GETTING MY FEET WET: AN INTERNSHIP DELINEATING WETLANDS WITH THE ADIRONDACK PARK AGENCY

by

Lydia Harvey

A report submitted in fulfillment of the requirements for the degree of

Master of Science – Natural Resources and Ecology

State University of New York at Plattsburgh

2024

Approved by

Chairperson of Supervisory Committee

Committee Member

Committee Member

Date – December 5, 2024

Table of Contents

List of Figures

List of Tables

Acknowledgements

I would like to express my deepest appreciation to my graduate advisor Dr. Mary Alldred, whose support and guidance in these last three semesters was invaluable. I am also grateful for her help in finding opportunities such as my internship with the Adirondack Park Agency and helping me become a certified wetland delineator. Her calming presence and humor was greatly appreciated during times of stress (there were many).

I am also grateful to my committee member and professor Dr. Danielle Garneau for her feedback and support on this project and in the classroom. Her enthusiasm for her work is truly contagious and has inspired me throughout my studies.

Also, many thanks to my committee member and internship supervisor Dr. Lizz Schuyler for her guidance and feedback on this project as well as for her mentorship during my internship. I greatly appreciate her help during the deep-water marsh surveys and for taking time out of her busy schedule to spend a few hours on the water each week collecting data.

I would like to thank RASS staff Mary O’Dell, Kelly McKean, and Casey Young for taking me along on site visits and teaching me all about the work that they do. Their enthusiasm for what they do and their willingness to include me was greatly appreciated.

Finally, I am forever grateful to my fiancé, Hudsen Timon, for his unwavering support and patience throughout the completion of my master’s program. Not only has he listened to both my proposal and defense presentations more times than I can count, but he has also read and re-read several sections of this report. His patience has been immeasurable, and I couldn’t have done this without him.

Abstract

The Adirondack Park Agency (APA) is a state agency in New York that was established in 1971 with the goal of protecting private and public resources within the Adirondack Park. Over the summer I had the opportunity to work with the APA as their Wetland Mapping Intern in the Resource Analysis and Scientific Services (RASS) division. One of the responsibilities of RASS is to oversee wetland regulations under the New York State Freshwater Wetlands Act and the APA Act. For part of this internship, I accompanied RASS biologists on wetland site visits where I learned more about wetland delineations and the permitting process. After seeing the high demand for wetland site visits, I used the site visit data from the 2024 field season to highlight areas within the Adirondacks with higher wetland site visit frequencies. To accomplish this, I created a graduated symbol map to show the town-specific distribution of site visits. North Elba, Long Lake, and Chester were the towns with the highest frequency of wetland site visits. The resulting map could be used by the APA in an annual report. The second part of my internship was an independent project mapping deep-water marshes in six Adirondack lakes. Deep-water marshes consist primarily of submergent and floating aquatic vegetation that covers at least 100% of an 18.6 m^2 (200 ft^2) area and is within a maximum water depth of 2 m (6.6 ft). GPS points along the boundary of each deep-water marsh were collected and used to create maps in ArcGIS Pro. I found that Lake Flower had the highest percent cover of deep-water marshes and that most of these marshes were less than an acre in size. This project helped expand the APA's wetland database, which is a useful tool in the permitting process.

Chapter 1: A field season for a biologist in the Resource Analysis and Scientific Services division in the Adirondack Park Agency

1.1 Introduction

The Adirondack Park Agency (APA) is a New York State government agency created by the New York State Legislature in 1971 (Ziemann et al. 2013). The APA was established to develop public and private land-use plans and to maintain protection of the Forest Preserve within the Adirondack Park. The Adirondack Park Agency Act was launched in 1973 and regulates land use within the Adirondack Park (Booth 1974). The goal of the APA is to protect private and public resources within the Adirondack Park (Ziemann et al. 2013).

Three statutes give the APA jurisdiction, specifically the New York State Freshwater Wetlands Act, the Adirondack Park Agency (APA) Act, and the New York State Wild, Scenic, and Recreational Rivers System Act.

The New York State Freshwater Wetlands Act, which was passed in 1975 protects all wetlands within New York State that are at least 5 ha (12.4 ac) in size and provides a 30.5 m (100 ft) buffer of protection around wetlands (*Freshwater Wetlands Program* 2023). However, within the Adirondack Park, wetland regulations are more stringent. Under the APA Act, all wetlands within the park that are at least 0.4 ha (1 ac) in size or have free interchange with surface waters are regulated (*Freshwater Wetlands Program* 2023). The New York State Wild, Scenic, and Recreational Rivers System Act provides protection to 18 stretches of river, covering approximately 165 mi as well as a corridor of 0.25 mi on either side of the river (Strauss 1973; Adirondack Park Agency 2012). Project review and permitting by the APA are required to develop or conduct forestry operations in areas that are protected under these three acts (Adirondack Park Agency 2012).

The staff in the Resource Analysis and Scientific Services (RASS) division play a vital role in ecosystem conservation within the Adirondack Park. The division is responsible for conducting research, data analysis, and assessments relating to land use, natural resource management, and conservation (Adirondack Park Agency). RASS biologists are responsible for delineating wetlands, studying biodiversity, investigating ecosystem function, and evaluating conservation strategies (Adirondack Park Agency). The RASS division also administers wetland regulations under the New York State Freshwater Wetlands Act and the APA Act (Adirondack Park Agency). When an applicant files a jurisdictional inquiry or requests a permit that could involve wetlands, a RASS biologist will conduct an initial desktop preview, which may be followed by a site visit to determine the extent of and delineate targeted wetlands at the project site. The information gained from the site visit is then used to determine whether a permit will be required. Further analysis based on the field data will also be used to determine whether the permit will be granted. Currently, the Agency has four trained and certified biologists that delineate wetlands when needed.

During my summer internship with the APA, I spent a portion of my time shadowing the RASS team on site visits and learned more about the permitting process and how to delineate wetlands. During this time, I also observed the high volume of applications to which the biologists are responding. When I accompanied staff on wetland site visits, we often visited multiple properties in a workday. The goal of this chapter was to investigate the 2024 field season for RASS biologists, by highlighting the frequency of wetland site visits and locating towns that have higher frequencies of site visits.

1.2 Methods

To illustrate the locations of sites in 2024, I created a graduated symbol map that represents the number of site visits per town using GIS software ArcGIS Pro (Esri 2024). A shapefile of the 2024 wetland site visits was provided by the APA. Since each point corresponded to an applicant’s property, I decided to visualize the frequency of site visits by town using the graduated-symbol symbology to maintain applicant privacy. The shapefiles for the Adirondack Park Blue Line boundary and Adirondack towns were sourced from ArcGIS Online (Adirondack Park Agency 2023) and the NYS GIS Clearinghouse (ShareGIS NY 2024), respectively. I clipped the towns/cities layer to only include towns within and intersecting the ADK Blue Line boundary using the "select by location" tool and exporting the selected data into a new layer. To assign a town to each of the site visitation locations, I created a one-to-one spatial join with the site visitation locations set as the targets and towns as the join features. The resulting output was a site visitation layer with assigned towns in the attribute table.

Using the new site visitation layer, I changed the symbology to graduated symbols using the town name field, which created town-specific centralized points that varied in size based on frequency of site visitation.

1.3 Results

In the 2024 field season, RASS conducted 264 wetland site visits between March and November. However, the data that I analyzed at the time of this project covered site visits from May to October. Within this time, three members of RASS staff conducted 110 wetland site visits across 50 Adirondack towns (Figure 1.1). The results show that the distribution of wetland site visitation was more concentrated in the eastern half of the park (Figure 1.1). In particular, North Elba, Long Lake, and Chester had the highest frequency of wetland site visits (Figure 1.1).

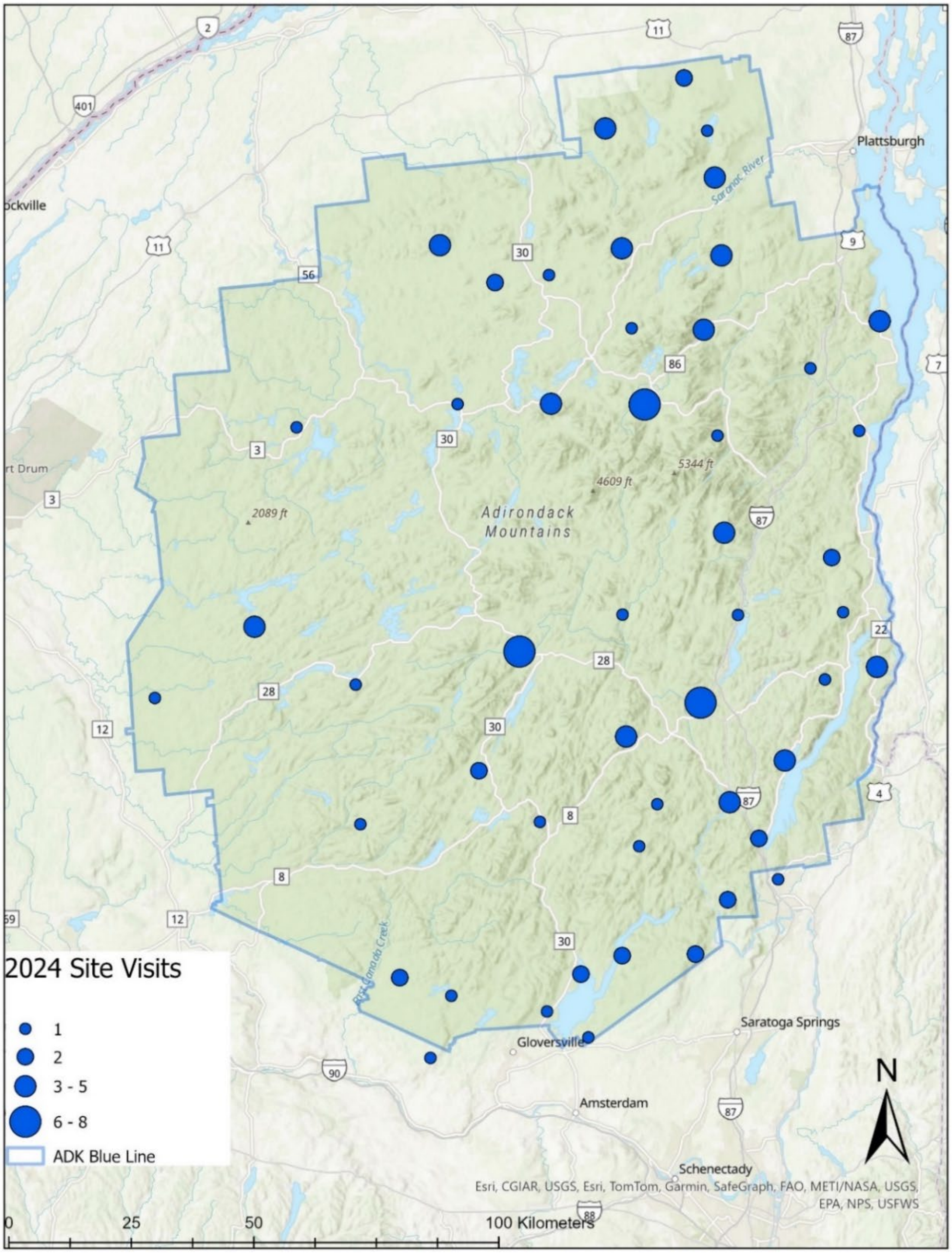

Figure 1.1 The number of RASS wetland site visits per town in 2024, with centroids placed in each town, so some points appear outside the Adirondack Park Blue Line boundary. This reflects the partial dataset that was used at the time of this project and does not represent the entire 2024 field season.

1.4 Conclusion

During this portion of my internship, I had the opportunity to learn about how the APA conducts wetland site visits. Often staff from multiple divisions such as Planning or Regulatory Programs are present to meet with the applicants while the RASS biologist delineates any wetlands present at the proposed project site. I also had the opportunity to go on a few enforcement site visits that involved wetlands. An enforcement visit is conducted when a landowner is suspected of committing a violation, such as filling or building in a wetland without a permit. During this type of site visit, an Enforcement Officer will meet with the landowner to discuss the potential violation while a RASS biologist will determine whether there were any wetland impacts. If there were wetland impacts, the landowner is provided with information on how to resolve the issue, such as removing the fill or structure.

The results of this project provided a visualization of the 2024 field season and insight into RASS staff effort through the distribution of site visits. The map indicated towns such as North Elba, Long Lake, and Chester, in the eastern portion of the park, were hotspots for wetland assessments. These towns have higher population densities compared to other towns within the Adirondack Park, which could result in higher land-use activity and development pressures (Barge & Jordan 2022). This trend could also be a result of population trends within the Adirondacks. The map created in this study could be a valuable tool for APA staff, enabling them to identify regions of the Adirondack Park that are experiencing higher demands for wetland permitting and better assess resultant landscape pressures and impacts.

1.5 References

Adirondack Park Agency. (2012). Citizen's Guide to Adirondack Park Agency Land Use Regulations. [Last accessed 8 October 2024] https://apa.ny.gov/Documents/Guidelines/CitizensGuide.pdf

Adirondack Park Agency (2023). Boundary Line of the New York State Adirondack Park, [shapefile]. ArcGIS Online. [Last accessed 16 October 2024] https://services2.arcgis.com/8krRUWgifzA4cgL3/arcgis/rest/services/AdirondackParkBoundary/FeatureServer

Barge, J. & Jordan, M. (2022). Adirondack Park Population and Land Classification Statistics [PDF]. Adirondack Park Agency. [Last accessed 24 January 2025] https://apa.ny.gov/Mailing/2022/02/Planning/2020CensusPresentationtoBoard20020210.pdf

Booth, R. S. (1974). Adirondack Park Agency Act: A Challenge in Regional Land Use Planning. *George Washington Law Review* 43: 612-634.

Esri (2024). *ArcGIS Pro* (Version 3.4) [Software]. Esri. https://www.esri.com/en-us/arcgis/products/arcgis-pro

Freshwater Wetlands Program. Department of Environmental Conservation. (2023). [Last accessed 10 October 2024] https://dec.ny.gov/nature/waterbodies/wetlands/freshwater-wetlands-program

ShareGIS NY (2024). NYS Civil Boundaries: Cities Towns [shapefile]. NYS GIS Clearinghouse. [Last accessed 23 October 2024] https://data.gis.ny.gov/maps/074d3456e5664f5e85d0fb251d05cc5b/about

Strauss, P. L. (1973). The New York Wild, Scenic and Recreational Rivers System Act. *Urban Law Annual* 1973: 137-148.

Ziemann, A. C., Reagan, K. D., Colarusso, T. W., Allen, E. B., Spada, D. M., Barge, J.W., Rooks, M. W., & Bogucki, D. J. (2013). Effectiveness of and Enhancements to the New York State Adirondack Park Agency's Wetland Protection Program. [Last accessed 10 October 2024] https://apa.ny.gov/Research/epa_projects.htm

Chapter 2: Mapping Deep-water Marshes in Adirondack Lakes

2.1 Introduction

Deep-water marshes are a type of wetland with permanent standing water that can range in depth from 15 cm to 2 m and have free interchange with a permanent waterbody (New York Natural Heritage Program 2024). Submergent and floating aquatic vegetation such as pondweeds (*Potamogeton* sp.), waterlilies (*Nymphaea* sp.), or pipeworts (*Eriocaulon* sp.) are often dominant. Emergent vegetation such as bulrushes (*Schoenoplectus* sp.), cattails (*Typha* sp.), or pickerelweed (*Pontederia cordata*) may also be present (New York Natural Heritage Program 2024). Like other types of wetlands, deep-water marshes are an important habitat, providing cover and resources for a range of species including waterfowl, muskrats, fish, amphibians, and aquatic insects (Cowardin 1979). The vegetation of deep-water marshes provides additional services such as helping to prevent shoreline erosion and improving water quality (Mitra et al. 2003).

Within the Adirondack Park, wetlands that are at least one acre in size, or any wetland that has free interchange with surface water, are protected under the APA Act and the NYS Freshwater Wetlands Act (Adirondack Park Agency 2019). For the APA to have jurisdiction over deep-water marshes, vegetation density and water depth are important factors. For an area to be classified as a deep-water marsh, the vegetation must cover at least 30% of a 55.7 m^2 (600 ft^2) area, or 100% cover within an 18.6 m^2 (200 ft^2 area), and the water depth must not exceed 2 m (6.6 ft).

The goal of this project was to map deep-water marshes along some of the more developed lakes in the Adirondack Park to be included in the APA's wetland inventory. Aquatic vegetation emerges in early July and begins senescence in late September;

therefore, the window to conduct applicant site visits is more limited compared to other wetland types. Maps of the locations of these wetlands would provide a resource for APA staff to use to inform permitting outside of the short growing season. In addition, delineating deep-water marshes often requires a watercraft, which is not always available during site visits and can be more time consuming. Updated maps of deep-water marshes help APA staff in determining jurisdiction and issuing permits more efficiently.

2.2 Methods

Study Sites

Lakes selected for this project had shorelines consisting primarily of private land and often received applications for shoreline projects such as boathouse or dock construction or expansion. In total, six lakes were surveyed (Figure 2.1, Table 2.1). Lake Flower is located in Saranac Lake and was created in 1827 when the Saranac River was dammed (Surprenant 2014). A DEC-managed boat launch near the dam at the northern end of Lake Flower can be used to access other lakes such as Oseetah Lake and Kiwassa Lake (Saranac Lake 2024). Kiwassa Lake, also in Saranac Lake, has a small boat launch in the north at the end of Lonesome Pond Road. Most of the shoreline is private property with some state land along the western portion of the lake (Adirondack Park Agency 2018). Upper Saranac Lake was the largest lake I surveyed (Table 2.1). Unlike the other lakes that were surrounded by mostly private land, approximately half of Upper Saranac Lake's shoreline is state land with public campsites and a boat launch at the northern end of the lake on County Route 46 (Adirondack Park Agency 2018). Chazy Lake is located in Dannemora and has a public boat launch at the northern end, off of Route 374. While most of Chazy Lake is privately owned, there is some state land at the southern end (Adirondack Park Agency 2018). Upper Chateaugay Lake, also in Dannemora, has a small patch of state land at the southern end of the lake (Adirondack Park Agency 2018). Lower Chateaugay Lake, located north of Upper Chateaugay Lake in Bellmont, is completely surrounded by private land (Adirondack Park Agency). Upper and Lower Chateaugay lakes are connected by a channel referred to as the Chateaugay Narrows. The boat launch to access both lakes is located in the Narrows off of Route 374.

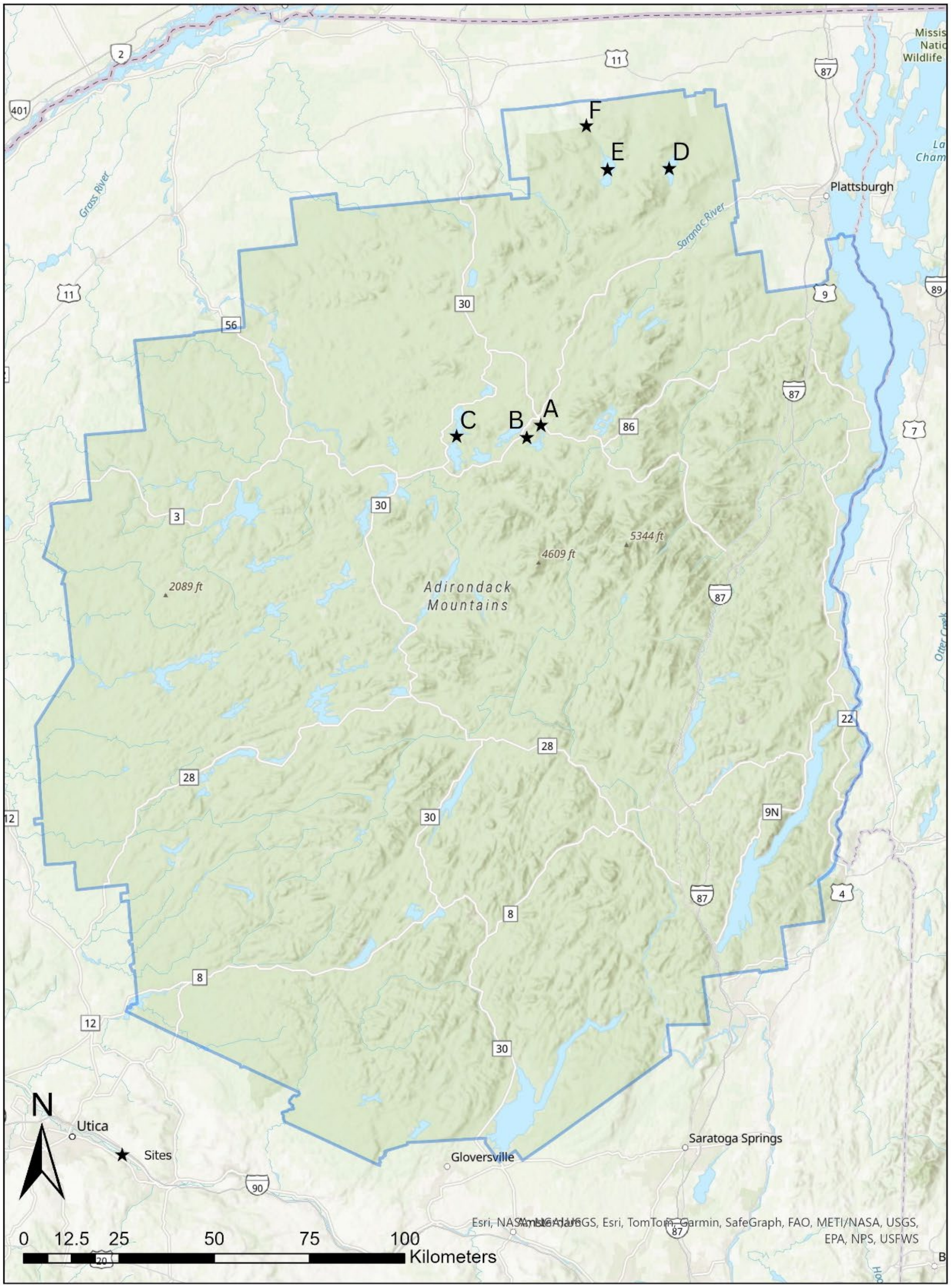

Figure 2.1 Locations of the six Adirondack lakes included in the deep-water marsh surveys conducted in 2024. (A) Lake Flower, (B) Kiwassa Lake, (C) Upper Saranac Lake, (D) Chazy Lake, (E) Upper Chateaugay Lake, and (F) Lower Chateaugay Lake.

Table 2.1 Area (ha), average depth (m), and maximum depth (m) for the six lakes included in the deep-water marsh surveys (NYSDECa-f).

	Area (ha)	Avg. Depth (m)	Max. Depth (m)
Lake Flower	81.7	1.5	3.0
Kiwassa Lake	114.5	6.4	12.2
Upper Saranac Lake	1,974.5	10.1	24.4
Chazy Lake	746.6	10.1	21.9
Upper Chateaugay Lake	1,009.3	10.1	23.7
Lower Chateaugay Lake	235.9	3.7	7.9

Field Methods

I conducted surveys for aquatic vegetation from July to mid-August 2024 during the peak of the growing season. Because windy conditions can impair visibility in the water column, I only conducted surveys on calm, sunny days. In some cases, the wind would pick up while surveying, making it difficult to see into the water, so we would stop and wait for the next clear day.

At each lake, I conducted surveys from either a solo canoe or motorboat. Following the shoreline, I would look for vegetation that met the density requirement of at least 33% cover within 600 m^2 and within a water depth of less than 2 m (Adirondack Park Agency 2019). In areas where the visibility was low, a vegetation rake would be tossed into the water and dragged along the bottom. The amount of vegetation pulled up on the rake would be used to estimate density. A piece of tape on the rake rope was used to determine water depth. When vegetation met the density and water depth requirements, points along the marsh boundary were logged in Avenza (Avenza Systems Inc. 2024). Avenza is a mobile app that allows users to upload maps for navigation using GPS tracking and can be used to collect georeferenced data points. To differentiate between separate marshes, points along each patch of vegetation were labeled with a different letter.

At each lake, I used a smartphone and the Survey123 mobile app by Esri to complete a project form entry developed by RASS staff. Survey123 allows users to create surveys that collect qualitative and quantitative data, georeferenced locations, photos, and to answer project-specific questions (Esri 2024b). The lake survey form included listing the three dominant plant species, the presence of any invasive species, and any relevant notes about the lake.

Data Analysis

At the end of each survey, the points collected in Avenza were exported as a shapefile and imported into ArcGIS Pro (ESRI 2024a). In ArcGIS Pro, I used the create feature class tool to create a new polygon layer. Then using the edit function, I drew polygons for each deep-water marsh using the survey points as a guide. The area of each deep-water marsh was calculated in ArcGIS Pro using the calculate geometry function. I used R Studio to create histograms depicting the size distribution of deep-water marshes for each lake (RStudio Team 2020). Using the calculated overall lake and deep-water marsh areas, I estimated the percent cover of deep-water marshes for each lake.

2.3 Results

Lake Flower had 18.9% deep-water marsh cover out of 75.1 ha (185.5 ac). This lake has a total area of 81.7 ha (202 ac), but the southern portion was not included in the survey. This part of the lake was shallow and had an abundance of large rocks and logs that could have damaged the boat's motor. Most of the shoreline consisted of deep-water marshes with the largest located along the western shoreline (Figure 2.2A). Kiwassa Lake had steeper shores compared to Lake Flower and only 1.4% deep-water marsh cover (Figure 2.2B). The largest deep-water marsh in this lake was found in a shallow cove at the lake's northern tip (Figure 2.2B). Upper Saranac Lake had 2.2% deep-water marsh cover, with the majority of larger deep-water marshes located in the northern half (Figure 2.2C). Chazy Lake had 3.7% deep-water marsh cover with the largest marsh located at the southern lake extent (Figure 2.2D). For both Upper and Lower Chateaugay Lakes, the Narrows that connects them was partially mapped but not included in the total area calculations. Upper Chateaugay Lake had 8.5% deep-water marsh cover, with the largest deep-water marsh located at the lake's southern extent (Figure 2.2E). Lower Chateaugay

Lake had 0.8% deep-water marsh cover, with most of the deep-water marshes located along the western shore (Figure 2.2F).

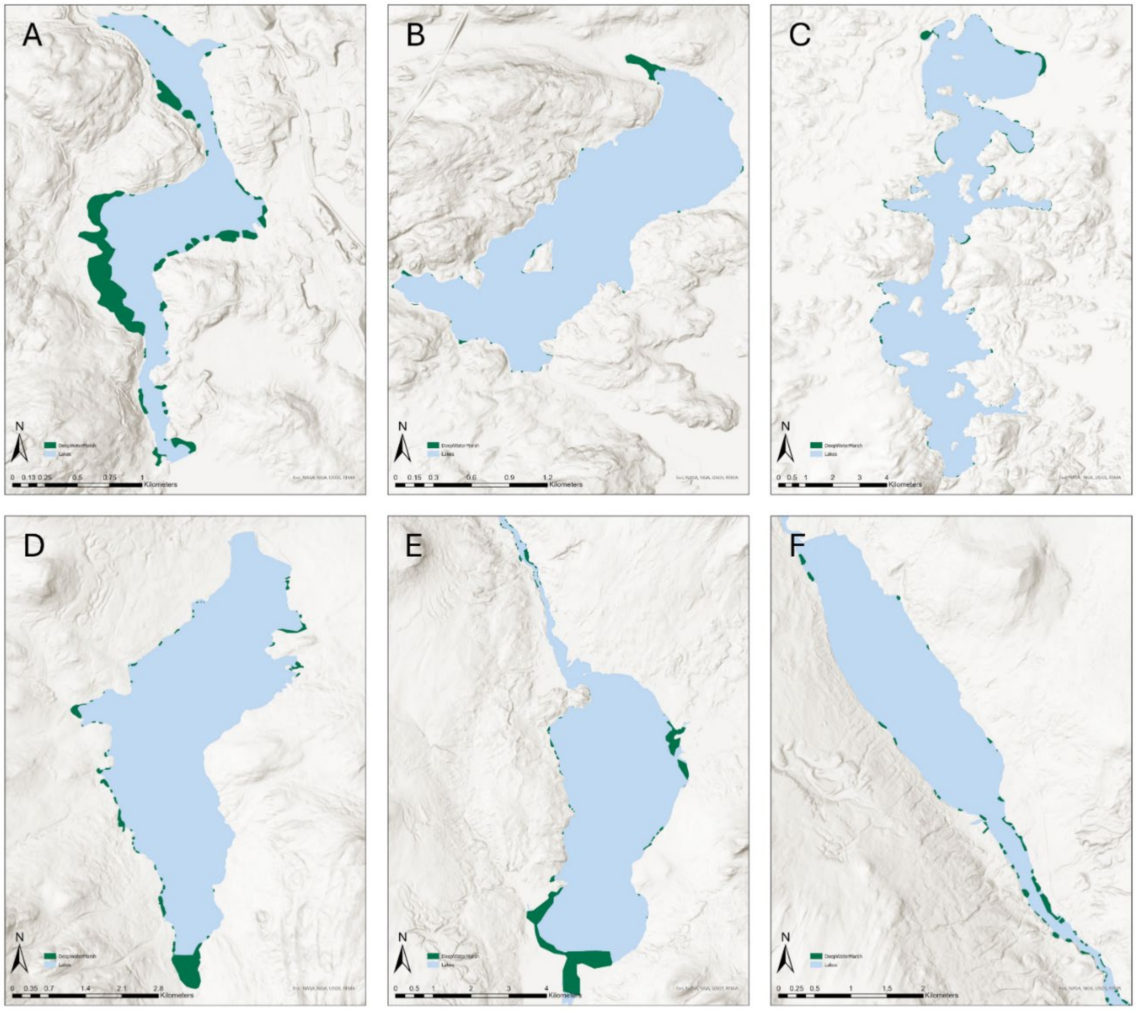

Figure 2.2 Maps of the distribution and area of deep-water marsh habitat in Adirondack lakes surveyed in summer 2024: (A) Lake Flower, (B) Kiwassa Lake, (C) Upper Saranac Lake, (D) Chazy Lake, (E) Upper Chateaugay Lake, and (F) Lower Chateaugay Lake.

Across all lakes, most of the deep-water marshes were an acre or less (Fig. 2.3). In Lower Chateaugay Lake, all of the deep-water marshes were less than an acre in size (Figure 2.3). The other five lakes had some deep-water marshes that were larger than an acre (0.4 ha); notably, Upper Chateaugay Lake had the largest deep-water marsh that covered over 100 acres (Figure 2.3).

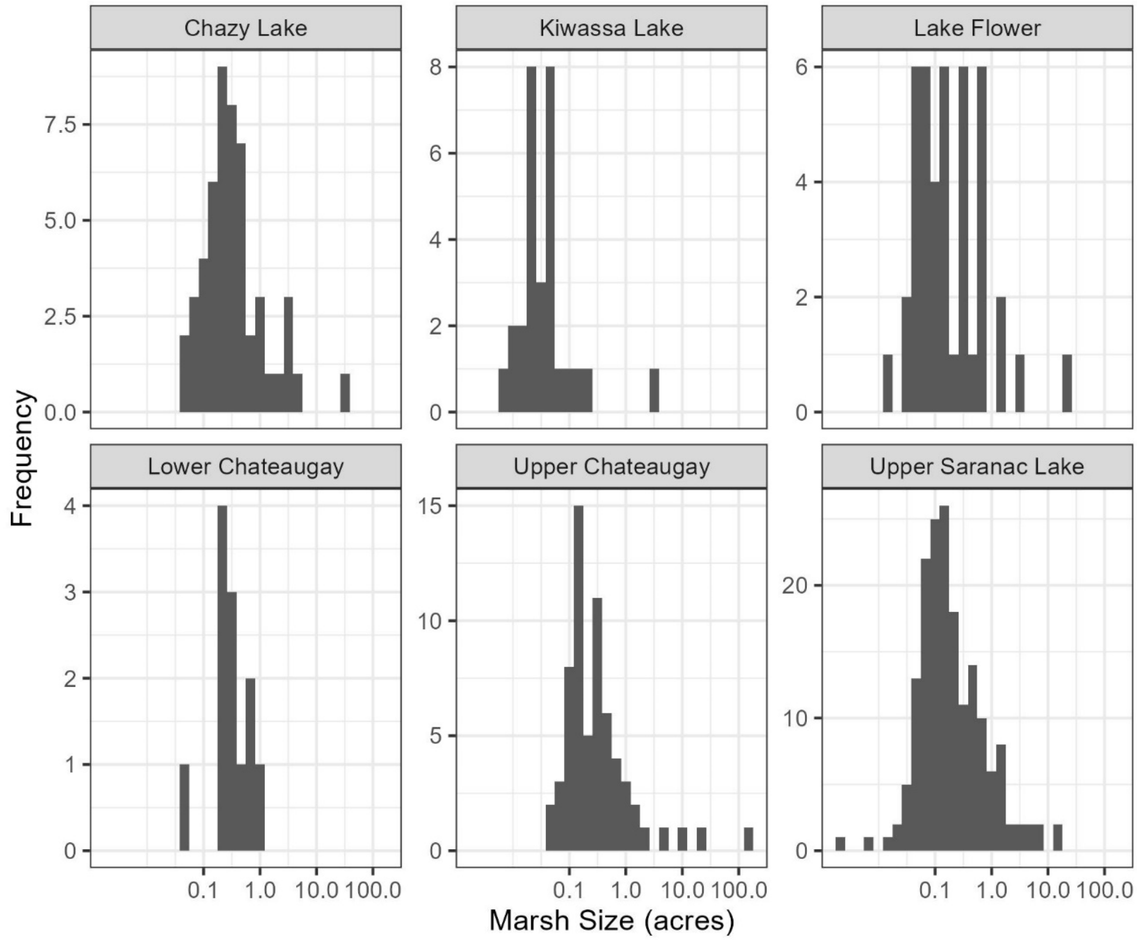

Figure 2.3 Histogram showing the size distribution of deep-water marshes in Adirondack lakes surveyed in summer 2024.

The vegetation was similar across all lakes. Some of the common species observed during the lake surveys included different species of pondweeds (*Potamogeton* sp.), spatterdock (*Nuphar lutea*), and white-water lilies (*Nymphaea odorata*). In Upper Saranac Lake pipeworts (*Eriocaulon* sp.) were also common. In Upper Chateaugay Lake, there was an abundance of bulrush (*Schoenoplectus* sp.). The presence of invasive species was also recorded, with Eurasian watermilfoil (*Myriophyllum spicatum*) found at five of the six lakes surveyed. Of note during the survey of Kiwassa Lake, Eurasian watermilfoil was not detected. During this survey, I met with a shoreline landowner who shared that the residents had previously paid for hand harvesting to remove Eurasian watermilfoil.

2.4 Conclusion

The results of this project offer insight into the distribution of deep-water marshes across six Adirondack lakes. Key findings include the variability in marsh coverage across each lake, with Lake Flower having the highest percent deep-water marsh cover (18.9%). The abundance of deep-water marshes could be explained by the shallow depth of the lake. A previous study by Fu et al. (2014) found that plant biomass and diversity decreased as water depth increased. Lake Flower's average depth is 1.5 m (5 ft), which could allow more light to reach the benthos (NYSDEC 2024c). In contrast, Lower Chateaugay Lake had the lowest percent of deep-water marsh cover (0.8%). In the areas between the mapped marshes, I often observed scattered vegetation present, but the density remained well below the jurisdictional threshold of 100% cover within 200 m^2, or the water depth was greater than 2 m.

While these findings provide valuable information, several challenges during the survey process could have affected the results. For example, during the Upper Chateaugay survey, I used the solo canoe, and the wind picked up as I reached the northern lake terminus. The resulting reduction in water visibility forced my efforts onto paddling, which may have limited my efforts along the eastern shoreline. Additionally, during surveys with the motorboat, if the water was too shallow or there were shoreline obstacles such as large rocks, the boundaries of any present deep-water marshes were estimated using the map on Avenza. This could have influenced the precision of some of the deep-water marsh boundaries.

Despite these limitations, my summer deep-water marsh surveys provided meaningful contributions to the Adirondack Park Agency's (APA) wetland database. The distribution and coverage maps created through this work will be useful for identifying jurisdictional wetlands more accurately during the permitting process, particularly when project submissions fall outside the wetlands' short growing season. Deep-water marsh habitat is highly variable year to year (Findlay et al. 2014). Factors such as turbidity, water depth, and shoreline disturbance can all impact vegetation density (Findlay et al. 2014). This could have an impact on the accuracy of the maps created during this project. In spite of this variability, these maps can still help APA staff by providing a starting point for site visits involving shoreline development such as dock or boathouse construction. Continued monitoring of the deep-water marshes within these lakes could allow managers to estimate variability in marsh cover from year to year, and would be useful in developing future management plans.

2.5 References

Adirondack Park Agency (2018). *State Land Map of the Adirondack Park* [Map] [Last accessed 20 February 2025] https://www.arcgis.com/apps/View/index.html?appid=5ead0c28a9a3436dbf98d6ffc80cb17e

Adirondack Park Agency (2019). *Freshwater wetlands*. Adirondack Park Agency. [Last accessed on 3 December 2024] https://apa.ny.gov/documents/Flyers/FreshwaterWetlands.pdf

Avenza Systems Inc. (2024). *Avenza Maps* (Version 5.0) [Mobile app]. Avenza Systems Inc. https://www.avenza.com/avenza-maps/

Cowardin, L. M. (1979). Classification of Wetlands and Deepwater Habitats of the United States. *US Department of the Interior Fish and Wildlife Service Office of Biological Services*.

Esri (2024a). *ArcGIS Pro* (Version 3.4) [Software]. Esri. https://www.esri.com/en-us/arcgis/products/arcgis-pro

Esri (2024b) *ArcGIS Survey123* (Version 3.20) [Mobile app] Esri. https://www.esri.com/en-us/arcgis/products/survey123

Findlay, S. E. G., Strayer, D. L., Smith, S. D., & Curri, N. (2014). Magnitude and Patterns of Change in Submerged Aquatic Vegetation of the Tidal Freshwater Hudson River. *Estuaries and Coasts 37*: 1233-1242.

Fu, H., Zhong, J., Yuan, G., Ni, L., Xie, P., & Cao, T. (2014). Functional Traits Composition Predict Macrophytes Community Productivity Along a Water Depth Gradient in a Freshwater Lake. *Ecology and Evolution 4*(9): 1516-1523.

Mitra, S., Wassmann, R., & Vlek, P. L. (2003). *Global Inventory of Wetlands and Their Role in the Carbon Cycle* (No. 1546-2016-132267).

New York Natural Heritage Program. 2024. Online Conservation Guide for *Deep Emergent Marsh*. [Last accessed 4 December 2024] https://guides.nynhp.org/deep-emergent-marsh/

New York State Department of Environmental Conservation. (2024a). *Chazy Lake contour map*. Division of Fish, Wildlife and Marine Resources, Lake Map Series. Retrieved from https://extapps.dec.ny.gov/docs/fish_marine_pdf/chzylkmap.pdf

New York State Department of Environmental Conservation. (2024b). *Kiwassa Lake contour map*. Division of Fish, Wildlife and Marine Resources, Lake Map Series. Retrieved from https://extapps.dec.ny.gov/docs/fish_marine_pdf/kwssalkmap.pdf

New York State Department of Environmental Conservation. (2024c). *Lake Flower contour map*. Division of Fish, Wildlife and Marine Resources, Lake Map Series. Retrieved from https://extapps.dec.ny.gov/docs/fish_marine_pdf/lkflwrmap.pdf

New York State Department of Environmental Conservation. (2024d). *Lower Chateaugay Lake contour map*. Division of Fish, Wildlife and Marine Resources, Lake Map Series. Retrieved from https://extapps.dec.ny.gov/docs/fish_marine_pdf/lrchatlkmap.pdf

New York State Department of Environmental Conservation. (2024e). *Upper Chateaugay Lake contour map*. Division of Fish, Wildlife and Marine Resources, Lake Map Series. Retrieved from https://extapps.dec.ny.gov/docs/fish_marine_pdf/upchatlkmap.pdf

New York State Department of Environmental Conservation. (2024f). *Upper Saranac Lake contour map*. Division of Fish, Wildlife and Marine Resources, Lake Map Series. Retrieved from https://extapps.dec.ny.gov/docs/fish_marine_pdf/upsaralkmap.pdf

RStudio Team. (2020). *RStudio: Integrated Development Environment for R*. RStudio, PBC. https://www.rstudio.com/

Saranac Lake. (2024). *Lake Flower*. Saranac Lake. [Last accessed 12 February 2025] https://www.saranaclake.com/paddling/lake-flower

Surprenant, N. (2014). *Images of America: Saranac Lake*. Arcadia Publishing. Charlestown, SC, USA.