# Documenting Water Depth Fluctuation and Waterfowl Occurrence within Wild Rice Beds in the St. Louis River Estuary


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## SUMMARY

The St. Louis River Estuary's shallow wetlands are home to northern wild rice (manoomin), an ecologically, economically, and culturally important keystone species. Wild rice abundance in the Estuary was negatively impacted by pollution and other human activities following the arrival of European settlers. Unfortunately, despite water quality improvements, habitat restoration, and seeding efforts, wild rice beds have not fully recovered to their previous distribution and density. This is likely due to several factors, including fluctuating water depth and herbivory by waterfowl. We documented water depth fluctuations and waterfowl occurrence in four sheltered bays during the 2020 growing season to help support future restoration decisions in the Estuary. Our observations show that estuary wild rice beds experienced 24-hour water depth fluctuations between 0.64 and 0.95 ft on average. Allouez Bay experienced the most extreme water depth fluctuations with a maximum of 2.1 ft in a 24-hour period. We documented much higher waterfowl occurrence, especially Canada goose presence, in Duck Hunter Bay South. Abundances were highest in mid-September indicating high levels of herbivory on maturing rice. We show some distinct differences in water depth fluctuations and waterfowl occurrences among sites and therefore preliminarily suggest differentially targeting seeding and goose management practices among wild rice beds as an initial management strategy.

## Introduction

Northern wild rice (*Zizania palustris*), or manoomin, is an annual aquatic grass native to northern North America. This species is extremely sensitive to its environment, preferring water that is ½ to 3 ft deep along streams and lake inlets and outlets because of moderate water level fluctuations and slowly flowing water (Moyle, 1944).

The St. Louis River Estuary (SLRE) once supported between 2,000 to 3,000 acres of wild rice, providing a staple food for the ancestors of the present-day Chippewa (Ojibwe) people (Ewald, 2019). Today, manoomin remains a vital part of the Lake Superior Chippewa Tribe's sustenance, identity, and culture. However, industry in Duluth and Superior and other human activities have dramatically reduced wild rice abundance in the Estuary (Ewald, 2019). The decline in wild rice beds can also be attributed to modified hydrology, including the creation of channels that drain the wetlands, inundation from dams, and shipping canal dredging (Schuldt et al., n.d.).

An ongoing monitoring study by the 1854 Treaty Authority suggests that impacts from water levels and waterfowl grazing are detrimental to wild rice restoration efforts (Vogt, 2019). Lake Superior experiences short-term water level changes from both a daily seiche and episodic storm surges that determine the daily and seasonal water levels (Trebitz, 2006) in Lake Superior and therefore within the SLRE. Rapidly changing water depth can damage wild rice especially during its floating-leaf life stage (mid-June to July). During this vulnerable phase, wild rice generally tolerates a water level fluctuation range of up to 6 inches (Moyle, 1944). Continued high water when plants begin to mature can submerge leaves and cause weak growth, resulting in a process

known as “drowning” where they are easily destroyed by wave action and adverse weather (Moyle, 1944).

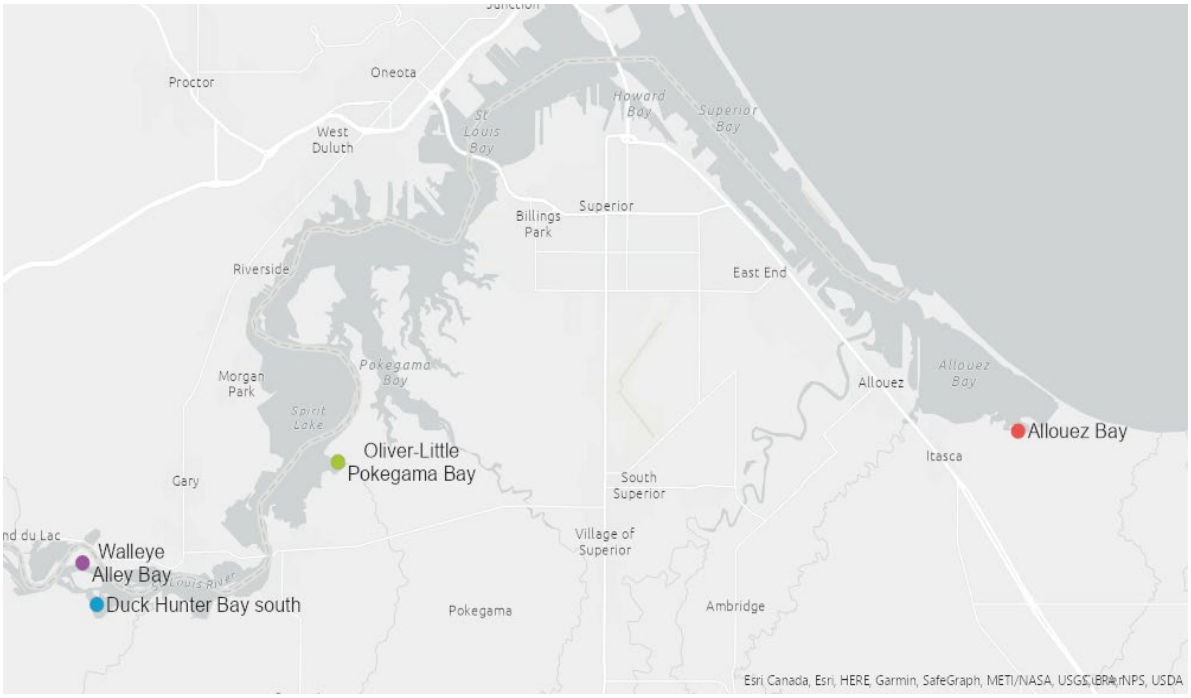
We set out to document water depth fluctuations within wild rice beds in the SLRE because high frequency depth data within bays was scarce. Additionally, we wanted to see if wild rice bays and tributary mouth habitats that vary in their distance to Lake Superior and degree of connectivity with the main St. Louis River channel had any major differences in water depth fluctuation.

Because waterfowl gather in large numbers in the SLRE and can feed heavily on maturing wild rice plants, we also documented waterfowl presence within wild rice beds with trail cameras. Geese and other waterfowl can destroy healthy crops, making it look like a weed whip moved through the area (Peter David, personal communication). Recently, Canada goose populations have increased dramatically in the SLRE (Liljenquist, Bracey, & Grinde, 2019) and ongoing monitoring suggests a negative relationship between wild rice presence and Canada goose abundance (Vogt, 2019).

We focused on two objectives: (1) report water depth fluctuations at a microhabitat scale within wild rice beds at different locations within the Estuary and assess differences, and (2) document waterfowl occurrence within wild rice beds that complement other larger-scale Canada goose counts in the Estuary.

The 1854 Treaty Authority, Fond du Lac Band of Lake Superior Chippewa, Great Lakes Indian Fish and Wildlife Commission, WDNR and MDNR, and the Minnesota Pollution Control Agency have been carrying out a large-scale wild rice restoration and monitoring since 2015. We hope our study can further inform their work.

Figure 1. Sites monitored for water depth and geese in the St. Louis River Estuary, which includes Allouez Bay, Oliver-Little Pokegama Bay, Walleye Alley Bay, and Duck Hunter Bay South.



## Research Methodology

We selected four sites for study during the summer of 2020 (Figure 1). Sites varied in their connectivity to the main river channel and predicted impact from Lake Superior seiche. All sites had wild rice present when equipment was installed in June.

At each site, loggers were installed in late June and recorded pressure every 15 minutes through August. We used three Onset HOBO and one In-Situ Level TROLL 500 pressure transducer data loggers to measure absolute pressure ($P_{abs}$). Using atmospheric pressure ($P_{atm}$) data from the Lake Superior National Estuarine Research Reserve's meteorological station (located at the Pokegama River Sentinel Site) and the fluid pressure for freshwater (0.433 psi/ft), we calculated True Water Depth using the formula below:

$$TWD = \frac{P_{abs} - P_{atm}}{0.433}$$

To validate depth readings, trail cameras facing an installed staff gauge captured photos or video at least every 15 minutes. These cameras also captured waterfowl presence and abundance. An additional trail camera was installed at each site to capture waterfowl activity from an additional perspective. We visited sites regularly to exchange camera SD cards and batteries.

We used TWD values to calculate the average and maximum water depth fluctuations for each site over 15-minute intervals and 24-hour intervals. Canada geese and other waterfowl were enumerated for every camera photograph. We calculated an average hourly goose count for each day. We did not attempt to determine if the birds in one image were the same birds observed in subsequent images. Therefore, our data do not represent counts of different birds, but rather the total number of birds seen in images in a given day standardized by the amount of time the cameras were successfully capturing imagery (some data were missing due to power failures, submersion, reflection, etc.).

Table 1. Wild rice biomass data from the 1854 Treaty Authority's 2019 & 2020 surveys compared with TWD fluctuation values collected from July through Sept 2020.

| Site | Biomass ($g/m^2$) 2019 | Biomass ($g/m^2$) 2020 | Average 15-minute TWD fluctuation (ft) | Maximum 15-minute TWD fluctuation (ft) | Average 24-hour TWD fluctuation (ft) | Maximum 24-hour TWD fluctuation (ft) |
|---|---|---|---|---|---|---|
| **Allouez Bay** | Not available | Not available | 0.11 | 0.83 | 0.95 | 2.10 |
| **Duck Hunter Bay South** | 2.2 | 2.8 | 0.05 | 0.31 | 0.81 | 1.69 |
| **Oliver-Little Pokegama Bay** | 0.3 | 0 | 0.05 | 0.34 | 0.64 | 1.30 |
| **Walleye Alley Bay** | 0.3 | 1.0 | 0.05 | 0.29 | 0.73 | 1.27 |

## Results

Water level fluctuations varied among sites. The difference was most drastic between Allouez Bay and the other three sites (Table 1; Figure 2). Allouez Bay had the highest average and maximum 15-minute and 24-hour fluctuations. These differences are attributable to proximity to Lake Superior and therefore a stronger seiche influence. But, there were also differences in fluctuation averages and maxima between the three other upper estuary sites. Even though Duck Hunter Bay South and Walleye Alley Bay are relatively close to one another (Figure 1) and experienced similar short term fluctuations (Table 1), Duck Hunter Bay South had a higher 24-hour fluctuation average and a more extreme fluctuation maximum (Figure 2).

Goose activity also varied among sites (Figure 3). Temporal trends at individual sites cannot be deduced because of gaps in data. Quickly growing vegetation (mostly cattails and bur-reed) grew so densely by mid-July that the cameras could not detect waterfowl that were more than a few meters away. But, data do reveal a strong increase in waterfowl and Canada goose activity in mid-September, especially at Duck Hunter Bay South (Figure 3). This timing coincides with wild rice seed ripening.

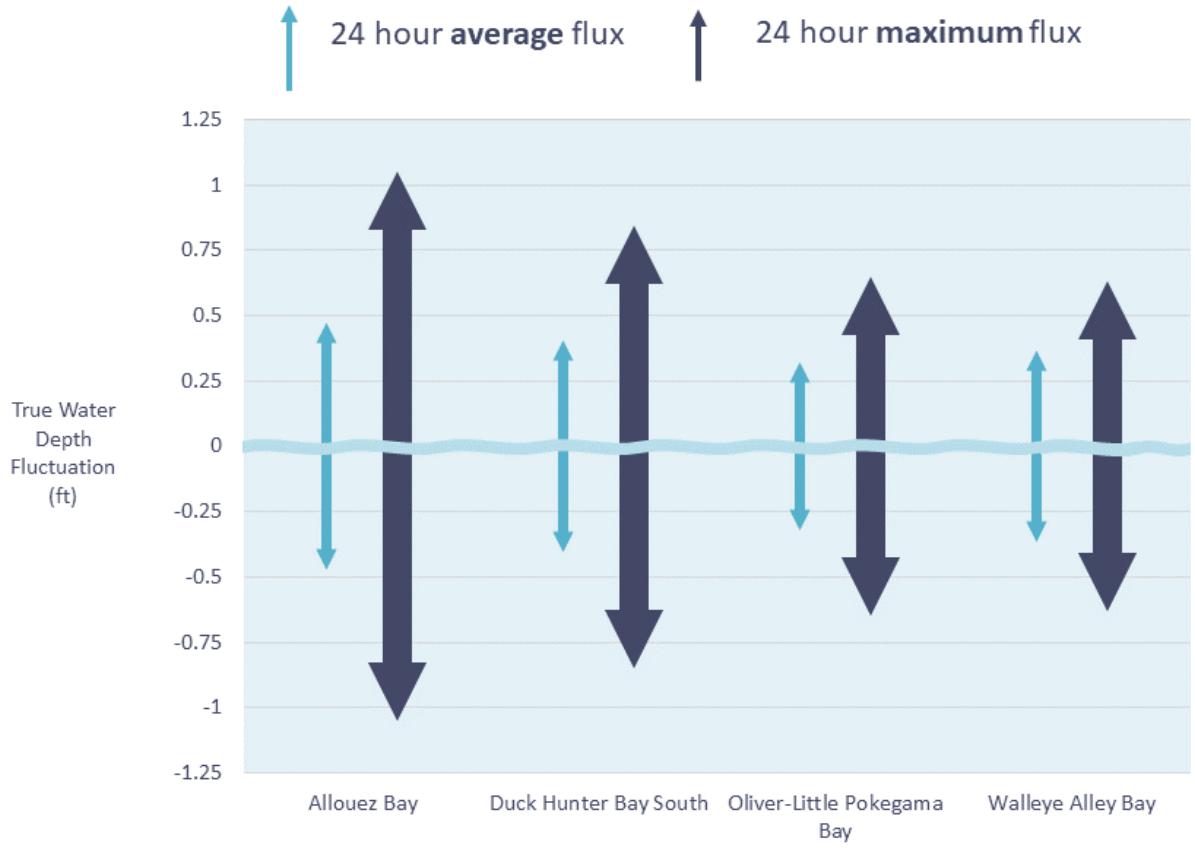



Figure 2. A representation of how water depth fluctuated above and below the average seasonal depth (set to zero) at each of the four sites over the study period.

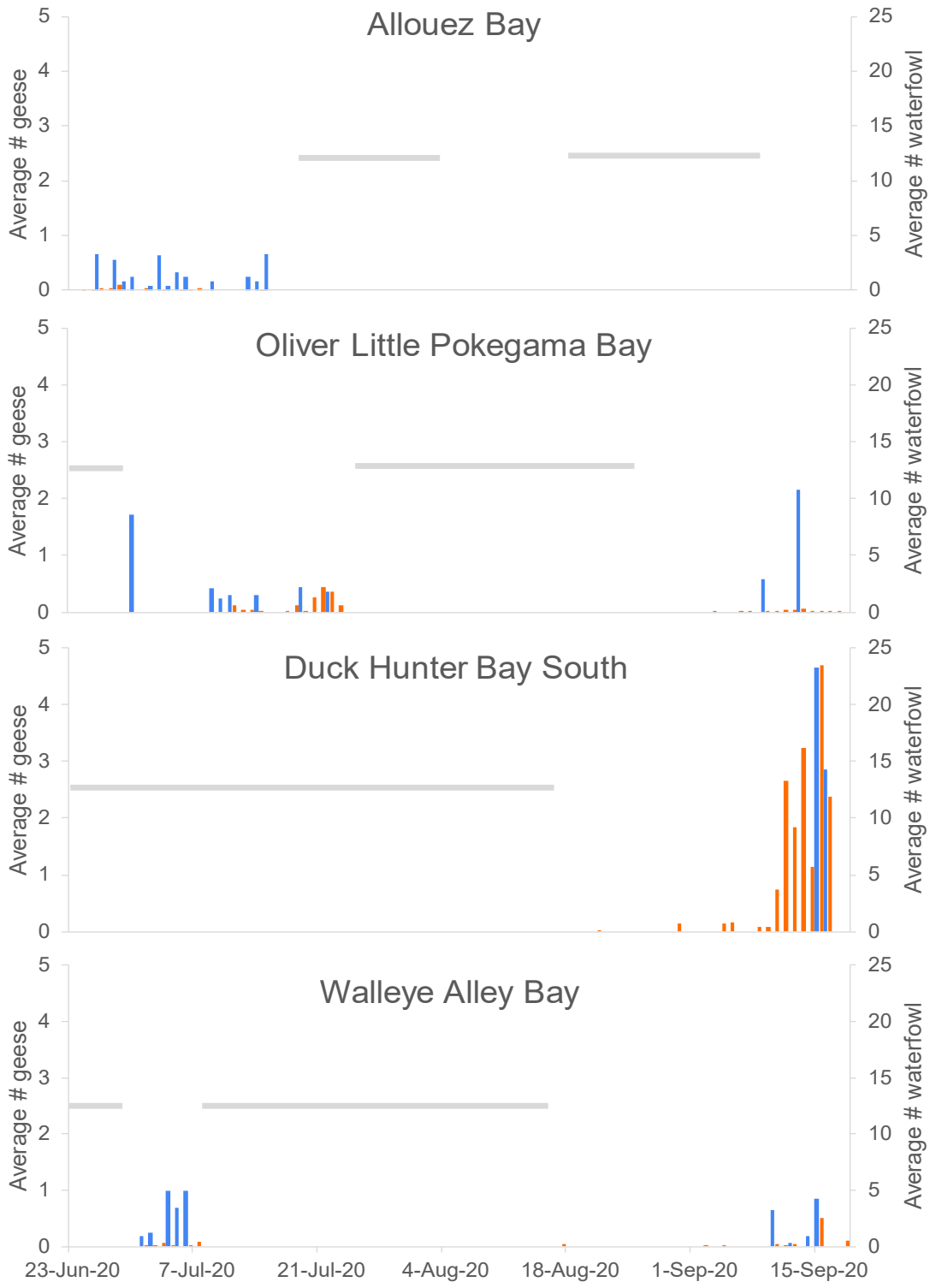



Figure 3. Hourly average goose and other waterfowl counts in each bay from June-September. Gray horizontal bars represent time periods when time-lapse images were not recorded.

## Discussion

Our study shows that waterfowl activity and water depth fluctuations vary among wild rice habitats in the SLRE and indicates that both have the potential to negatively impact wild rice growth. Extreme water depth fluctuations (>2 ft in a 24-hour period) are most likely to negatively impact restoration efforts in Allouez Bay, and waterfowl are most likely to negatively impact wild rice maturation in Duck Hunter Bay South. The higher levels of waterfowl and Canada goose activity in mid-September when wild rice has gone to seed, suggests that geese are targeting rice beds at this critical stage in the plant's life cycle.

Despite the fact that waterfowl activity and high water depth fluctuations in these bays have the potential to impact wild rice, our study did not assess whether these factors directly correlate with wild rice biomass. Future research on goose activity and water depth fluctuations would benefit from adding more data collection stations within bays for a more thorough characterization of water depths throughout wild rice beds that can be directly related to wild rice biomass. In addition, waterfowl activity would have to be paired with herbivory surveys several times throughout the growing season in order to understand cause and effect.

Our results show differences in water depth fluctuations among sheltered bays that are in close proximity to one another in the SLRE, meaning that each wild rice bed undergoing restoration warrents a unique approach due to differences in hydologic connectivity to the St. Louis River's main channel and/or additional tributary inputs. Because we only recorded water depths in four of many wild rice beds in the Estuary that are undergoing restoration, we recommend further data collection in bays of particular interest.

## Conclusion

Our study revealed some specific water depth fluctuation conditions that can affect wild rice and documented the timing of waterfowl pressure on wild rice in the SLRE. We hope this study adds valuable data to the growing library of knowledge available to SLRE wild rice managers.

## Acknowledgments

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