St. Louis River Estuary Wild Rice Restoration Monitoring (2015-2022)

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Technical Report 22-12
November 2022

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Supported by contract with the Wisconsin Department of Natural Resources through funding from the Great Lakes Restoration Initiative administered by the U.S Environmental Protection Agency

Introduction

In 2015-2022, 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, St. Croix Chippewa Indians of Wisconsin, 1854 Treaty Authority, Great Lakes Indian Fish & Wildlife Commission, University of Wisconsin Superior, St. Louis River Alliance, Lake Superior National Estuarine Research Reserve, U.S. Department of Agriculture – Wildlife Services, City of Duluth, and City of Superior. The Wisconsin Department of Natural Resources employs a St. Louis River Wild Rice Restoration & Habitat Project Coordinator who assists in organizing and coordinating restoration activities.

The 1854 Treaty Authority completed wild rice monitoring activities in 2015-2022. The purpose of the monitoring program is to document the success of wild rice restoration. 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 has been initiated at Oliver-Little Pokegama Bay.

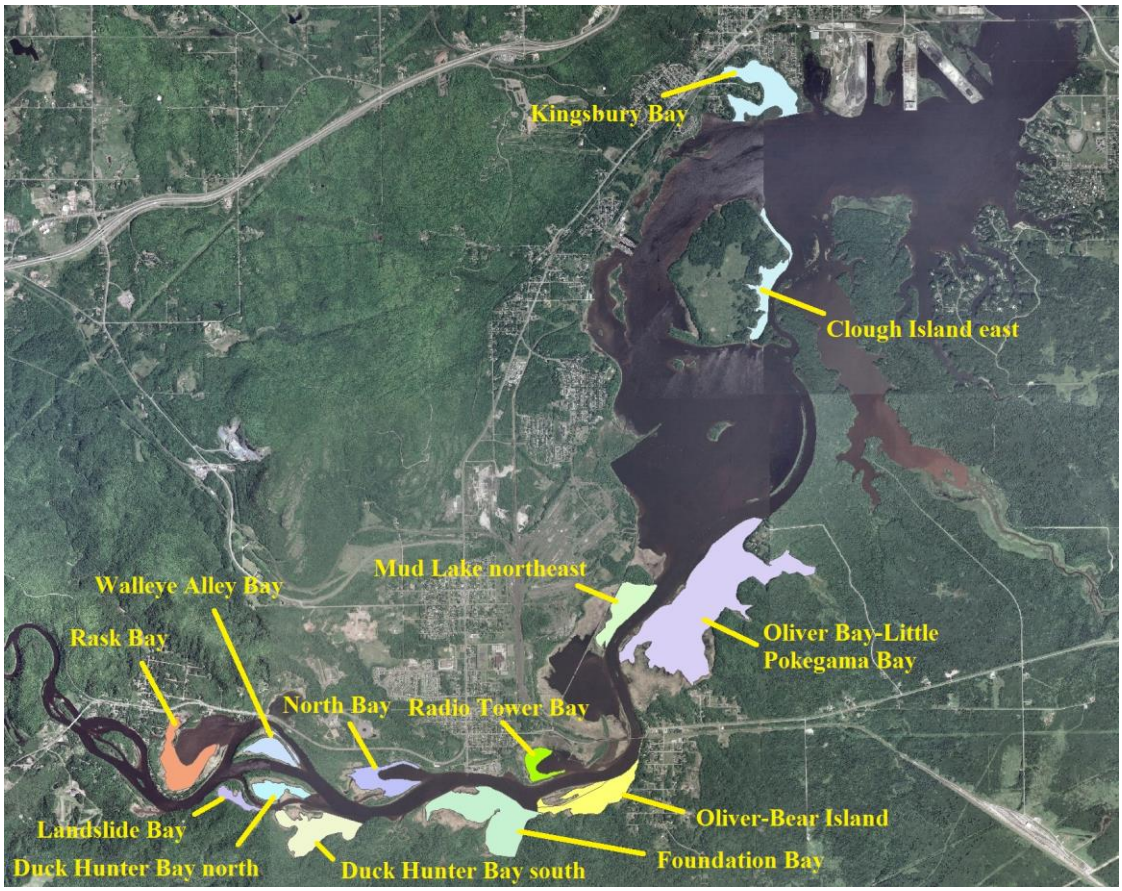


Figure 1: Wild Rice Monitoring in the St. Louis River Estuary

In 2021-2022, the Wisconsin Department of Natural Resources completed monitoring surveys for wild rice in Allouez Bay (Figure 2).

Figure 2: Wild Rice Monitoring in Allouez Bay

Wild rice monitoring sites:

- **2015-2022** Rask Bay, Duck Hunter Bay north, Duck Hunter Bay south, North Bay, Radio Tower Bay
- **2016-2022** Walleye Alley Bay, Landslide Bay, Oliver-Bear Island, Mud Lake northeast, Clough Island east
- **2017-2022** Foundation Bay, Oliver-Little Pokegama Bay, Kingsbury Bay
- **2021-2022** Allouez Bay

Wild Rice Restoration Overview

Wild rice (*Zizania palustris)* restoration work was implemented in 2015-2022. The Fond du Lac Band completed restoration activities most years 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). Other initiatives completed wild rice seeding in 2015 including Clough Island east (5-10 acres, 400-500 lbs of seed) and Allouez Bay (38 acres, 1932 lbs of 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*
Allouez Bay		*38*	*1932*

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. Other partners also seeded Allouez Bay with about 500 pounds over about 10 acres in fall 2018.

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*
Allouez Bay		*about 10*	*about 500*

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*

In 2021, wild rice seed availability was limited. Wild rice production across the region was generally good due to lower water levels from drought conditions, but harvester effort was down or people were not willing to sell seed due to difficult or perceived access issues from low water. The Wisconsin DNR seeded 363 pounds of wild rice over about 4 acres in Allouez Bay on 9/15/2021. The St. Louis River Alliance seeded 500 pounds of wild rice over about 3 acres in Kingsbury Bay on 9/9/2021 (Table 7). The Kingsbury Bay seeding provided good opportunity to establish wild rice after recent restoration dredging work was completed in 2021.

Table 7: Wild Rice Restoration Sites in the St. Louis River Estuary, 2021

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
Foundation Bay	0	0	0
Red River	0	0	0
totals:	**0**	**0**	**0**
Allouez Bay	*0*	*4*	*363*
Kingsbury Bay	*0*	*3*	*500*

Seeding in 2022 was conducted by the Fond du Lac Band in Rask Bay, Duck Hunter Bay north, North Bay, Walleye Alley Bay, and Landslide Bay. The Wisconsin Department of Natural Resources seeded Allouez Bay with 1176 pounds, and the St. Louis River Alliance led seeding on 9/14/22 of 500 pounds in Kingsbury Bay. In total, 8,057 pounds of wild rice was seeded in over 58 acres in 2022 (Table 8).

Table 8: Wild Rice Restoration Sites in the St. Louis River Estuary, 2022

St. Louis River Estuary	Acres Mechanically Treated	Acres Seeded with Wild Rice	Pounds of Wild Rice Seed
Rask Bay	0	11.81	1866
Duck Hunter Bay north	0	13.42	1304
Duck Hunter Bay south	0	0	0
North Bay	0	4.06	557
Radio Tower Bay	0	0	0
Walleye Alley Bay	0	12.26	1790
Landslide Bay	0	6.80	864
Oliver-Bear Island	0	0	0
Mud Lake northeast	0	0	0
Clough Island east	0	0	0
Foundation Bay	0	0	0
Red River	0	0	0
Allouez Bay	0	7.30	1176
Kingsbury Bay	0	2.50	500
totals:	**0**	**58.15**	**8057**

The total for all wild rice seeding from 2015 to 2022 is up to 67,746 pounds over about 260 acres (Table 9).

Table 9: Pounds of Wild Rice Seeded in the St. Louis River Estuary, 2015-2022

St. Louis River Estuary	2015	2016	2017	2018	2019	2020	2021	2022	totals
Rask Bay	2085	1650	1647	0	1530	3349	0	1866	**12,127**
Duck Hunter Bay north	2165	948	953	0	1642	2805	0	1304	**9,817**
Duck Hunter Bay south	1642	1935	2006	0	1151	2306	0	0	**9,040**
North Bay	1666	718	707	0	379	1534	0	557	**5,561**
Radio Tower Bay	946	750	767	0	701	1499	0	0	**4,663**
Walleye Alley Bay	0	1247	850	0	592	1105	0	1790	**5,584**
Landslide Bay	0	553	425	0	419	812	0	864	**3,073**
Oliver-Bear Island	0	2120	1341	0	743	130	0	0	**4,334**
Mud Lake northeast	0	2089	1788	0	0	0	0	0	**3,877**
Clough Island east	500	508	550	400	1500	500	0	0	**3,958**
Foundation Bay	0	0	0	0	285	101	0	0	**386**
Red River	0	0	0	0	180	175	0	0	**355**
Allouez Bay	1932	0	0	500	0	0	363	1176	**3,971**
Kingsbury Bay	0	0	0	0	0	0	500	500	**1,000**
totals:	**10,936**	**12,518**	**11,034**	**900**	**9,122**	**14,316**	**863**	**8,057**	**67,746**

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 75 based upon the best fit for a grid of points across the monitored area (Table 10). Maps showing sampling points in each bay are included in Appendix A (Figures A1-A14).

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 15 in 2015-2022. 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. No restoration work has been initiated at Oliver-Little Pokegama Bay. Monitoring of this area (and other areas before restoration work started) began 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 annually by helicopter: 6/10/15 before vegetation treatment activities and 9/1/15 after treatment activities, 9/1/16, 8/31/17, 8/30/18, 8/29/19, 8/27/20, 8/31/21, 8/30/22. 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 10: Wild Rice Density and Biomass, 2022

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	7.8 (0-62)	68.5
Duck Hunter Bay north	21	35	12.4 (0-72)	88.2
Duck Hunter Bay south	60	42	1.5 (0-17)	8.5
North Bay	36	36	3.8 (0-40)	24.3
Radio Tower Bay	18	28	1.0 (0-10)	6.8
Walleye Alley Bay	25	41	8.0 (0-65)	44.1
Landslide Bay	11	29	4.2 (0-29)	23.9
Oliver-Bear Island	62	47	0.5 (0-8)	2.5
Mud Lake northeast	45	41	0.05 (0-1)	0.3
Clough Island east	39	43	0.0 (0)	0.0
Foundation Bay	110	44	0.0 (0)	0.0
Allouez Bay	44	75	2.3 (0-28)	16.2
Kingsbury Bay	72	46	0.0 (0)	0.0
* Oliver-Little Pokegama bays	300	37	0.2 (0-3)	0.6

*no wild rice restoration work initiated at this location

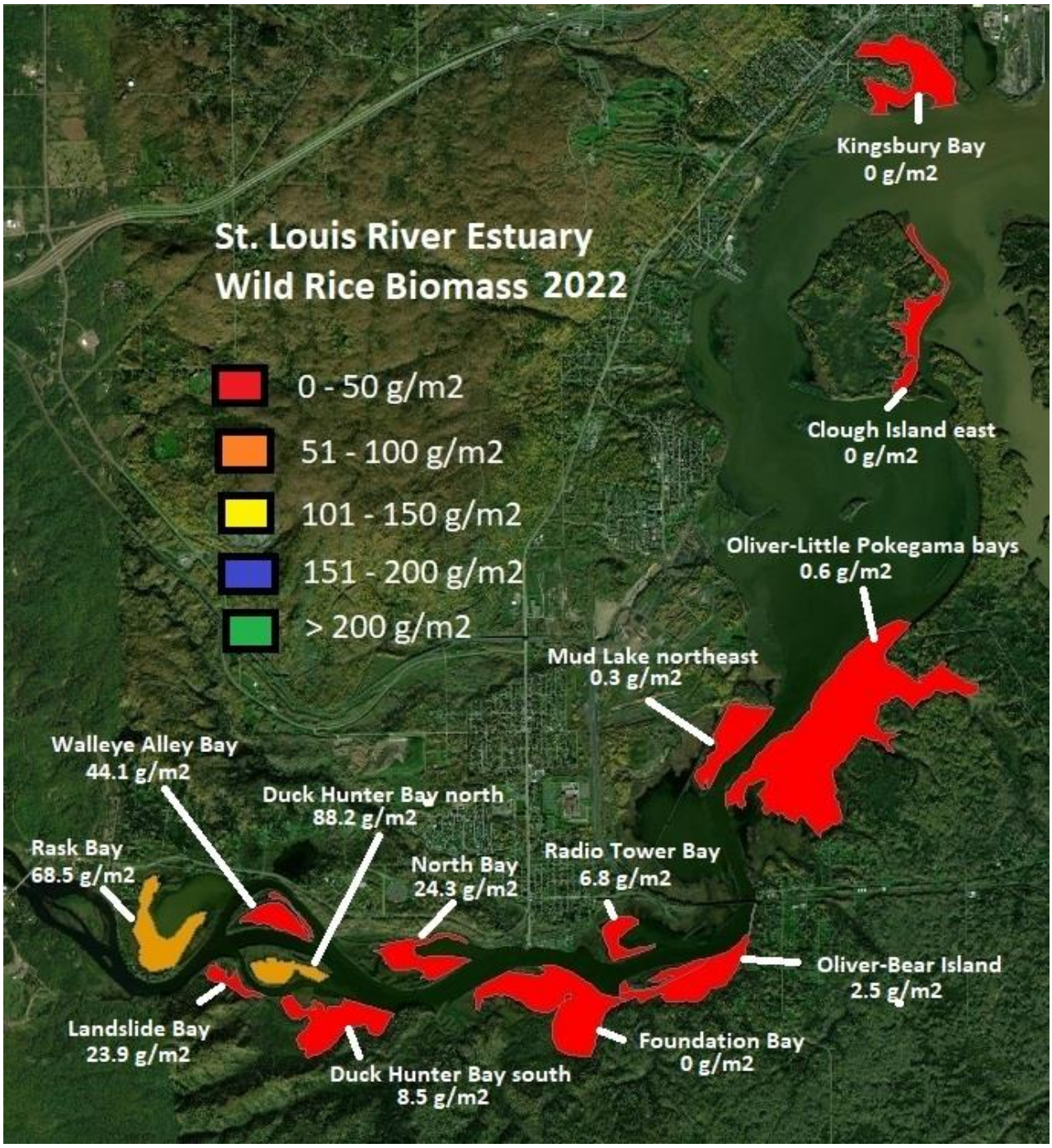


Figure 3: Wild Rice Biomass in Monitored Areas (2022)
(Allouez Bay not depicted: 16.2 g/m2)

Table 11: Average Total Wild Rice Plant Height and Water Depth at Sampling Points, 2022

St. Louis River Estuary	Date	Average Total Plant Height in Inches (range in parentheses)	Average Water Depth in Inches (range in parentheses)
Rask Bay	8/23/2022	64 (51-72)	36 (14-52)
Duck Hunter Bay north	8/24/2022	58 (27-82)	31 (14-52)
Duck Hunter Bay south	8/25/2022	56 (43-73)	43 (15-100)
North Bay	8/25/2022	54 (41-60)	44 (7-74)
Radio Tower Bay	8/29/2022	55 (44-70)	47 (14-74)
Walleye Alley Bay	8/23/2022	54 (41-71)	34 (9-54)
Landslide Bay	8/24/2022	55 (39-66)	42 (17-82)
Oliver-Bear Island	8/29/2022	52 (45-56)	67 (13-250)
Mud Lake northeast	8/26/2022	57 (48-65)	53 (27-192)
Clough Island east	9/1/2022	NA	53 (19-95)
Foundation Bay	8/25/2022	NA	47 (22-80)
Allouez Bay	8/31/2022	53 (26-70)	26 (7-54)
Kingsbury Bay	9/1/2022	NA	58 (9-100)
* Oliver-Little Pokegama bays	8/26/2022	47 (40-53)	53 (21-91)

*no wild rice restoration work initiated at this location

Table 12: Wild Rice Density and Biomass, 2015-2022

		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
* Kingsbury Bay	72					0	0
* Oliver-Little Pokegama bays	300					0.03	0.1

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
* Kingsbury Bay	72	0	0	0	0	NA	NA
* Oliver-Little Pokegama bays	300	0	0	0.05	0.3	0	0

St. Louis River Estuary	Acres Monitored	2021 Avg # stalks per 1/2 m²	2021 Biomass (g/m²)	2022 Avg # stalks per 1/2 m²	2022 Biomass (g/m²)
Rask Bay	50	4.3	25.3	7.8	68.5
Duck Hunter Bay north	21	9.8	123.2	12.4	88.2
Duck Hunter Bay south	60	2.4	13.6	1.5	8.5
North Bay	36	2.9	13.5	3.8	24.3
Radio Tower Bay	18	2.5	20.8	1.0	6.8
Walleye Alley Bay	25	3.3	22.2	8.0	44.1
Landslide Bay	11	3.3	39.1	4.2	23.9
Oliver-Bear Island	62	0.4	2.9	0.5	2.5
Mud Lake northeast	45	0.07	0.5	0.05	0.3
Clough Island east	39	0.3	1.2	0	0
Foundation Bay	110	0.1	0.4	0	0
Allouez Bay	44	1.6	6.2	2.3	16.2
* Kingsbury Bay	72	NA	NA	0	0
* Oliver-Little Pokegama bays	300	0	0	0.2	0.6

*no wild rice restoration work initiated at these locations in years shaded, no monitoring completed in Kingsbury Bay in 2020 and 2021 due to ongoing dredging activities

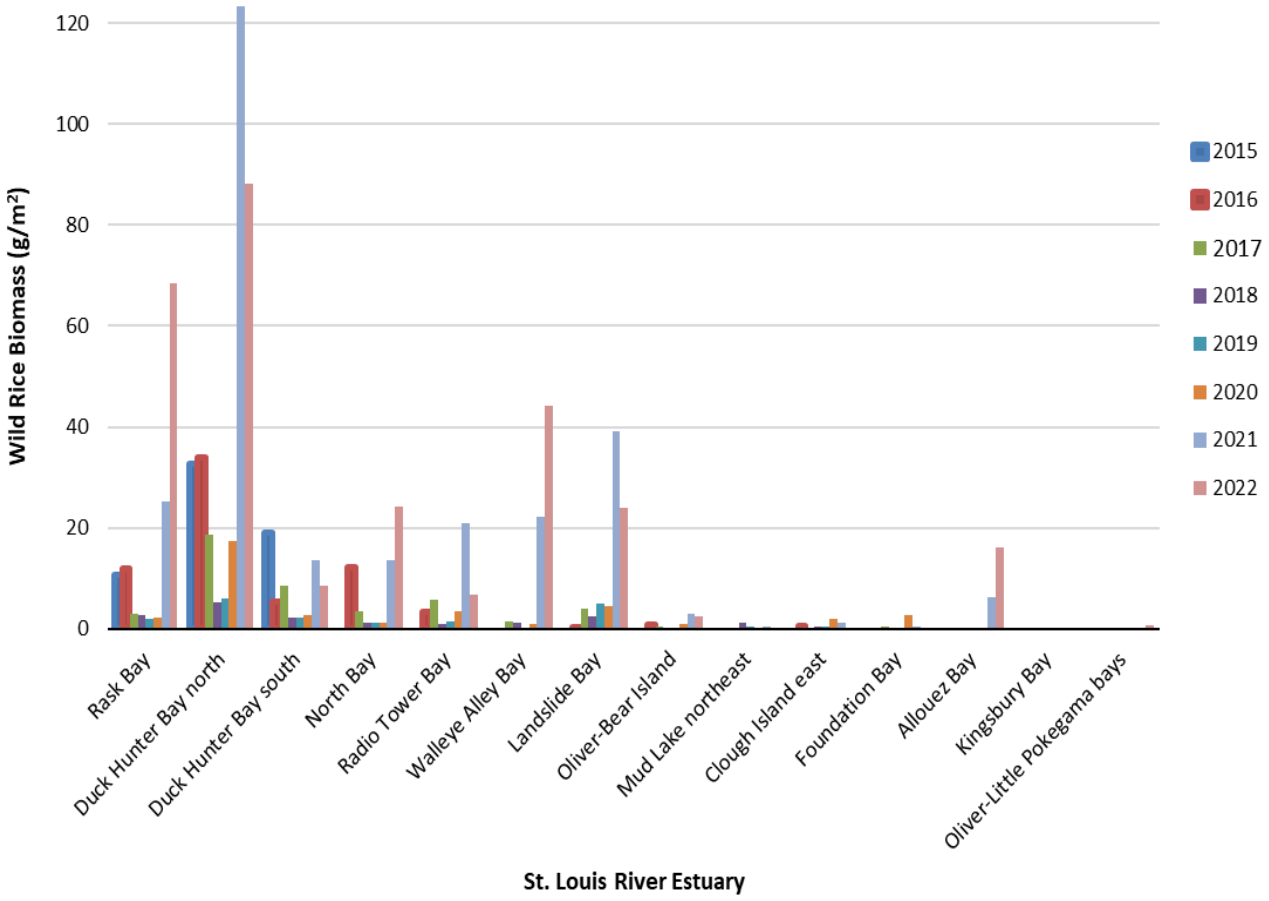


Figure 4: Wild Rice Biomass in Monitored Areas

Discussion

Survey results in 2022 (Table 10, Figure 3) indicate a range of average wild rice biomass from 0 grams/m^2 in Clough Island east, Foundation Bay, and Kingsbury Bay (although some wild rice plants present in these areas) to 88.2 grams/m^2 in Duck Hunter Bay north. Other 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. 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 2022 were generally near or greater than the upper end of this range (Table 11). However, it must be noted that these reported depths were on a single date, and not representative of the entire 2022 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 and skewing reported average water depths.

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 2022 (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 in 2021-2022 were considerably lower (about 1 foot) than several previous years that had high levels, including in 2019 when Lake Superior set monthly record highs in summer and neared the all-time record high level. On May 1 in 2022, Lake Superior was about 7.1 inches lower than that time in the previous year. By June, the lake was about at the same level as the previous year and near long-term average. Into October 2022, Lake Superior was about 5 inches higher than the previous year. Lower/average water levels in the estuary in 2021 and 2022 likely contributed to improved 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 2017-2022.

Annual monitoring results show changes in wild rice density and biomass in each restoration area across years (Table 12, Figure 4). Monitoring completed in 2022 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. In 2021, three locations had wild rice presence in at least 50% of the sampling points: Duck Hunter Bay north at 66%, Radio Tower at 65%, Rask Bay at 50%. In 2022, three locations had wild rice presence in at least 50% of the sampling points: Duck Hunter Bay north at 83%, Rask Bay at 53%, Landslide Bay at 50%,

<u>Rask Bay</u>

In 2022, wild rice was generally moderate to good density along the west, south, and east sides. Areas of good density rice were found near shore and into the north arm of the bay. Wild rice density and biomass in 2022 were the highest observed since monitoring began in 2015, with considerable improved growth over previous years. At least one stalk of wild rice was present in 53% of the sampling points. Moderate grazing impact, presumably from geese, was observed during the August 2022 survey and 11 geese were present. Many leaves had been nipped off and some stalks were broken. During a site visit on 7/18/22, moderate to good density wild rice was observed along shore with plants in the floating-leaf stage to standing two feet. Some plants had grazing impact, and about 5 geese were observed in the north arm. Photo points have been established at six sampling locations and will be useful in showing changes across years.

<u>Duck Hunter Bay north</u>

In 2022, moderate to good density wild rice was present across most of the bay. Density was the highest observed for this bay since monitoring began, but biomass decreased

slightly form 2021 (indicating shorter plants in 2022). This bay continues to have the highest density and biomass of all restoration areas. At least one stalk of wild rice was present in 83% of the sampling points. Moderate grazing impact was observed during the August 2022 survey, with many leaves nipped and some stalks broken, but no geese were present. On the 7/18/22 field visit, moderate density wild rice was found across most of the bay with plants floating-leaf to standing 2 feet. Most plants had been nipped and about 11 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.
- 2021: Eight exclosures were installed on 6/1/21 and 6/2/21 by the Fond du Lac Band with some assistance from partners. On the 7/20/21 site visit, wild rice was taller with more plants flowering in some exclosures when compared to areas outside. In late August during the density survey, wild rice near/between the exclosures appeared similar in density and height to plants within the fencing and had little impact from geese. Many plants were tall, standing up to 7 feet out of the water. Two sampling points were completed in each of the 8 exclosures.
- 2022: Ten exclosures were installed by the Fond du Lac Band. On 7/18/22, wild rice within exclosures was observed to be taller than areas outside. During the density survey in August, moderate to good density wild rice was within and adjacent to exclosures and was more dense than in the center of the bay. Two sampling points were completed in each of the 10 exclosures, and wild rice was slightly less dense within exclosures than the bay as a whole (could be factor of sampling point choices within exclosures). A comparison of wild rice within exclosures versus the summary for the other portion of the bay in 2020-2022 is included in Table 13. Photos of the exclosures can be found in Appendix D.

Table 13: Wild Rice Height, Density, and Biomass in Duck Hunter Bay North, 2020-2022

Duck Hunter Bay north	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 monitoring 2020	35	61 (43-77)	2.5 (0-13)	17.3
2 exclosures 2020	8	86 (73-100)	16.9 (7-30)	295.6
entire monitoring 2021	35	73 (58-105)	9.8 (0-39)	123.2
8 exclosures 2021	16	85 (72-105)	16.5 (0-34)	288.3
entire monitoring 2022	35	58 (27-82)	12.4 (0-72)	88.2
10 exclosures 2022	20	66 (51-85)	8.0 (1-15)	73.8

Duck Hunter Bay south

In 2022, sparse wild rice was observed around most of the bay, with moderate density found in the northwest portion of the area. Wild rice density and biomass declined slightly from 2021. At least one stalk of wild rice was present in 26% of the sampling points. Grazing impact on wild rice observed during the August 2022 survey was minor to moderate (some leaves nipped and a few stalks broken). During the survey, 9 geese were seen in the bay. On the 7/18/22 visit, sparse floating-leaf wild rice was observed and no geese were present. Photo points have been established at 11 locations.

North Bay

In 2022, sparse wild rice was present along the south and west sides of the bay. Some areas of moderate to good density were also present. Wild rice density and biomass in 2022 were the highest observed since monitoring began in 2015. At least one stalk of wild rice was present in 25% of the sampling points. Moderate grazing impact was observed during the August 2022 survey, with many rice leaves and some stalks nipped or broken. Between 40-45 geese were observed in the bay during the survey. On 7/18/22, moderate to good density wild rice was seen on the west end. Wild rice was floating-leaf to standing about one foot, with many standing plants nipped. No geese were present in the bay. Photo points have been established at four locations.

Exclosures in North Bay

- 2021: Five exclosures were installed on 7/8/21 and 7/9/21 by the MN Department of Natural Resources and WI Department of Natural Resources. On the 7/20/21 site visit, wild rice was taller and thicker within the exclosures. During the density survey in late August, wild rice within some of the exclosures was thicker and taller than the surrounding area. Some exclosures had portions of fencing down with some evidence of grazing within. Two sampling points were completed in each of the 5 exclosures.
- 2022: Five exclosures were installed by the MN Department of Natural Resources and WI Department of Natural Resources. During the density survey in late August, wild rice within and near the exclosures was thicker and taller than the surrounding area. Two sampling points were completed in each of the 5 exclosures. A comparison of wild rice within exclosures versus the summary for the other portion of the bay in 2021-2022 is included in Table 14. Photos of the exclosures can be found in Appendix D.

Table 14: Wild Rice Height, Density, and Biomass in North Bay, 2021-2022

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 monitoring 2021	36	51 (38-73)	2.9 (0-10)	13.5
5 exclosures 2021	10	54 (38-69)	11.8 (1-25)	62.6
entire monitoring 2022	36	54 (41-60)	3.8 (0-40)	24.3
5 exclosures 2022	10	69 (52-89)	24.1 (10-51)	249.5

Radio Tower Bay

In 2022, areas of sparse density wild rice were found along the fringes of the bay. Some small areas of moderate density were located near shore. Wild rice density and biomass decreased from 2021. At least one stalk of wild rice was present in 23% of the sampling points. Moderate impacts from grazing were observed during the August 2022 survey, with many wild rice leaves nipped and some stems nipped or broken. No geese were observed during the survey. During the 7/18/22 site visit, sparse wild rice was found in the restoration area, with plants in floating-leaf stage to starting to stand. Ten geese were present in the bay. Photo points have been established at five locations.

Walleye Alley Bay

In 2022, sparse wild rice covered the center of the bay with moderate to good density along the south shore and in the west end. Wild rice density and biomass increased significantly from previous years and was the highest since monitoring began. At least one stalk of wild rice was present in 44% of the sampling points. Grazing impact on wild rice was moderate (many rice leaves nipped, some stalks broken) in sparse areas and minor to none in thicker areas during the August 2022 survey, and 6 geese were present in the bay. On 7/18/22, moderate to good density wild rice was observed along shore and in the west end, with plants standing up to 3 feet. Many plants away from the exclosures had been nipped and no geese were observed in the bay. Photo points have been established at six locations.

Exclosures in Walleye Alley Bay

- 2021: Five exclosures were installed on 6/2/21 and 6/3/21 by the Fond du Lac Band with some assistance from partners. In late August during the density survey, wild rice near the exclosures appeared similar in density and height to plants within the fencing and had little impact from geese. Two sampling points were completed in each of the 5 exclosures.
- 2022: Six exclosures were installed by the Fond du Lac Band. On a 7/18/22 visit, wild rice within the exclosures was taller than areas outside. In late August during the density survey, wild rice near the exclosures appeared similar in density and height to plants within the fencing and had little impact from geese. Wild rice was shorter and more sparse in areas further from the exclosures. Two sampling points were completed in each of the 6 exclosures. A comparison of wild rice within exclosures versus the summary for the other portion of the bay in 2021-2022 is included in Table 15. Photos of the exclosures can be found in Appendix D.

Table 15: Wild Rice Height, Density, and Biomass in Walleye Alley Bay, 2021-2022

Walleye Alley 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 monitoring 2021	41	57 (41-71)	3.3 (0-30)	22.2
5 exclosures 2021	10	71 (41-80)	13.0 (0-46)	156.7
entire monitoring 2022	41	54 (41-71)	8.0 (0-65)	44.1
6 exclosures 2022	12	83 (73-92)	35.7 (20-61)	535.6

Landslide Bay

In 2022, sparse to moderate wild rice was present across most of the bay. Wild rice density was the highest and biomass the second highest (lower than 2021) in the bay since monitoring began. At least one stalk of wild rice was present in 50% of the sampling points. Moderate grazing impacts on wild rice were observed during the August 2022 survey, and no geese were observed in the bay. Many rice leaves had been nipped and some stalks had been nipped or broken. On 7/18/22, moderate density wild rice was observed in parts of the bay, with most plants floating-leaf to standing 2 feet. Most standing plants had been nipped and no geese were observed. In 2017, eight sets of poles with ribbon were present to act as a goose deterrent, but by the August survey most were not operational with ribbons gone. Photo points have been established at three locations.

Exclosures in Landslide Bay

- 2022: Five exclosures were installed by the Fond du Lac Band. In late August during the density survey, wild rice within and near the exclosures was thicker and taller than other parts of the bay. Two sampling points were completed in each of the 5 exclosures. A comparison of wild rice within exclosures versus the summary for the other portion of the bay in 2022 is included in Table 16. Photos of the exclosures can be found in Appendix D.

Table 16: Wild Rice Height, Density, and Biomass in Landslide Bay, 2022

Landslide 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 monitoring 2022	29	55 (39-66)	4.2 (0-29)	23.9
5 exclosures 2022	10	65 (51-82)	8.6 (2-37)	91.8

Oliver-Bear Island

In 2022, sparse wild rice was generally found across the area. Wild rice density and biomass in 2022 remained low and was similar to conditions seen in 2021. At least one stalk of wild rice was present in 13% of the sampling points. Grazing impact seen in August 2022 was moderate with many wild rice leaves and some stalks nipped, and 4 geese were observed during the survey. During a field visit on 7/18/22, sparse density wild rice was seen across much of the area with plants floating-leaf to standing 1 foot. No geese were present. Photo points have been established at six locations.

Mud Lake northeast

In 2022, 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. Minor grazing impact was observed in August 2022 with a few stalks nipped and 18 geese observed during the survey. Photo points have been established at three locations.

Clough Island east

In 2022, very sparse wild rice was present in areas along the east side of the island. Wild rice density and biomass remained low, and no wild rice was present in any of the sampling points. Moderate to severe grazing impact was observed in August 2022 with most wild rice plants nipped or broken. No geese were observed during the survey. 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. In 2022, one small patch of moderately dense wild rice was found in the northwest portion of the monitored area and sparse wild rice was present along the southwest shore of the bay (which coincided with the areas that were previously seeded). Scattered wild rice plants were found in other areas of the monitored area. However, wild rice was not present in any of the sampling points. Grazing impact seen in August 2022 was moderate with many leaves nipped, and 12 geese were observed during the survey. On a field visit on 7/18/22, no wild rice was evident and no geese were observed. Photo points have been established at 11 locations.

Oliver – Little Pokegama bays

Wild rice restoration work has not started at Oliver-Little Pokegama bays, but monitoring was initiated in 2017 to track conditions before potential future restoration efforts. In 2022, sparse wild rice was observed in Little Pokegama Bay, and some scattered wild rice plants were observed along the west and south sides of Oliver Bay. Wild rice was present at two sampling points in 2022, equating to about 5% of the points. No grazing impact was observed in August 2022 on the limited rice plants present. Photo points have been established at seven locations.

Kingsbury Bay

Wild rice restoration work was not started at Kingsbury Bay until fall 2021, but monitoring was initiated in 2017 to track conditions before restoration efforts. Monitoring was not completed in Kingsbury Bay in 2020 and 2021 due to equipment working on other restoration efforts. In 2022, moderate to good wild rice was present within the exclosures, but little was found elsewhere. Very sparse wild rice was found in the northwest corner, near the exclosures in the north part of the bay, and in some locations along the east shore. During survey work on 9/1/22, most plants outside the exclosures had been nipped and 26 geese were observed. Photo points have been established at five locations.

Exclosures in Kingsbury Bay

- 2022: Five exclosures were installed on 5/2/22 with personnel from the MN Department of Natural Resources, WI Department of Natural Resources, 1854 Treaty Authority, and Lake Superior National Estuarine Research Reserve. On 9/1/22 during the density survey, moderate to good density wild rice was present within the exclosures and only sparse plants elsewhere. Two sampling points were completed in each of the 5 exclosures. A comparison of wild rice within exclosures versus the summary for the other portion of the bay in 2022 is included in Table 17. Photos of the exclosures can be found in Appendix D.

Table 17: Wild Rice Height, Density, and Biomass in Kingsbury Bay, 2022

Kingsbury 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 monitoring 2022	46	NA	0.0 (0)	0.0
5 exclosures 2022	10	75 (63-86)	11.2 (0-32)	143.3

Allouez Bay

In 2022, moderate to good density wild rice was found in the restoration area in the southeast corner of the bay. The WI Department of Natural Resources began monitoring in 2021, and both density and biomass showed increases in 2022. Personnel from the Wisconsin Department of Natural Resources, 1854 Treaty Authority, and Lake Superior National Estuarine Research Reserve installed 6 goose exclosures on 5/23/22 and 5/24/22. Good wild rice density within and near the exclosures was noted later in the season, and impact from geese was minimal. No additional sample points were completed within exclosures in 2022.

Geese Impacts and Evaluation

Impacts from geese on wild rice restoration are a concern in the St. Louis River Estuary. In July 2022, staff from the 1854 Treaty Authority and WI Department of Natural Resources visited most of the restoration sites to observe wild rice growth and possible impacts from geese. In many areas, rice was beginning to stand but many plants had been nipped off, likely by geese. Additional impacts (leaves nipped, stalks nipped or broken) were noted during the density surveys in August. Further observations of impacts from geese are included in discussions above on each restoration area.

Exclosures are fenced off areas that restrict access by geese and have been utilized in many seasons to promote wild rice growth. Size and construction of these exclosures has varied, but each one is typically about 20 feet x 100 feet and consists of posts (wood or metal) and some type of fencing (plastic, metal, wire, string). As described above for each restoration area, 37 exclosures were installed in 2022. While impossible to use exclosures over a large acreage, they have proven effective at establishing stands of wild rice with the goal to become self-sustaining. Geese tend to avoid impacting areas of thicker vegetation and wild rice. Besides the exclosures themselves, areas near and in between the fenced areas have also been effectively protected from geese impacts.

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 18). 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 18: 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.

In 2021 and 2022, a coordinated Canada goose roundup effort was led by the Wisconsin Department of Natural Resources and U.S. Department of Agriculture – Wildlife Services to remove geese near wild rice restoration areas and reduce herbivory pressure. Geese in waters and capture sites on the Minnesota side of the estuary were unavailable to capture crews due to permitting constraints. In 2021, a total of 187 geese were removed from the Wisconsin side of the estuary during the two-day project (7/1/21 – 7/2/21). A report entitled "Wild Rice Restoration and Canada Goose Management in the St. Louis River Estuary – 2021 Goose Roundup Report" summarizes the roundup effort. During a field visit to restoration sites on 7/20/21, 1854 Treaty Authority staff counted approximately 114 geese present from Rask Bay to the Oliver bridge. In 2022, a similar roundup removed 229 geese over two days (6/28/22 – 6/29/22). On 6/29/22 the Wisconsin Department of Natural Resources conducted a scouting flight over the estuary with an estimated count of 675-950 geese (after the initial removal of 170 geese during

the first day). Most non-breeding adults and molt migrants were concentrated in the shipping areas of the port and not near the wild rice restoration sites.

It appears that Canada goose removal is an effective tool for reducing herbivory on wild rice, both within a year and across years. Roundup efforts in 2021 reduced goose herbivory impacts in 2022. Allouez Bay, where geese were abundant in 2021, serves as an example of roundup success with wild rice density and biomass increasing in 2022 following removal in 2021. Although geese were still present in 2022, they were observed in low abundance and herbivory was relegated to the low-density fringes of the core wild rice patches within restoration areas. These results suggest that the benefits of roundups may carry over across years and that annual goose removal may become unnecessary once wild rice reaches higher densities.

Summary

The 1854 Treaty Authority completed a monitoring program in 2015-2022 on wild rice restoration areas in the St. Louis River Estuary. Monitoring was also completed by the Wisconsin Department of Natural Resources beginning in 2021. The purpose of the program is to document the success of wild rice restoration. Lower to near average water levels likely contributed to improved wild rice growth in 2021-2022. However, impacts from grazing by geese continue to be detrimental to wild rice restoration success. In 2022, 8,057 pounds of wild rice was seeded in seven different areas. Monitoring of restoration areas in 2023 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

The following individuals assisted with monitoring activities in 2022:

Tony Anselmo – Fish and Wildlife Specialist, 1854 Treaty Authority
Nick Bogyo – Fisheries Biologist, 1854 Treaty Authority
Jeffrey Flory – Invasive Species Specialist, 1854 Treaty Authority
Ashley Harris – Fish and Wildlife Aide, 1854 Treaty Authority
Erin Jansky - Invasive Species Aide, 1854 Treaty Authority
Abby Novak - Invasive Species Aide, 1854 Treaty Authority
Matt Santo – Invasive Species Specialist, 1854 Treaty Authority
David Grandmaison – St. Louis River Wild Rice Restoration & Habitat Project Coordinator, Wisconsin DNR

Monitoring activities in 2022 were supported by contract with the Wisconsin Department of Natural Resources (thank you to Matt Steiger and David Grandmaison) through funding from the Great Lakes Restoration Initiative administered by the U.S Environmental Protection Agency. Other funding that has supported restoration activities since 2015 includes the National Fish and Wildlife Foundation-Sustain Our Great Lakes, Minnesota Outdoor Heritage Fund, and SLRIDT Natural Resources Damage Assessment settlement.

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)

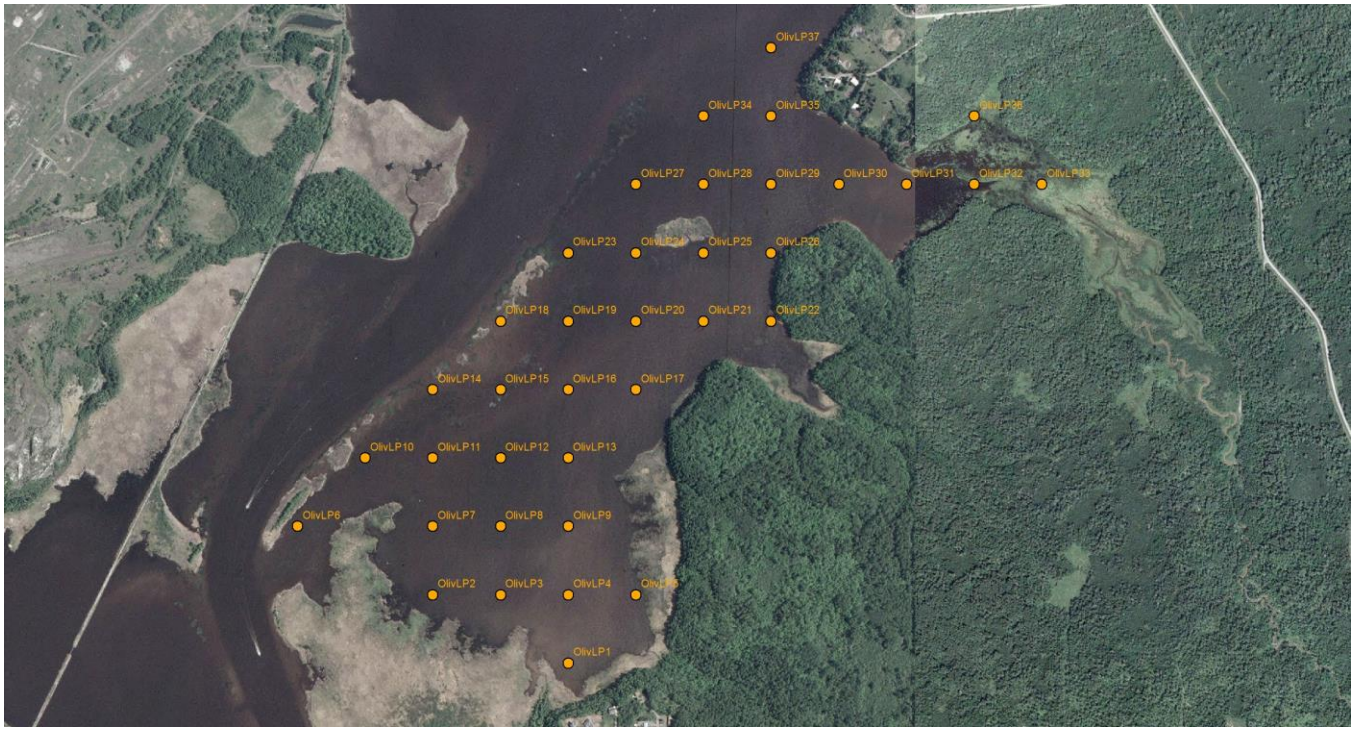


Figure A-12: Monitoring Points in Oliver-Little Pokegama (37 points, 175 m grid)

Figure A-13: Monitoring Points in Kingsbury Bay (46 points, 80 m grid)

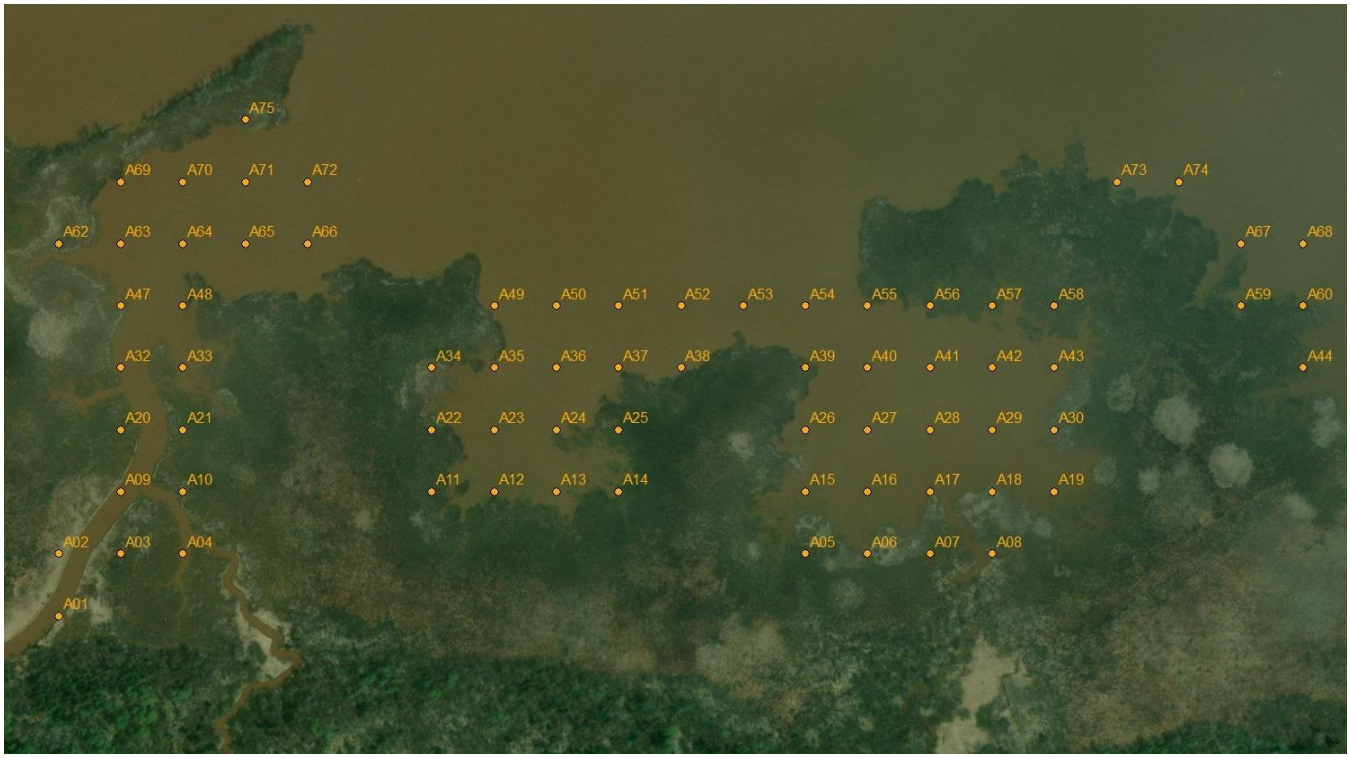
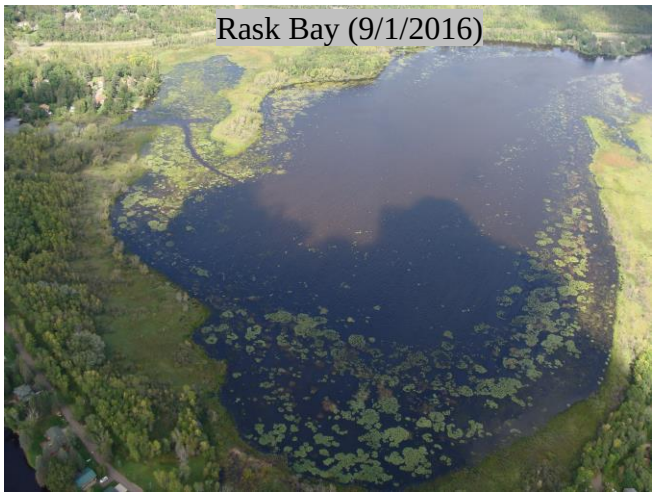


Figure A-14: Monitoring Points in Allouez Bay (75 points, 57 m grid)

Appendix B

Aerial Photographs

Rask Bay (2015-2022)




Rask Bay (8/31/2021)


Rask Bay (8/30/2022)

Duck Hunter Bay north (2015-2022)


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 north (8/31/2021)


Duck Hunter Bay north (8/30/2022)

Duck Hunter Bay south (2015-2022)


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)


Duck Hunter Bay south (8/29/2019)


Duck Hunter Bay south (8/27/2020)


Duck Hunter Bay south (8/31/2021)


Duck Hunter Bay south (8/30/2022)

North Bay (2015-2022)


North Bay (8/31/2021)


North Bay (8/30/2022)

Radio Tower Bay (2015-2022)


Radio Tower Bay (9/1/2015)


Radio Tower Bay (9/1/2016)


Radio Tower Bay (8/31/2017)


Radio Tower Bay (8/30/2018)


Radio Tower Bay (8/29/2019)


Radio Tower Bay (8/27/2020)


Radio Tower Bay (8/31/2021)


Radio Tower Bay (8/30/2022)

Walleye Alley Bay (2016-2022)


Walleye Alley Bay (9/1/2016)


Walleye Alley Bay (8/31/2017)

Walleye Alley Bay (8/30/2018)

Walleye Alley Bay (8/29/2019)

Walleye Alley Bay (8/27/2020)

Walleye Alley Bay (8/31/2021)

Walleye Alley Bay (8/30/2022)

Landslide Bay (2016-2022)


Landslide Bay (8/30/2022)

Oliver-Bear Island (2016-2022)


Oliver-Bear Island (9/1/2016)


Oliver-Bear Island (8/31/2017)


Oliver-Bear Island (8/30/2018)

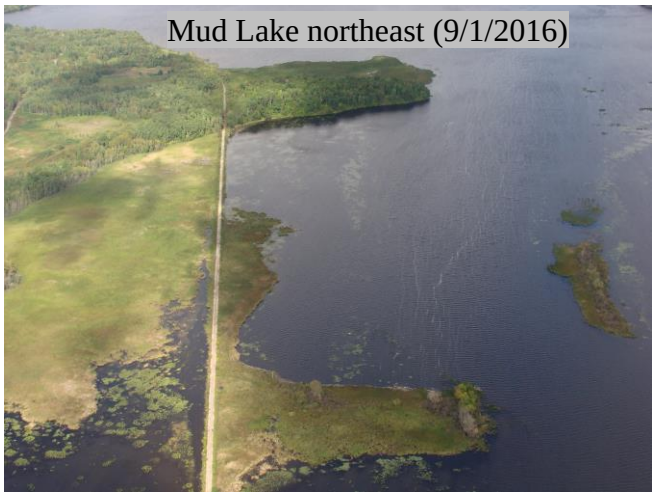

Oliver-Bear Island (8/29/2019)


Oliver-Bear Island (8/27/2020)


Oliver-Bear Island (8/31/2021)


Oliver-Bear Island (8/30/2022)

Mud Lake northeast (2016-2022)


Mud Lake northeast (9/1/2016)

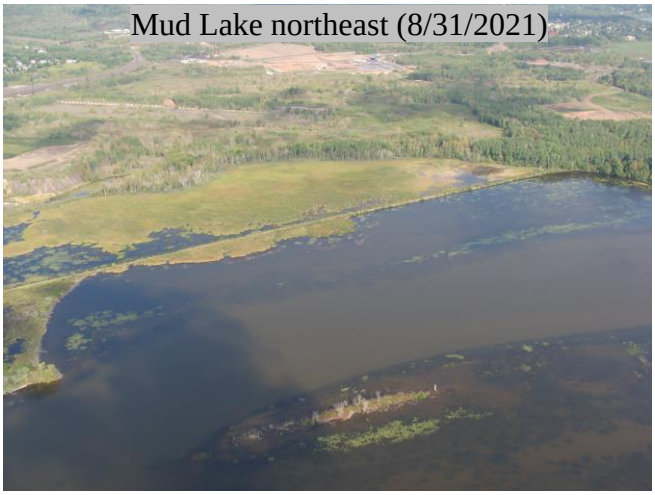

Mud Lake northeast (8/31/2017)

Mud Lake northeast (8/30/2018)

Mud Lake northeast (8/29/2019)

Mud Lake northeast (8/27/2020)

Mud Lake northeast (8/31/2021)



Mud Lake northeast (8/30/2022)

Clough Island east (2016-2022)

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)

Clough Island east (8/31/2021)


Clough Island east (8/30/2022)

Foundation Bay (2017-2022)


Foundation Bay (8/31/2017)


Foundation Bay (8/30/2018)


Foundation Bay (8/29/2019)


Foundation Bay (8/27/2020)


Foundation Bay (8/31/2021)


Foundation Bay (8/30/2022)

Oliver-Little Pokegama (2017-2022)


Oliver – Little Pokegama (8/31/2017)


Oliver – Little Pokegama (8/30/2018)


Oliver – Little Pokegama (8/29/2019)


Oliver – Little Pokegama (8/27/2020)

Oliver – Little Pokegama (8/31/2021)

Oliver – Little Pokegama (8/30/2022)

Kingsbury Bay (2017-2022)

Kingsbury Bay (8/31/2017)

Kingsbury Bay (8/30/2018)

Kingsbury Bay (8/29/2019)

Kingsbury Bay (8/27/2020)

Allouez Bay (2022)

Appendix C

Water Depth and Elevation at Oliver Bridge

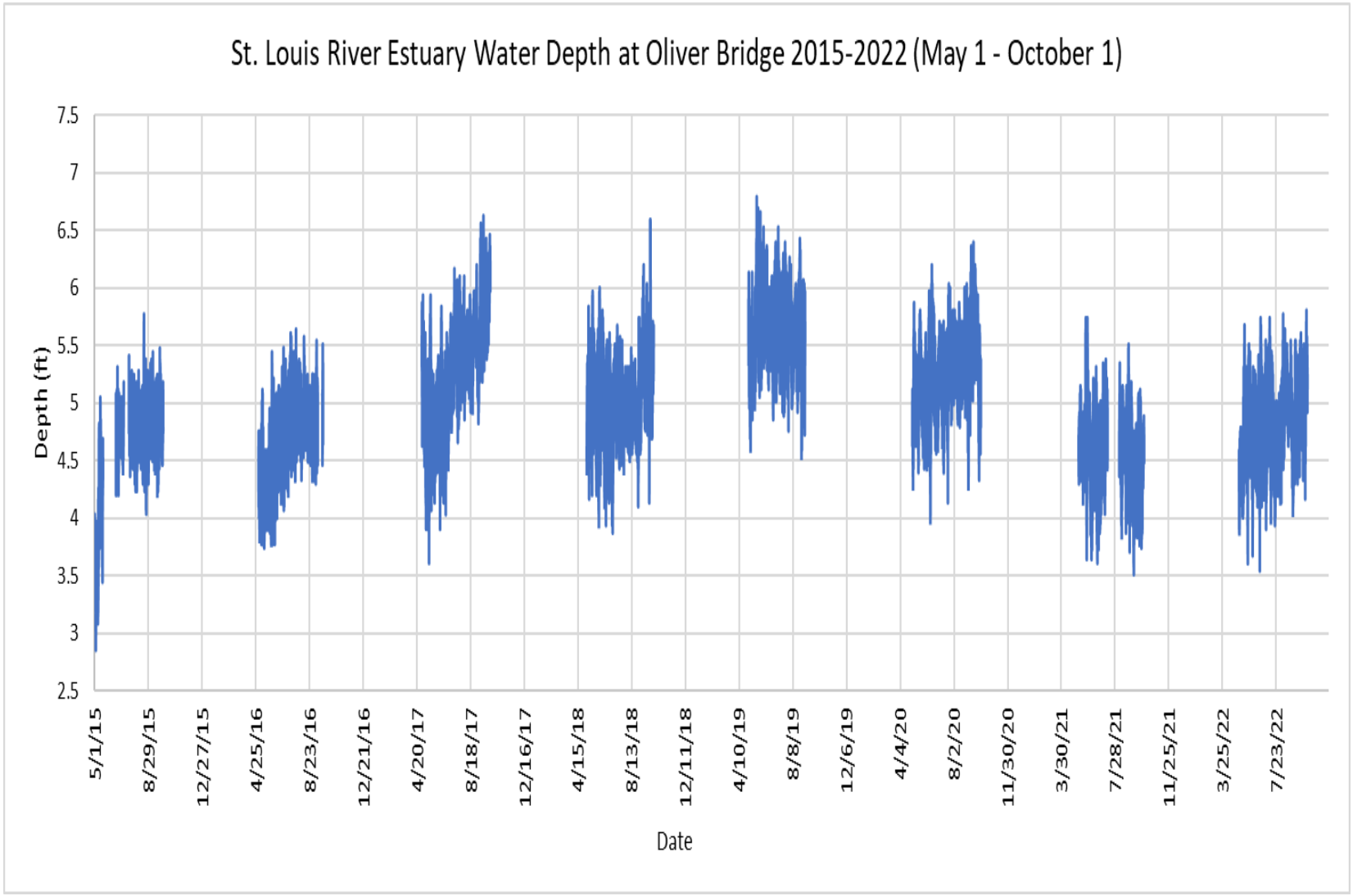


Figure C-1: Water Depth at Oliver Bridge
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program)

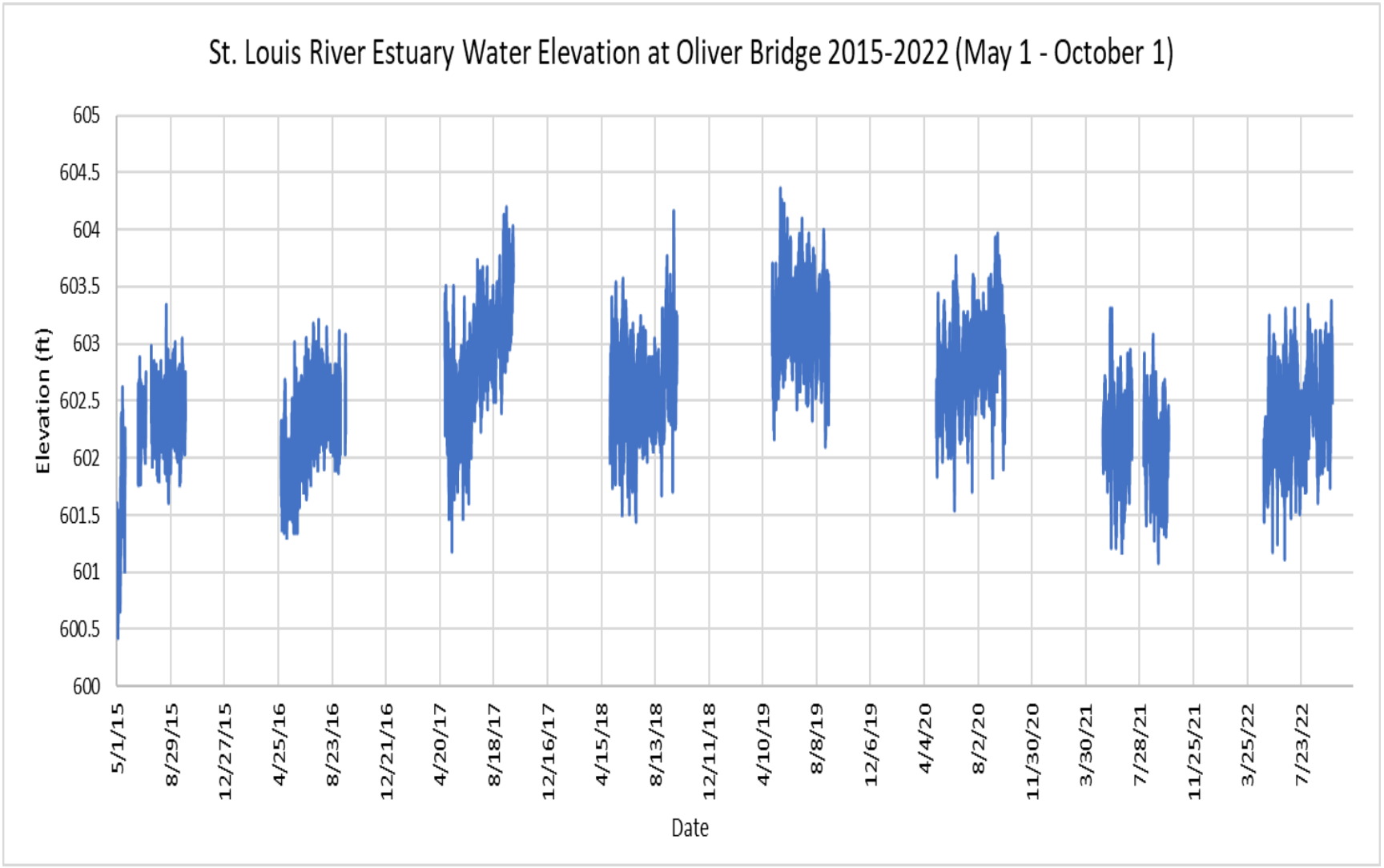
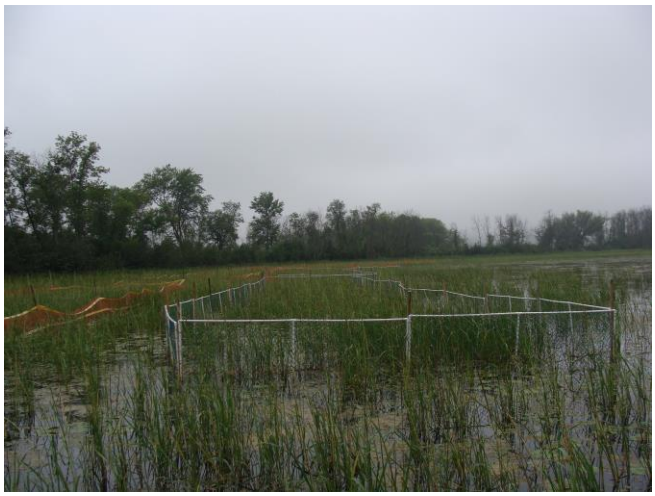


Figure C-2: Water Elevation at Oliver Bridge (estimated from combining two data sources)
Data from NOAA Lake Superior National Estuarine Research Reserve System (System Wide Monitoring Program) and U.S. Geological Survey

Appendix D

Photographs of Exclosures in 2022

Duck Hunter Bay North



8/24/2022

8/24/2022

8/24/2022

8/24/2022

8/24/2022

8/30/2022

North Bay

8/25/2022

8/25/2022

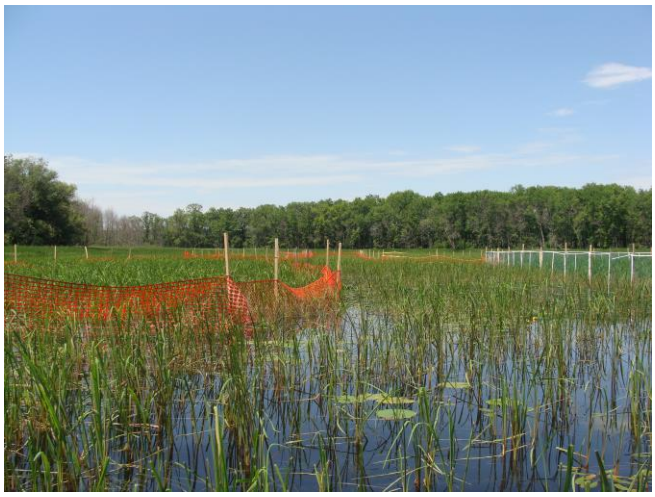
8/25/2022

8/25/2022

8/25/2022

8/30/2022

Walleye Alley Bay



7/18/2022

7/18/2022

8/23/2022

8/23/2022

8/23/2022

8/30/2022

Landslide Bay

7/18/2022

7/18/2022

8/24/2022

8/24/2022

8/24/2022

8/30/2022

Kingsbury Bay

8/30/2022

9/1/2022

9/1/2022

9/1/2022

9/5/2022

9/5/2022