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A Comparison of Desmid Communities in Two New Hampshire Wetlands

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Introduction

Ecology is an important field of study for understanding the world around us. Our world faces numerous environmental challenges, including climate change, pollution, and the decline of biodiversity worldwide. Biodiversity is important because of the interconnected roles various species play in an ecosystem (Clarke et al. 2018a). By looking at the species in an ecosystem, it is possible to get a more holistic understanding of their ecological role. This is because species interact with each other, so the health of one species will affect the health of species it preys on, competes with, or forms a symbiotic relationship with, for example. These predator-prey relationships and other relationships make up a food web, which is a map of how different species interact based on which species eat which other species. It is similar to a food chain, except it connects more species and accounts for overlap, because very rarely does a species only feed on one other species. Every food web has a layer known as the primary producers, which are species that harness the Sun's energy and acquire carbon from an inorganic source. A common example of primary producers are plants, which take in energy from the Sun and carbon from atmospheric CO_2, and are then eaten by the primary consumers (herbivores).

Humanity is no exception to these relationships; we rely on other species for food and resources, and changes in these organisms' populations can positively or negatively affect us. An example of this is in how many drugs and pharmaceutical chemicals have been historically developed from plants, and the loss of plant species could negatively impact our ability to create new medicines (Clarke et al. 2018b). The loss of biodiversity impacts both the health of the ecosystem, and negatively impacts humanity. With the ongoing increase in anthropogenic climate change, loss of biodiversity is only expected to increase in coming decades (Hance 2017).

As pollution and climate change become bigger concerns, it is expected that the distribution of worldwide organisms will change (Hance 2017). This is because species require certain environmental conditions to survive, and as these conditions change the places a species can inhabit will change. Species migration impacts biodiversity because not all species will migrate in the same ways (Gross 2016). For example, if one species starts to migrate in a new direction, but their prey does not migrate in this new way, the predator species will be negatively impacted. Changes like this can affect all life on Earth, even groups that have historically not been studied in ecology. While biodiversity studies tend to focus on macroscopic organisms, microscopic biodiversity can also be affected by human activity, and in turn affect humans and other macroscopic organisms. There are many different ways to study the impact of pollution on the environment, and this study examined algae biodiversity to understand how biodiversity can be impacted by human pollution.

Algae as a barometer for biodiversity and environmental health

In this study, we looked at one group of producers, algae, found in New England wetlands. A wetland is an area where the ground is covered by water or the soil is hydric, either year round or for extensive parts of the year (EPA 2018). Common examples of wetlands include ponds, swamps, and marshes. Wetlands are important in environmental conservation because they are home to a wide variety of organisms, such as fish, birds, plants, amphibians, and mammals (EPA 2018). Wetlands and other bodies of water are important parts of our landscape because they retain and purify water, and harbor rich floras and faunas. Wetlands receive runoff from the land around them. This means that any pollution on neighboring fields, shopping malls, or neighborhoods will be washed into a body of water by the rain, so pollutants can become concentrated in these bodies. Because pollutants become more concentrated in wetlands, they are often more severely affected by pollution than the land around them (WWT 2021). This means that wetlands can be studied to learn the impacts of the pollution before they impact the wider world. In this study, the effect of pollution on algal species diversity was examined.

Algae is a broad term that refers to mostly aquatic and photosynthetic organisms, many of which are unicellular. Algae are found in freshwater and saltwater all around the world. Some species have narrow habitat ranges, only being found in certain parts of the world, whereas others have a global distribution (Mekah 2021). There are several major divisions of algae (Mekah 2021), with some being more closely related to familiar land plants than others. Algae play a crucial role in many ecosystems, primarily as photosynthesizers that provide oxygen and food for the rest of the food web. As producers in food webs, algae are easily affected by pollution in their environment, which then impacts the rest of the food web. Algae growth is often limited by available nutrients in the water (NWF 2021). When there is an increase in nutrients, this can lead to an algal bloom, where the population of algae rapidly increases, and then quickly dies off when the temporary increase of material decreases and the newly large population cannot support itself. This bulge in resources can impact the whole food web, as many other species rely on algae for food.

Pollution affects algae in other ways, too. Because many algae have narrow ecological niches, pollution can affect which types of algae are able to grow in an area. Even if two species rely on the same nutrients, when the nutrients increase one species might be better equipped to use the nutrients. An example of this is when you put a lot of fertilizer in a garden but it helps the weeds grow more than the plants you are actually trying to raise. This is a potential issue for the whole food web that the algae are part of. For algae, if there is an increase in resources then one species will probably undergo an “algae bloom” which is when a species’ population drastically rises and is often visible as a green coating on the surface of the water. Algae blooms often happen due to an increase in nitrogen or phosphorus in the water. This is problematic because it uses up a variety of resources like nitrogen and phosphorus that other algae and organisms also rely on to live. The population spike can also outcompete other microscopic organisms or prevent underwater plants from getting sunlight and photosynthesizing. In short, changes in algae population can impact other organisms in wetlands as well.

Understanding the health of an ecosystem is more than just seeing if life is persisting in an area, it is about which species are doing well and the long term picture, and how many species are able to exist in the system, providing it with greater stability. This is true about microscopic algae, as well as the plants we see everyday. A study conducted in the Mutha River in India found that the dominant algae species in polluted regions were not dominant in clean portions of the river (Jafari 2006). This study found that there was an overarching consistency in which algae species were able to grow in polluted areas, which implies that algae samples can be used to determine how polluted a body of water is. It also shows that human activity affects different species in different ways, so in order to understand how to protect the environment we need to understand how different species of algae are affected by pollution. Even if some species thrive in polluted conditions, the ecosystem as a whole might be doing poorly, because many species are not thriving. It is rare that a type of pollution affects every species in an ecosystem in the exact same way.

Assessing the health of an environment is often a complex and difficult task. While many species make up an ecosystem, researchers will often look at a few key species to assess the overall system. This provides a simplified view of the ecosystem that can still provide insight. Such ecologically sensitive species are known as indicator species, and these are used to assess the ecosystem in general (Weaver 1995). Looking at one species provides a simplified understanding of the ecosystem, and it is often much more feasible to assess a few organisms than to assess every organism in an ecosystem. A species can be a good indicator species if it is endemic or otherwise specific to the ecosystem, is part of the food web of the ecosystem, and reacts to changes in the ecosystem similarly to how other species in the ecosystem react (Magne 2005). Algae have regularly been used as indicator species in research, due to their sensitivity to pollutants and changes in nutrients (Gary 1991).

By looking at which algae species are present in an area, it is possible to assess the quality of the water, as certain species are only found in certain conditions related to water quality (Coesel 2003). Not every algae species would necessarily make a good “indicator species”, however (Rodriguez 2021). As with macroscopic organisms, certain microscopic organisms are “weedlike” in the sense that they can survive in a variety of conditions and their presence is not too telling of the overall water quality. Others are more sensitive to their environment and have been used as indicators of environmental health for decades - for example, diatoms, which are microscopic algae related to kelps. An indicator species must be able to provide representative context on the environment, so it should be a species that tends to be affected by pollution in the same way as other present species. This principle was key in this study, in which desmid algae from two ponds were morphologically identified, and then the species makeup of these ponds was analyzed to discern a correlation between species present and water quality.

Algae within the family Desmidiaceae were examined in this research. Commonly called desmids, this family of charophyte algae has a global distribution, primarily in freshwater (Silva 1980). Charophyte algae is a group of algae that is closely related to land plants, sharing several similar qualities such as their method for photosynthesis (McCourt 2004). Charophyte algae is a type of green algae, which is algae that has a primary chloroplast as a result of endosymbiosis of cyanobacteria (Keeling 2004). To put it another way, desmids are a family of algae that are closely related to land plants. Desmids were examined in this study for several reasons: they are relatively easy to identify morphologically, and many species have been described (Figure 3). Because desmids are also closely related to land plants, they are affected by similar pollution as land plants, and they are generally thought to prefer cleaner water. Additionally, studies have been conducted in the Netherlands, relating particular desmid species to water quality, which provided needed context for using Desmids to study water quality in North America (Coesel 2003). Desmids also survive well in storage after being taken out of the pond, which is helpful as processing samples can take some time.

Understanding microscopic organisms like Desmidiaceae algae can provide important context in understanding the biology of macroscopic plants or animals. By gaining a more concrete understanding of the relationship between pollutants and algae species found in a pond, it will be possible to examine algae in another pond and ascertain the overall biological health of this pond. Macroscopic biodiversity is frequently used as an indicator of human environmental impact, and with further research microscopic biodiversity can be used in a similar way.

Methods

Samples of desmids were gathered from multiple points around two ponds, Pratt Pond in Mason, New Hampshire and Round Pond in Nashua, New Hampshire (Figure 1). Pratt Pond is located in Russell Abbott State Forest, and has been largely protected from anthropogenic pollutants and disturbances, aside from recreational activities such as kayaking or fishing. Conversely, Round Pond is located along Amherst Road (Rt. 101A) on the edge of Nashua, between a CVS Pharmacy, an office supply store, and Harcros Chemicals (Figure 2). The flora and fauna of Round Pond likely has been impacted by the cityscape that surrounds it. Samples were gathered from Pratt Pond on August 15, 2020 and September 26, 2020. Samples were gathered from Round Pond on August 3, 2020 and September 12, 2020. The samples from August 3 were gathered by Cameron Choquette (AU ‘22). Samples were gathered from four different sites around the perimeter of Pratt Pond, and from three sites around Round Pond, as public access allowed. All sites had adequate sun exposure for algae to grow, and algae were gathered on sunny days.

At every site, samples were gathered by dragging a Wildco fine mesh net (10 µm) through the water two or three times, and then draining most water out of the net, so as to concentrate the algae into a small amount of water, which was then put into labeled plastic bags for transport. Algae were then examined using an Amscope microscope and photographed using a MU1000-ck digital camera and AmScope Software in the week or two following sampling. Algae were primarily visualized at 40x magnification. Algae were kept refrigerated at 38°F when not being examined to preserve the samples.

The photographs of the algae specimens were uploaded to inaturalist.org for identification. Algae were also identified using *A Synopsis of North American Desmids* (Prescott et al. 1975, Prescott et al. 1977, Prescott et al. 1981, Prescott et al. 1983). Once algae specimens were identified to species, the quantity of each species was tabulated and the data were analyzed. Morphological identification was conducted by using the inaturalist AI to identify to family or genus, and then dichotomous keys from the *Synopsis of North American Desmids* were used to identify the sample to species. Additional to the samples gathered in this study, samples from June and July 2020 that were gathered by Cameron Choquette (AU ‘22) from the two ponds were identified on inaturalist and included in the data.

The species richness of both ponds was calculated by totaling the number of desmid species observed in each pond, regardless of their abundance. The Simpson Diversity Index was calculated using the formula $D=1-\Sigma(n/N)^2$, where D is the value of the index, n is the number of specimens observed within a species, and N is the total number of specimens observed in all species. The purpose of this value is to show the variety of species observed within a pond, while also accounting for their abundance. A sample with many specimens of only a few species would have low diversity, and a score close to zero. A sample with an even representation of all species in it would have a value closer to one. The Shannon Diversity Index was calculated using the formula $H=-\Sigma(n/N)\ln(n/N)$, where H is the final value, $\Sigma(n/N)$ is the sum of the number of individuals of a species compared to the total number of individuals observed, and $\ln(n/N)$ is the natural log of this value. The Shannon Diversity Index differs from the Simpson Diversity index in that the range of possible values goes from zero to ten, so it is easier to see a range in data processed through the Shannon Diversity Index. The two indices have a similar purpose but measure and present the diversity slightly differently.

Results

While more species were observed in Pratt Pond, Round Pond has higher scores on both the Simpson and Shannon Indices for species diversity (Table 1). The reason for this difference lies in the relative populations of Desmidiaceae from the ponds when compared to each other. Despite having more Desmidiaceae overall, Pratt Pond is dominated by *Xanthidium*, which make up 42.6% of Desmidiaceae in the pond. *Cosmarium* comes in a distant second, at 15.3% (Figure 4). In Pratt Pond, there were several species found in abundance. For example, there were 102 *Xanthidium cristatum* algae observed, which is 26% of the 399 total Desmidiaceae algae observed in Pratt Pond. Species observed in Pratt Pond were mostly split between only one or two individuals observed, or several observed like with *X. cristatum*. This means that the actual diversity in the pond is low, because most species are barely observed, and there are a couple which dominate. Conversely, while Round Pond had fewer Desmidiaceae species observed, the species that were observed had a smaller range of individual observations within each species. See Appendix 1 for a full table of observed species and quantities observed. This means that Desmidiaceae composition of Round Pond is more evenly distributed, and not dominated by a couple species, which is why Round Pond has a higher diversity rating. In Round Pond, *Cosmarium* was the most abundant genus, containing 40% of observed Desmidiaceae, with *Euastrum* coming in second at 26.7% (Figure 4). This shows how the algae observed is more evenly distributed across genera in Round Pond, causing a higher diversity index despite the pond's lower quantity of algae observed.

Certain Desmidiaceae species are considered "Red List" species (Coesel 2003). Red List species are species of algae that are considered a sign of a "healthy" body of water if they are present. These species are a sign of the successional maturity and high ecological value of a wetland. That is to say, when these species are present, it is a sign that the wetland has a quality amount of biodiversity and has had it for some time. This is because research has established that a Red List species is very sensitive to pollutants or excess nutrients, so if too much pollution is present the species will die out in the pond. There were six Red List species observed in Pratt Pond, and six different Red List species observed in Round Pond.

Figures and Tables

Table 1: Species Richness and Diversity Indices at Pratt and Round Ponds. While Pratt Pond logged more total species, Round Pond scores higher on diversity indices due to a more even species distribution

Species Richness	
Round Pond	**Pratt Pond**
37	46
Red List Species in Each Pond	
Round Pond	**Pratt Pond**
6	6
Simpson Index	
Round Pond	**Pratt Pond**
0.943	0.895
Shannon Index	
Round Pond	**Pratt Pond**
3.28	2.83

Species Present at both Ponds	
12	

Table 2: Desmidiaceae species found in Both Pratt and Round Ponds

Species
Closterium setaceum
Cosmarium amoenum
Cosmarium contractum
Cosmarium punctulatum
Desmidium swartzii
Euastrum bidentatum
Euastrum ornatum
Euastrum turneri
Netrium digitus
Triploceras verticillatum
Xanthidium antilopaeum
Xanthidium octocorne

Figure 1: Pratt Pond (left), which is protected from human development, compared to Round Pond (right), which is at a greater potential to be impacted by human activity.

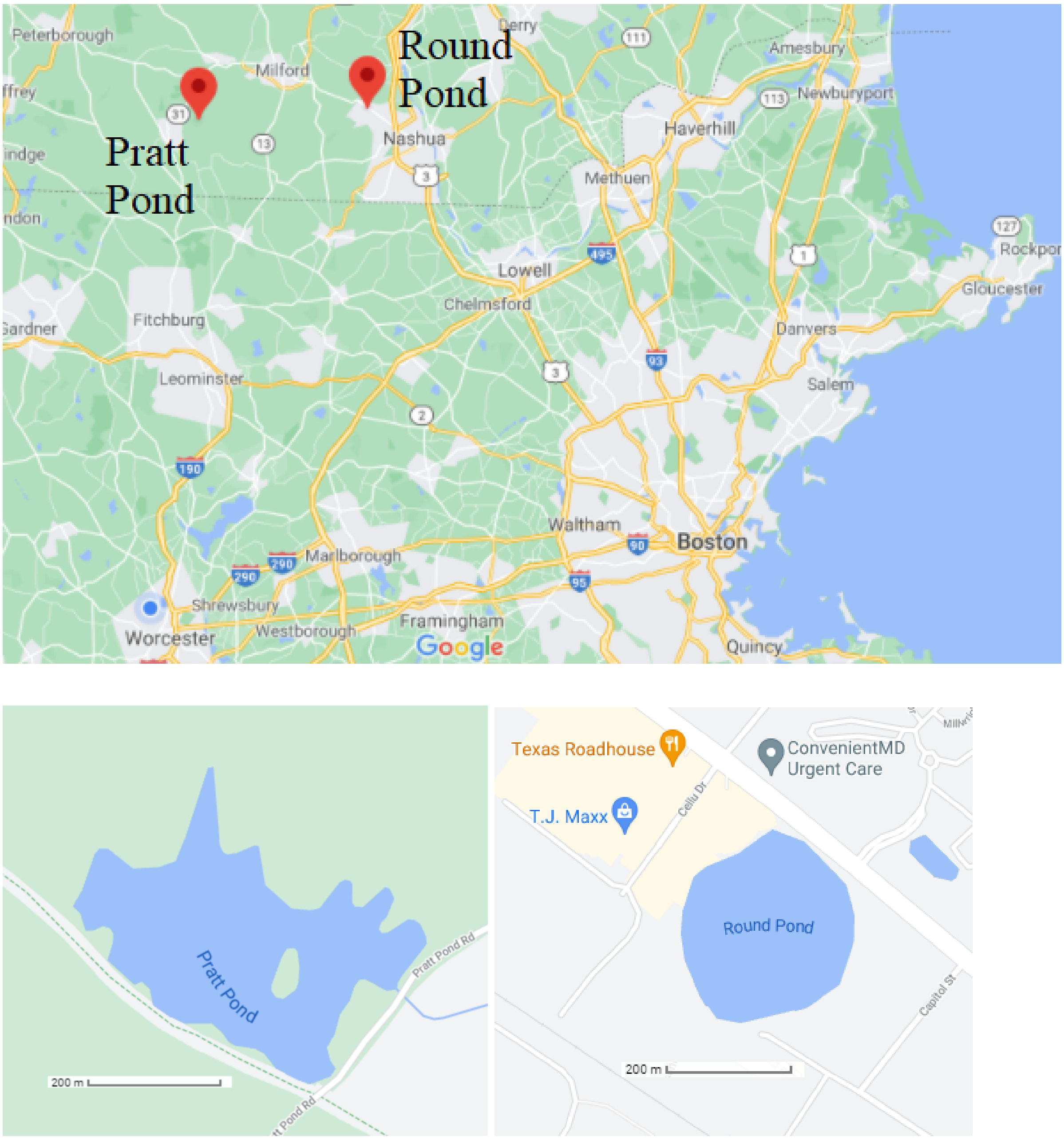


Figure 2: A map of the locations of Pratt Pond and Round Pond in relation to Worcester and Boston, as well as maps showing the shape of the two ponds.

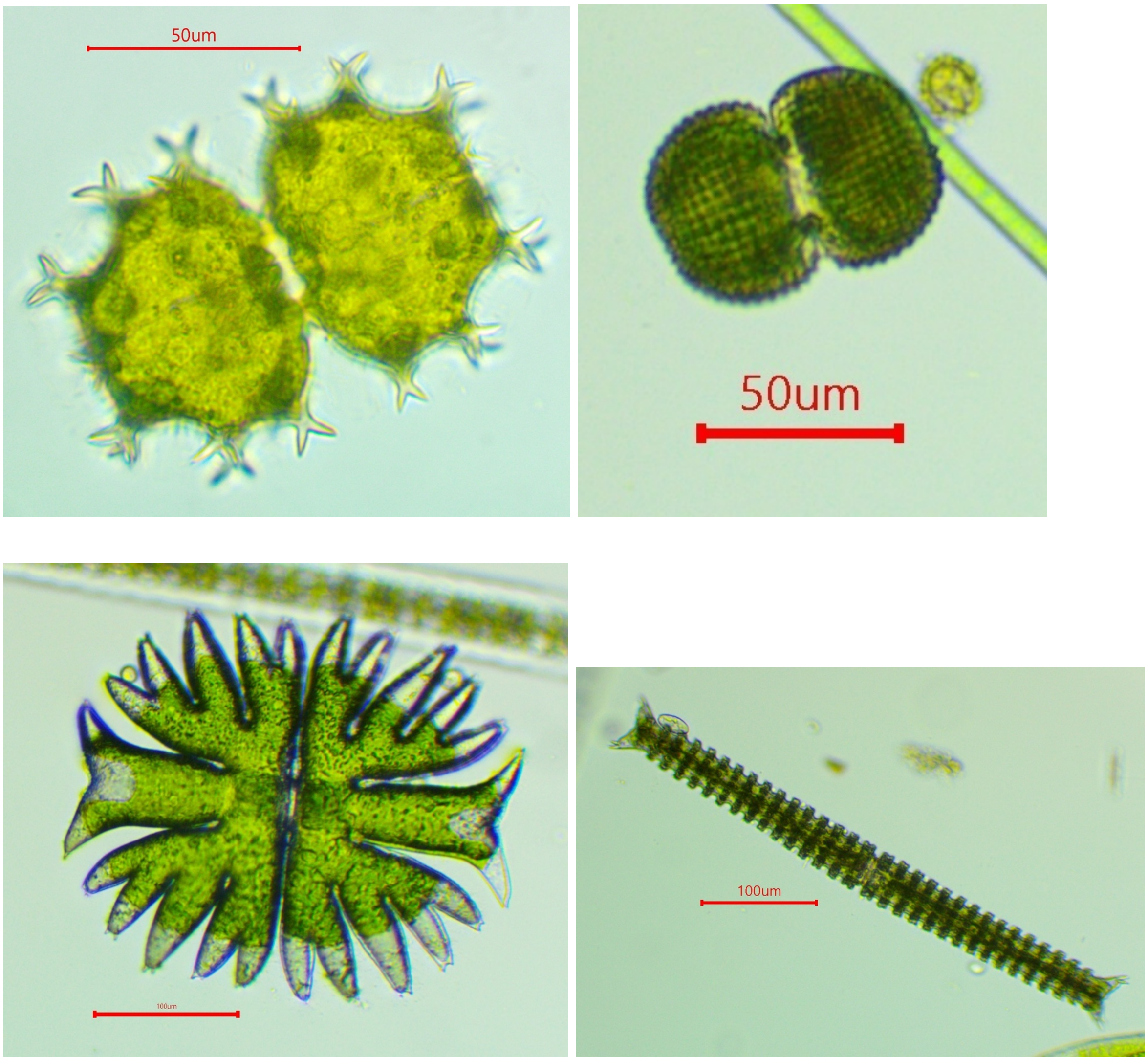
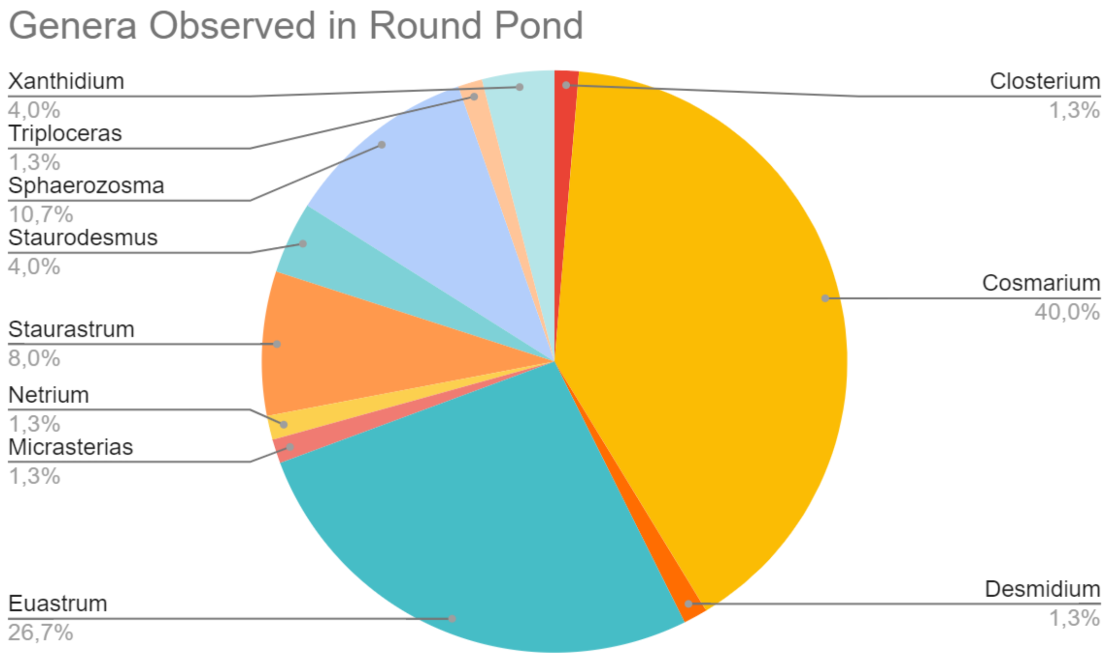


Figure 3: Selected Desmidiaceae species, photographed at 40x magnification, with the exception of *Triploceras verticillatum,* photographed at 10x. Upper left *Xanthidium armatum*, Upper right *Cosmarium broomei,* Lower Left *Micrasterias torreyi,* Lower Right *Triploceras verticillatum*. Note the diversity in shape of the species, which is key in morphological identification.



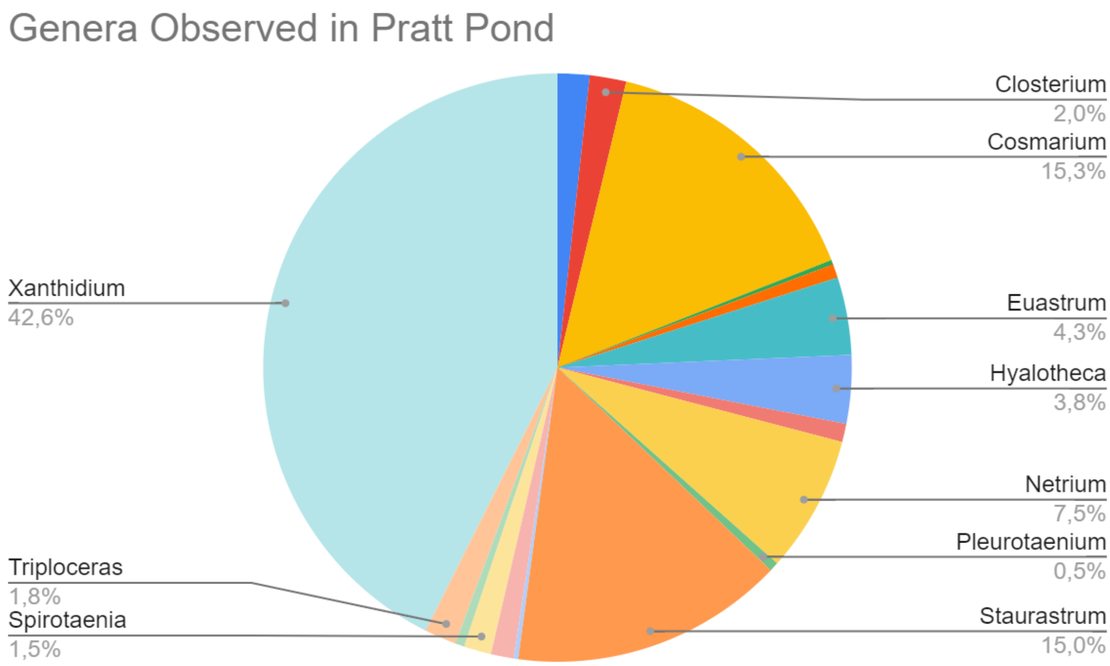


Figure 4: A comparison of the Desmidiaceae genera found in Round and Pratt Ponds. In Pratt Pond, almost half of observed specimens were in the genus *Xanthidium*.

Discussion

When Pratt Pond and Round Pond were selected for this project, Pratt Pond was picked as a more pristine body of water, whereas Round Pond was assumed to be more polluted. Samples gathered from Pratt Pond contained four times as many desmids as Round Pond's samples, which may be indicative of pollutants limiting the population of desmids. It is also possible that Pratt Pond contained more nutrients to support desmid growth, and this lack of nutrients in Round Pond served as a limiting factor for desmid growth. A future study could help resolve this question by collecting water chemistry data in both ponds. However, while more limited in Round Pond, the desmid species makeup of Round Pond was more diverse, both on the Simpson and Shannon Diversity Indices. This is because of how certain species like *Xanthidium cristatum* were very common in Pratt Pond, and the greater population of Pratt Pond desmids was mostly due to the large populations of a few species and genera. Conversely, in Round Pond the fewer desmid species that were present were all present in similar quantities, so the population was more evenly distributed across species and genera. This even distribution gives Round Pond higher diversity index values because the community is not dominated by a few species.

Pratt Pond had six Red List species, *Cosmarium blyttii, Cosmarium ocellatum, Desmidium grevillei, Staurastrum brachiatium, Staurastrum cerastes,* and *Sphaerozosma filiforme.* Round Pond also had six Red List species, *Cosmarium isthmochondrum, Cosmarium pseudoconnatum, Cosmarium regnesii, Micrasterias apiculata, Sphaerozosma vertebratum,* and *Xanthidium armatum*. All Red List species were found in low abundance, with less than five specimens found, except for *Staurastrum cerastes* and *Xanthidium armatum*. *S. cerastes* had 13 specimens in Pratt Pond, and there were 8 specimens of *X. armatum* in Round Pond. Red List species are generally very rare and found in low numbers, so it is reasonable that about half of the Red List species observed only had a single sample.

Based on both ponds having an equal number of Red List species, it appears that Pratt Pond and Round Pond are at roughly equal levels of ecological health and maturity.

A species is considered a Red List species if it has very high rankings of maturity and rarity. There are many species of desmids which are rare and or indicate wetland maturity, but not to the extent where they rank as Red List species. These species are marked in orange in Appendix I. Both ponds contained many orange species with moderate scores in maturity or rarity. This shows that both ponds are ecologically healthy, because in addition to the Red List species there are very many other indicator desmids. In addition to these species, both ponds did also have large and diverse desmid populations overall, which further supports both ponds having similar ecological health. If one or both ponds was ecologically unhealthy, there would be significantly fewer desmids and probably minimal Red List or other indicator species.

It is unexpected that Round Pond had an equal amount of Red List species as Pratt Pond, given how Pratt Pond is more isolated from human activities. However, Pratt Pond and Round Pond do not exist in isolation, both are connected to streams and other parts of the New Hampshire watershed. Therefore, it is possible for desmid species to travel between areas with waterflow. The desmid populations of the two ponds do not exist in isolation of the larger ecosystem. If the desmid populations in one of the ponds was significantly smaller than the other, that would indicate that something was present in the ponds limiting desmid growth, because the desmids are able to flow into the pond but something was there presenting their growth. The equal numbers of Red List species and overall desmid diversity indicate that both ponds are healthy and have not been adversely affected by pollution or excess nutrient levels. It is also worth noting that there are many different types of pollution that can affect algae, such as nutrient pollution, metal pollution, and organic matter. Not all of these pollutants affect desmid species in the same way necessarily, and it is likely that some species are more sensitive to certain types of pollution than others, and can only indicate changes in certain types of pollution.

Between the two ponds, there was one species that was present in very high quantities. Pratt Pond had over 100 samples of *Xanthidium cristatum*, making it by far the most common species found in this study. *Xanthidium cristatum*'s high population in Pratt Pond is potentially indicative that this species is weedy, or not as sensitive to its environment as other desmid species. However, Coesel (1998) did place this species on his indicator list, and gave it a high "maturity" value. The species is not a Red-list species, and may behave differently in North America than it does in Europe. As discussed earlier, certain microscopic organisms thrive in certain environments more than others, and the ubiquity of *X. cristatum* is probably due to its faster growth rate under the conditions of Pratt Pond. *Xanthidium cristatum* is closely related to *Xanthidium antilopaeum*, another species that was observed in our study (Stastny, 2013). *X. antilopaeum* was not observed in the same quantities as *X. cristatum*, which appears to indicate that the difference between these two species is related to its survival in different habitats.

The higher diversity rating of Round Pond may indicate that pollutants limit desmid growth evenly. If there were only a few species present in Round Pond, that would indicate that only certain desmids are affected by pollution. But because there are many species present in Round Pond, all in roughly similar amounts, this appears to indicate the pollution, or possibly low nutrient levels, generally limit desmid growth evenly across species. Conversely, in Pratt Pond it appears that the desmid populations were not as limited, and certain species like *X. cristatum* were able to flourish in the pond. This is because all of the algae species sampled were growing in the same environment, but certain species were much more prevalent than others. The species that were more prevalent appear to be more common in pristine environments.

A Red List species must be well studied to establish its sensitivity to environmental changes. The Coesel study which was used as reference for this study's Red List species was based on desmidiaceae populations in Europe, but it is difficult to be certain that these data translate well to North America. It is possible there is variation between the two continents in how the desmid species interact with the other organisms in the ecosystem, which would impact their ecological sensitivity and their Red List rating. Another important aspect of a Red List species is its rarity, and a species that is rare in Europe might not necessarily be rare in North America. Further research is necessary to establish if the desmid Red List species in North America are the same as in Europe. Morphological identification of microscopic organisms can also be limiting, even for morphologically diverse taxa like desmidiaceae. Because many desmid species have not had their genomes sequenced, it is possible that what is considered to be one desmid species is actually two desmid species that are morphologically identical. Because of desmid morphological diversity, morphology has been used as the defining characteristic in species identification, but this is potentially inaccurate. Some recent studies of charophyte algae genomes have found certain genera belong to different orders than the ones they were assigned to morphologically, for example (Hall 2008). Further advancement in desmid genetic phylogeny could impact the results of this study and similar future studies by changing which genera are considered desmids.

The species diversity and species counts from Pratt and Round Ponds appear to indicate that species count can be more telling of algal health than species diversity is. This is because the "more polluted" pond actually had a higher diversity rating than the "pristine" pond, which is contrary to what was hypothesized. The differences in pollution levels were only assumed, they were not measured before or during the study. However, the number of algae sampled in Pratt Pond was quadruple the number of algae sampled in Round Pond. This difference appears to indicate that pollution or a lack of nutrients limits the number of algae that are able to grow, but not the variety of algae.

Conclusion

Further studies would be crucial in establishing the trend of pollution's effect on desmids, as there has been little previous research on the relationships between desmids and pollution. Collecting data on the water chemistry of the two ponds would provide insight into the potential chemicals that limit or promote the growth of different desmids. This would also be important in using desmids to understand the overall health of a wetland. By establishing that the absence of certain nutrients limits certain desmid species, it would then be possible to assess the overall health of a wetland by simply sampling the water and identifying which desmids were present.

Due to the relative ease of sampling and identifying desmids, it would be possible to sample desmids in other bodies of water and observe the effect of pollutants on the body of water. The presence of indicator species from Coesel's (1998) list in high numbers may indicate that the wetland is in good health. The presence or absence of the "Red List" species would be indicative of the good ecological state of the wetland. This is because Red List species have previously been established as a sign of ecological maturity in a body of water, so if the species are present that is evidence for the overall health and standing of the body of water. However, Coesel's method must first be validated for North American desmids - desmids samples from more ponds will be needed, including water chemistry data for each water body.

While algae are often overlooked in studying biodiversity and ecological health, there are many ways desmids and other algae can be used in ecological research. Due to both the roles desmids play in the food chain and their sensitivity to pollutants and low nutrients, studying the desmids in a given wetland can potentially provide a strong understanding of the wetland's health. As conservation remains an important field and innovative ways to study the environment are paramount, examining microscopic diversity can be crucial in future research. Studies of macroscopic biodiversity have played a key role in the conservation movement and understanding climate change, and studying microscopic biodiversity can be just as beneficial.

Appendix 1: Species Observed in the two ponds and their Abundance

Red List Species are marked in red; other indicator species from European studies by Coesel (1998, 2001) are marked in orange, and their indicator values (rarity and maturity - per Coesel 1998) are reported.

Species	**abundance**		**indicator value**	
	Round Pond	**Pratt Pond**	**Rarity**	**Maturity**
Bambusina borreri	0	7		
Closterium navicula	0	6	1	2
Closterium setaceum	1	2	2	2
Cosmarium americanum	0	1		
Cosmarium amoenum	4	23	1	2
Cosmarium blyttii	0	1	2	2
Cosmarium broomei	1	0		
Cosmarium contractum	3	26	1	2
Cosmarium crenulatum	1	0		1

Cosmarium logiense	1	0		
Cosmarium isthmochondrum	1	0	3	3
Cosmarium isthmium	0	1		
Cosmarium margaritiferum	1	0	1	2
Cosmarium moniliforme	0	1	1	
Cosmarium ocellatum	0	4	3	3
Cosmarium praemorsum	1	0	1	
Cosmarium pseudoconnatum	2	0	3	3
Cosmarium punctulatum	13	2	1	
Cosmarium regnesii	1	0	2	3
Cosmarium scrobiculosum	1	0		
Cosmarium superbum	0	1		
Cosmarium transitorium	0	1		
Cylindrocystis brebissonii	0	1		
Desmidium baileyi	0	1	3	
Desmidium grevillei	0	1	3	3
Desmidium swartzii	1	1	1	3
Euastrum abruptum	1	0		
Euastrum bidentatum	4	2		2
Euastrum binale	5	0		
Euastrum denticulatum	2	0		2
Euastrum divaricatum	0	5	3	
Euastrum insulare	1	0		
Euastrum luetkemuelleri	1	0	3	

Euastrum ornatum	1	6		
Euastrum pectinatum	1	0	1	2
Euastrum pulchellum	1	0	1	2
Euastrum rectangulare	1	0		
Euastrum rimula	1	0		
Euastrum turneri	1	4		
Hyalotheca dissiliens	0	15		
Micrasterias apiculata	1	0	3	3
Micrasterias compereana	0	1		
Micrasterias denticulata	0	1	2	
Micrasterias torreyi	0	2		
Netrium digitus	1	30		
Pleurotaenium interruptum	0	1		
Pleurotaenium trabecula	0	1		1
Staurastrum alterans	1	0		2
Staurastrum brachiatum	0	1	2	2
Staurastrum cerastes	0	13	3	3
Staurastrum gracile	0	1		
Staurastrum johnsonii	0	1		
Staurastrum leptocladum	0	2		
Staurastrum longispinum	0	42		
Staurastrum tetracerum	5	0		
Staurodesmus cuspidatus	1	0		
Sphaerozosma filiforme	4	0	3	3

Sphaerozosma laeve	4	0	3	
Sphaerozosma vertebratum	0	1	3	3
Spinoclosterium cuspidatum	0	5		
Spirotaenia condensata	0	6	2	
Tetmemorus granulatus	0	2		1
Triploceras gracile	0	3		
Triploceras verticillatum	1	4		
Xanthidium antilopaeum	2	41		1
Xanthidium armatum	0	8	2	3
Xanthidium cristatum	0	102	1	3
Xanthidium octocorne	3	1	1	2
Xanthidium uncinatum	0	1		
Xanthidium wewahitchkense	0	17		
Total Desmids Observed	75	399		

Citations

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