1/2015



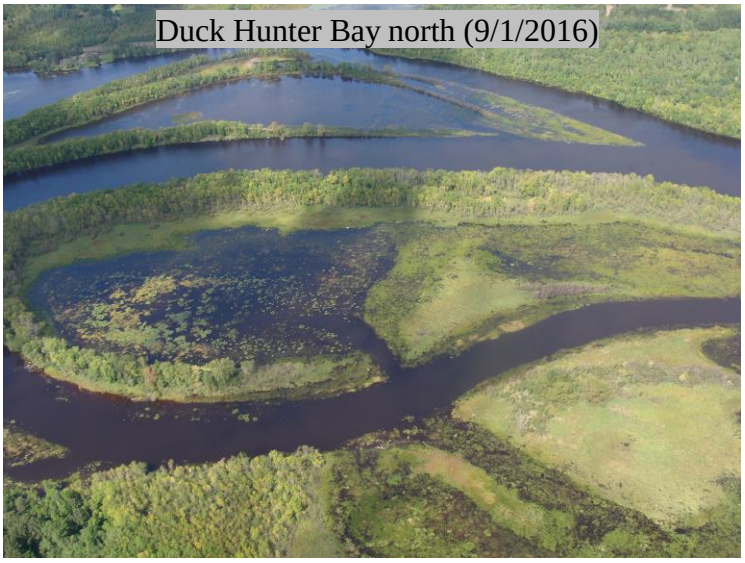
Rask Bay (9/1/2016)

Rask Bay (8/31/2017)

Rask Bay
(2015-2017)

Duck Hunter Bay north (9/1/2015)

Duck Hunter Bay north
(2015-2017)

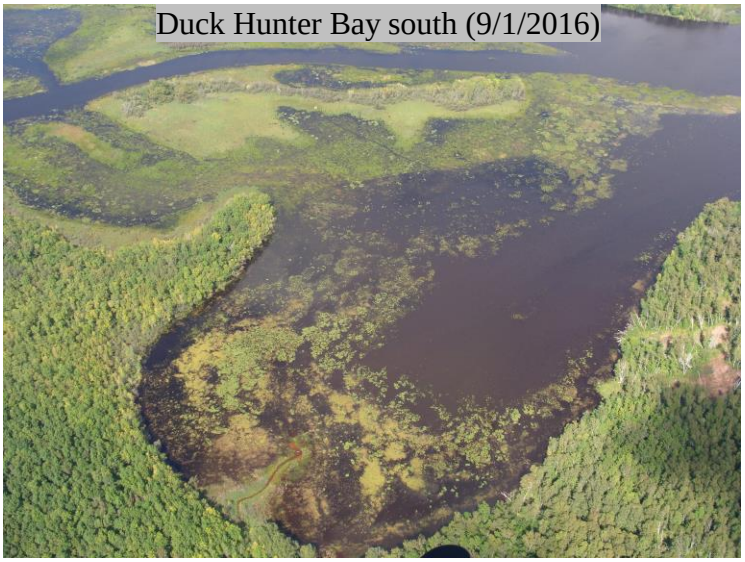


Duck Hunter Bay north (9/1/2016)

Duck Hunter Bay north (8/31/2017)

Duck Hunter Bay south (9/1/2015)

Duck Hunter Bay south
(2015-2017)



Duck Hunter Bay south (9/1/2016)

Duck Hunter Bay south (8/31/2017)

North Bay (9/1/2015)

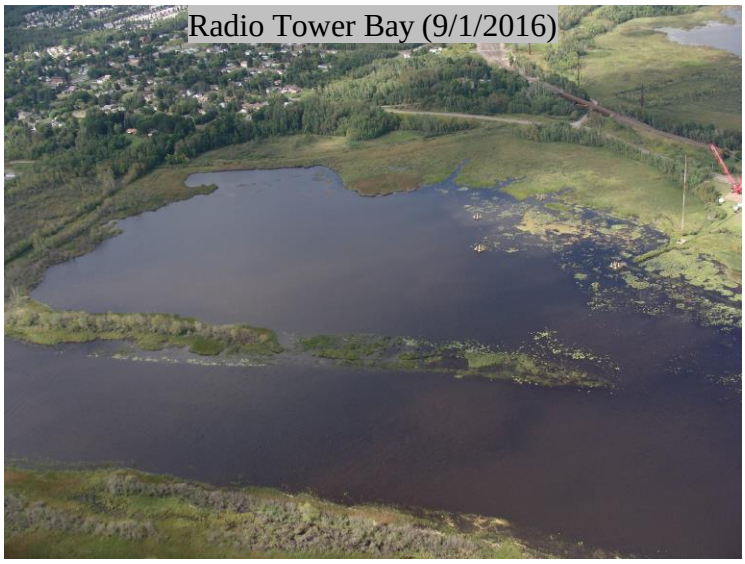
North Bay (9/1/2016)

North Bay (8/31/2017)

North Bay
(2015-2017)

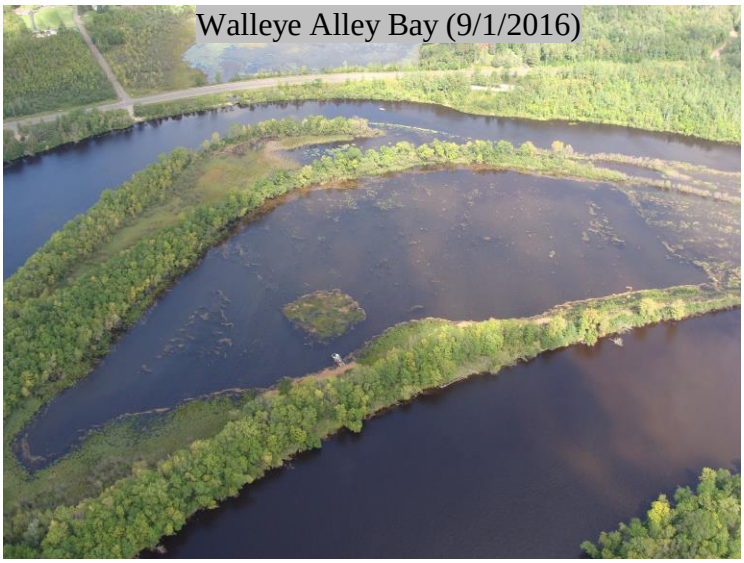
Radio Tower Bay (9/1/2015)

Radio Tower Bay (9/1/2016)



Radio Tower Bay (8/31/2017)

Radio Tower Bay
(2015-2017)



Walleye Alley Bay (9/1/2016)

Walleye Alley Bay
(2016-2017)

Walleye Alley Bay (8/31/2017)

Landslide Bay (9/1/2016)

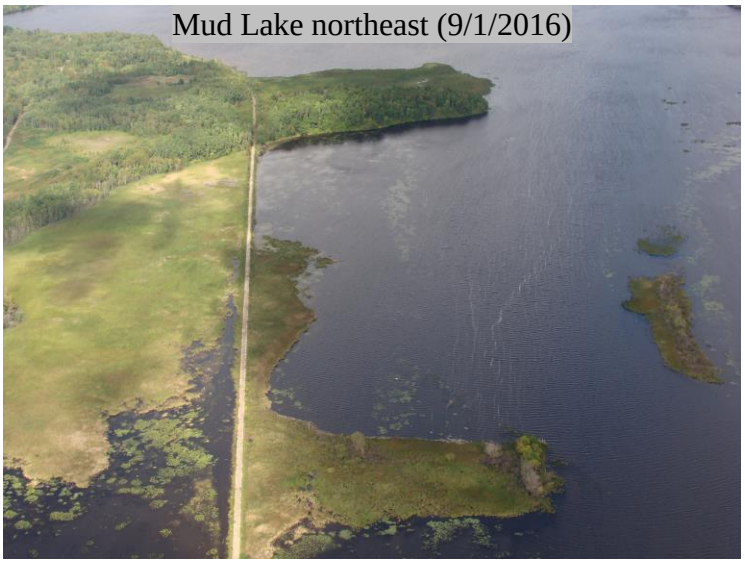
Landslide Bay
(2016-2017)

Landslide Bay (8/31/2017)

Oliver-Bear Island (9/1/2016)

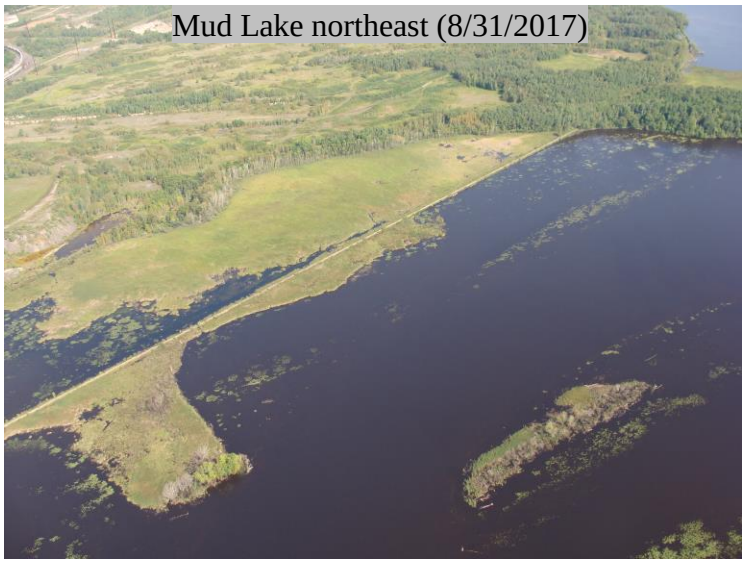
Oliver-Bear Island
(2016-2017)

Oliver-Bear Island (8/31/2017)



Mud Lake northeast (9/1/2016)

Mud Lake northeast
(2016-2017)



Mud Lake northeast (8/31/2017)

Clough Island east (9/1/2016)

Clough Island east
(2016-2017)

Clough Island east (8/31/2017)

Foundation Bay (8/31/2017)

Foundation Bay
(2017)

Oliver – Little Pokegama (8/31/2017)

Oliver-Little Pokegama
(2017)

Kingsbury Bay (8/31/2017)

Kingsbury Bay
(2017)

Appendix C

Water Depth and Elevation at Oliver Bridge

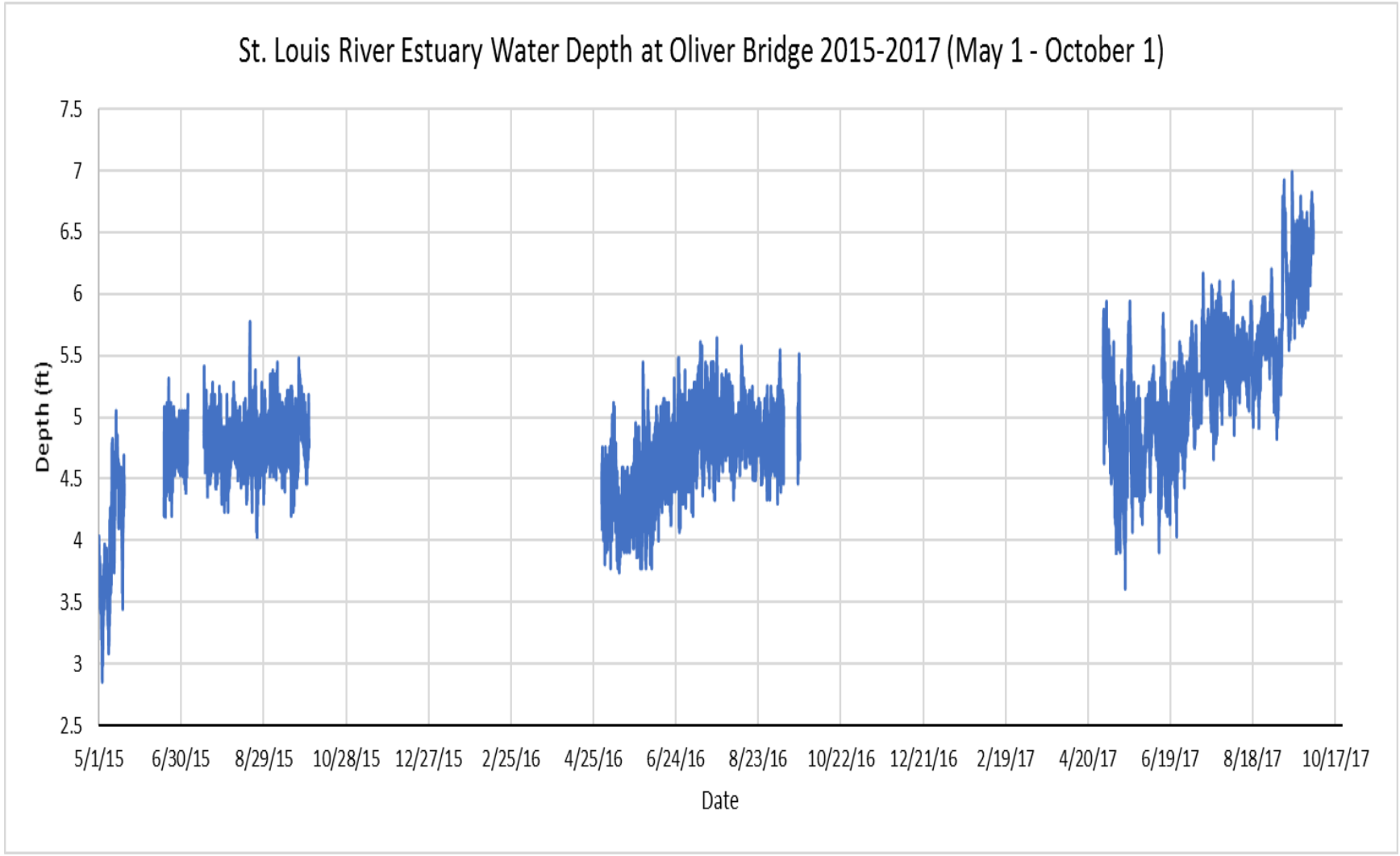


Figure C-1: Water Depth at Oliver Bridge
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program)

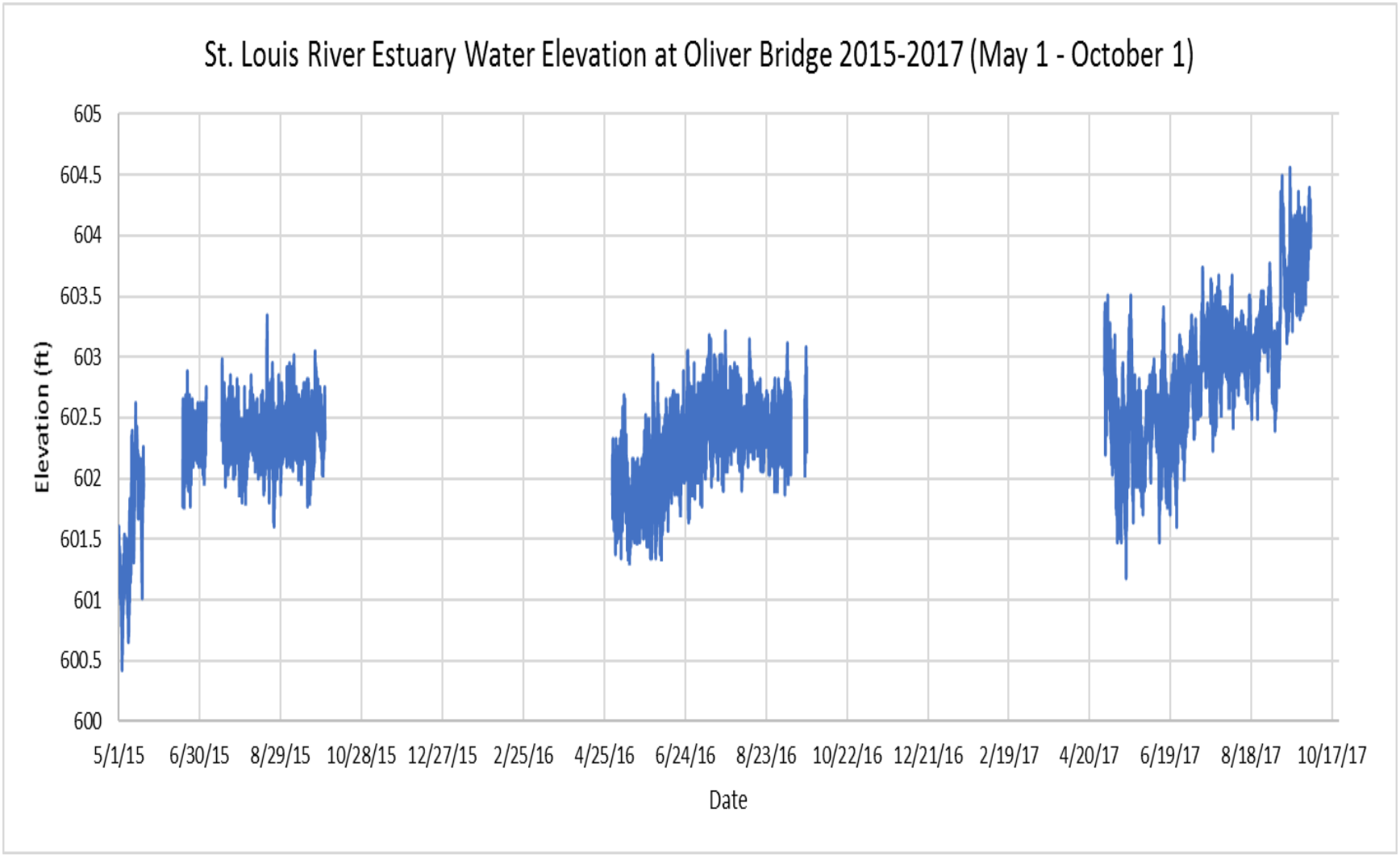


Figure C-2: Water Elevation at Oliver Bridge (estimated from combining two data sources)
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program) and U.S. Geological Survey