ESP 126-Tuesday.

Final Lab Report.

Sam Matey.

5/1/18.

Surveying diversity, composition, and variation of macroscopic vascular plant communities in the Frazier Preserve wetland, Gorham, Maine, USA.

By Sam Matey.

Abstract

This lab report describes observational research conducted to survey diversity, composition, and variation of macroscopic vascular plant communities in the Frazier Preserve wetland of Gorham, Maine, both within and outside the riparian zone. Two transects were set to sample plant communities. Species richness and composition of six quadrats along each transect were evaluated. Plants were counted as ramets, not genets, as genetic sampling is outside the scope of this study. The Simpson Reciprocal Index and Jaccard Similarity Index were used to analyze the resulting data. The overall pattern found was of low diversity at small scales, but high diversity at larger scales. Individual quadrats had low diversity, but the landscape as a whole shows high variation in species composition.

Keywords: riparian zone, wetland, Frazier Preserve, vascular plants, Simpson Reciprocal Index, Jaccard Similarity Index, Balsam fir (*Abies balsamea*)

Introduction

The area around a stream (the riparian zone) is a highly complex and mutable habitat. Environmental filtering due to the local hydrological gradient and dispersal filtering due to the multiple methods that propagules can arrive in the area combine to form rich, dynamic plant communities in stream riparian zones (Fraije et al., 2015). Streamside plant communities also serve multiple ecological functions, including providing food and shelter for wildlife, providing shade and organic matter for the stream, and stabilizing stream banks by preventing erosion (Dwire et al., 2004).

Standard methods of quantifying the characteristics of plant communities include species richness, the Gini-Simpson or Simpson Reciprocal index, and the Jaccard index (Jost, 2006). Species richness is simply the number of species in a given area, while the Simpson Reciprocal index is calculated as $1/\Sigma p_i^2$, where p_i is the fractional abundance of a species. The Jaccard index gives the similarity of two areas' communities, and is calculated as N_{shared}/N_{tot}, or the number of species the two communities share divided by the total number of species in both communities (Jost, 2006).

The Frazier Preserve wetland is an 11.66 acre freshwater palustrine deciduous forested wetland, located in the town of Gorham, ME, on land owned by the Presumpscot Regional Land Trust (National Wetlands Inventory Wetlands Mapper, n.d., Gorham Times Staff, 2017). Gully Brook, a first-order stream, forms in this wetland. This research project will use transect surveying, the Simpson Reciprocal index, and the Jaccard index to evaluate the plant communities of a riparian zone within the Frazier Preserve wetland and, for contrast, a random part of the Frazier Preserve wetland. Given the environment, I expected to see wetland species common in Maine palustrine wetlands, such as red maple (*Acer rubrum*), balsam fir (*Abies balsamea*), and yellow birch (*Betula allegheniensis*).

Materials

- 1 one hundred-meter tape measure.
- 4 yellow surveying flags.
- 1 two-meter Mini-Rod.
- 1 smartphone, with camera and iNaturalist app installed.
- 1 laptop, with Excel program installed.

Methods

A 20-meter transect was set beginning at a random point in the Frazier Preserve wetland. Every 4 meters (at 0, 4, 8, 12, 16, and 20 meters) a 1-meter by 1-meter quadrat was defined, centered on the relevant meter mark. A subset of species richness and composition were noted for each quadrat; only macroscopic living emergent vascular plants were counted, as invertebrates, bryophytes, and microbiota were outside the scope of this study. Plants were counted as ramets (physiological individuals), not genets, as genetic sampling is outside the scope of this study. A second 20-meter transect was then set beginning at the edge of a local waterbody and moving upland into the woods. Every 4 meters (at 0, 4, 8, 12, 16, and 20 meters) a 1-meter by 1-meter quadrat was defined, centered on the relevant meter mark. The same subset of species richness and composition were noted for each quadrat of this transect. The app iNaturalist was used as an identification aid for species in both transects. The data from these two transects and their 12 total quadrats were then uploaded to Excel and analyzed.

Results

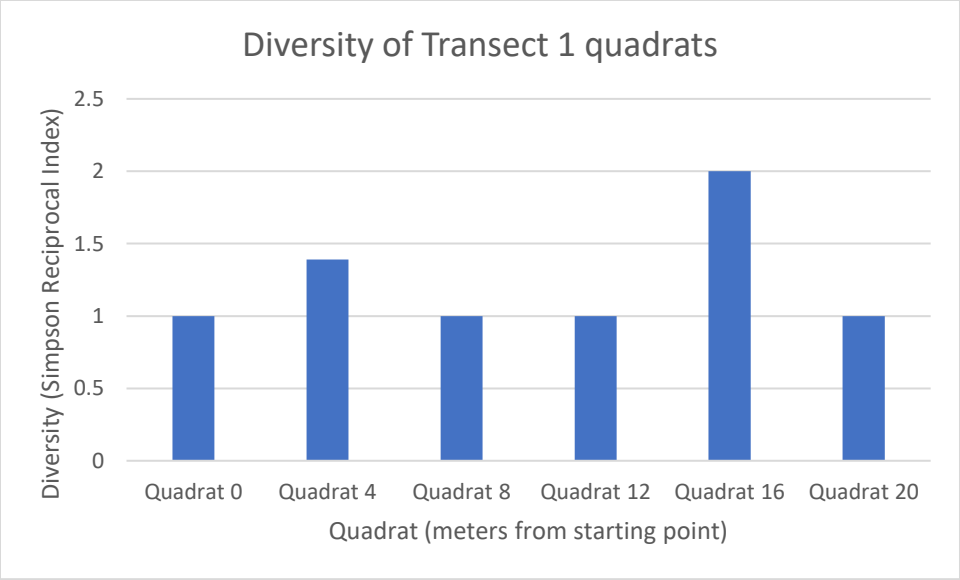

Figure 1: Diversity of Transect 1 quadrats

The first transect conducted was of a random part of the Frazier Preserve wetland. Of the six one-square-meter quadrats surveyed, four of them hosted only one species of macroscopic living emergent vascular plants (hereinafter referred to as "species") and so had a species richness of 1 and a diversity (as measured by the Simpson Reciprocal Index) of 1 (Figure 1). The quadrat centered on the 0-meter mark of the transect (Quadrat 0), for example, hosted 11 ramets of an unknown graminoid species, possibly a sedge of some sort. Quadrat 4 had the highest species richness (n=3), and the second-highest diversity (n=1.39) with 16 ramets of an unknown pale-barked woody plant (possibly young *Quercus* spp.), 1 ramet of an unknown red-barked woody plant (possibly *Betula* spp) and 2 ramets of an unknown white, waxy, and knob-like plant (possibly *Monotropa* spp). Quadrats 8 and 20 both only hosted ramets of balsam fir (*Abies balsamea*) and so had species richness and Simpson Reciprocal Index diversities of 1. Quadrat 12 hosted only one pteridophyte of unknown species, and so had a species richness and Simpson Reciprocal Index diversity of 1. Quadrat 16, although having the highest diversity as measured by the Simpson Reciprocal Index (n=2), only hosted two ramets: one adult beech

(*Fagus grandifolia*) and one young *A. balsamea*. Overall species richness for the six quadrats counted together was 7, and overall Simpson Reciprocal Index diversity was 3.36.

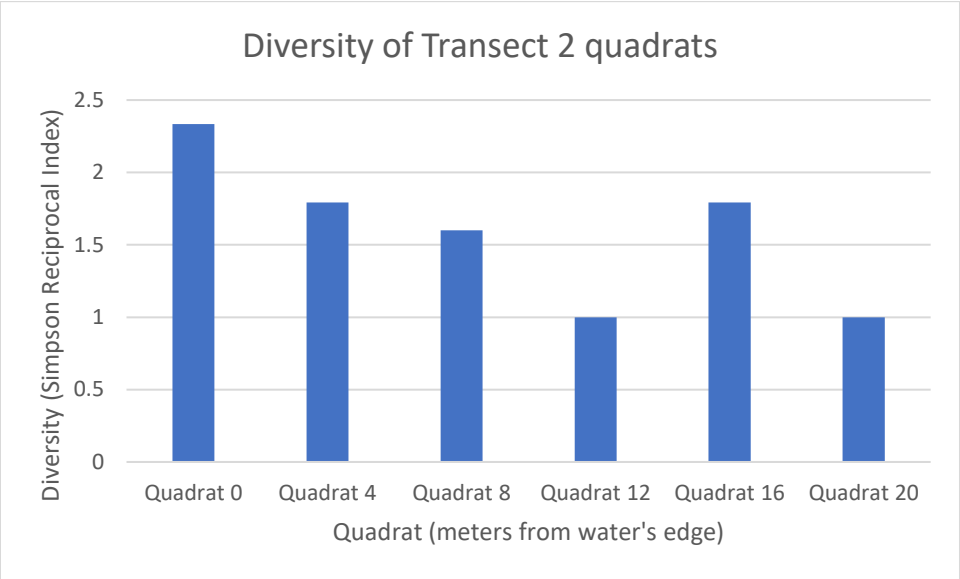

Figure 2: Diversity of Transect 2 quadrats

The second transect conducted began at the edge of a ditched waterway near the border of the Frazier Preserve wetland. Quadrat 0 had a species richness of 3 and a Simpson Reciprocal Index diversity of 2.33, the highest value of any quadrat on either transect (Figure 2). It hosted 4 ramets of American wintergreen (*Gaultheria procumbens*), 2 ramets of an unknown young tree species (possibly *Acer* spp.) and 1 ramet of an unknown graminoid (possibly sedge). Quadrat 4 had a species richness of 2 and a Simpson Reciprocal Index diversity of 1.79. It hosted 2 ramets of another unknown young tree species (possibly *Quercus* spp.) and 1 adult black ash (*Fraxinus nigra*). Quadrat 8 had a species richness of 2 and a Simpson Reciprocal Index diversity of 1.6. It hosted 3 ramets of *G. procumbens* and 1 ramet of the unknown graminoid. Quadrats 12 and 20 only hosted ramets of *A. balsamea*, and so had species richness and Simpson Reciprocal Index diversities of 1. Quadrat 16 hosted 2 ramets of the unknown graminoid and 1 adult red maple (*Acer rubrum*). Its species richness was 2 and its Simpson Reciprocal

Index was 1.79. Overall, species richness for the six quadrats counted together was 7, and overall Simpson Reciprocal Index diversity was 2.97.

Table 1: Transect 1 Jaccard Similarity Indices

Transect 1	**Jaccard Indices of Similarity:**
0 vs 4	0
0 vs 8	0
0 vs 12	0
0 vs 16	0
0 vs 20	0
4 vs 8	0
4 vs 12	0
4 vs 16	0
4 vs 20	0
8 vs 12	0
8 vs 16	0.5
8 vs 20	1
12 vs 16	0
12 vs 20	0
16 vs 20	0.5

Table 2: Transect 2 Jaccard Similarity Indices

Transect 2	**Jaccard Indices of Similarity:**
0 vs 4	0
0 vs 8	0.666666667
0 vs 12	0
0 vs 16	0.4
0 vs 20	0
4 vs 8	0
4 vs 12	0
4 vs 16	0
4 vs 20	0
8 vs 12	0
8 vs 16	0.333333333
8 vs 20	0
12 vs 16	0
12 vs 20	1
16 vs 20	0

Jaccard similarity indices were calculated for both transects. For Transect 1, 12 of the 15 pairings had

Jaccard values of 0 (i.e. had no species in common). The pairing of Quadrat 8 and Quadrat 20 had a Jaccard value of 1 (all species in common) and the pairings of Quadrat 8 and 16 and Quadrat 16 and 20 had Jaccard values of 0.5. For Transect 2, 11 of the 15 pairings had Jaccard values of 0. The pairing of Quadrat 0 and Quadrat 8 had a Jaccard value of 0.67, the pairing of Quadrat 0 and Quadrat 16 had a Jaccard value of 0.4, the pairing of Quadrat 8 and Quadrat 16 had a Jaccard value of 0.33, and the pairing of Quadrat 12 and Quadrat 20 had a Jaccard value of 1.

Discussion

Overall species richness for individual quadrats was low, with no quadrat having a species richness greater than 3. In Transect 1 (the random sample of the wetland) four of the six quadrats had a species richness of 1: Quadrat 1 hosted only an unknown graminoid, Quadrats 8 and 20 hosted only *Abies balsamea*, and Quadrat 12 hosted only an unknown pteridophyte. Quadrats 4 and 16 hosted somewhat more complex communities. As this is a random sample of the wetland, Transect 1's variation may be taken as a "baseline" for the wetland.

Figure 3: Transect 2 Quadrat 1

Transect 2, in contrast, appeared to show gradual reduction in diversity as a function of distance from the water's edge. Quadrat 0 (Figure 3), which was directly on the water's edge, had a species richness of 3 and a Simpson Reciprocal Index diversity of 2.33, the highest value of any quadrat on either transect. Quadrats 4 and 8 had gradually decreasing diversities, until Quadrat 12 reached a diversity of 1. This trend was broken by Quadrat 16, which had a diversity of 1.79 and a species richness of 2. However, Quadrat 20 resumed the trend. Although this research project was unable to evaluate enough replicates for full

statistical verification, it appears that diversities are higher closer to the water's edge. This was also verified by personal observation: several species not represented in the transect, such as maleberry (*Lyonia ligustrina*) and alders (*Alnus* spp.) were present near the water's edge but absent elsewhere in the wetland.

Despite the apparent low diversities and species richness in individual quadrats, variation between quadrats was very high. As shown by the Jaccard similarity indices, the vast majority of quadrat pairings had zero species in common. The overall pattern is of low diversity at small scales, but high diversity at larger scales. Individual quadrats have low diversity, but the landscape as a whole shows high variation in species composition.

Figure 4: Transect 1 Quadrat 20

Interestingly, four of the twelve total quadrats surveyed (Transect 1 Quadrats 8 and 20 and Transect 2 Quadrats 12 and 20) hosted only ramets of balsam fir (*Abies balsamea*). Figure 4 shows Transect 1 Quadrat 20, which hosted 7 ramets of *A. balsamea* and no other species. As *A. balsamea* was identified with a high degree of confidence (the characteristic "Christmas tree" smell was present, and iNaturalist users concurred with the identification), it is likely that this species is indeed establishing dominance in localized areas of the Frazier Preserve wetland. This is potentially due to allelopathic effects. Pellissier and Souto (1999) note that tannins isolated from *A. balsamea* were found to inhibit nitrifying bacteria, making it more difficult for other plants to become established in the area. This information supports my supposition.

Figure 5: “Island-like” structures in the Frazier Preserve wetland.

An overall pattern present in the Frazier Preserve wetland was the existence of “island-like” structures with high plant diversity surrounded by leaf litter with low plant diversity (Figure 5). Based on previous visits to the wetland, this appears to be due to inundation of the leaf litter-covered areas during the winter. This pattern led to some quadrats being set in the leaf litter area, and so having very low species richness. For example, Transect 1 Quadrat 12 only hosted one young pteridophyte. For future research on this wetland’s plant communities, larger quadrats (perhaps 2 or 3 square meters instead of 1) at wider intervals along the transect could provide a more accurate representation of overall species diversity.

References

Dwire, K. A., Kauffman, J. B., Brookshire, E. J., & Baham, J. E. (2004). Plant biomass and species composition along an environmental gradient in montane riparian meadows. *Oecologia, 139*(2), 309-317.

Gorham Times Staff (2017, September 21). Gorham Trails and Presumpscot Regional Land Trust Merge. Retrieved March 12th, 2018, from http://www.gorhamtimes.com/gorham-trails-presumpscot-regional-land-trust-merge/.

Fraaije, R. G., Braak, C. J., Verduyn, B., Verhoeven, J. T., & Soons, M. B. (2015). Dispersal versus environmental filtering in a dynamic system: drivers of vegetation patterns and diversity along

stream riparian gradients. *Journal of Ecology, 103*(6), 1634-1646.

Jost, L. (2006). Entropy and diversity. *Oikos, 113*(2), 363-375.

National Wetlands Inventory Wetlands Mapper. (n.d.). [Map of Frazier Preserve area]. Retrieved January 23rd, 2018, from https://www.fws.gov/wetlands/data/mapper.html.

Pellissier, F., & Souto, X. C. (1999). Allelopathy in northern temperate and boreal semi-natural woodland. *Critical Reviews in Plant Sciences, 18*(5), 637-652.