The Community Foundation *for* Greater New Haven

QUINNIPIAC RIVER FUND FINAL REPORT- 2015

Please complete and submit completed form via e-mail to dcanning@cfgnh.org at The Community Foundation for Greater New Haven by March 31, 2016.

Date: 17 January 2017

Group/Organization Name: University of New Haven

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Project Name: Assessment of biodiversity and copper contamination of benthic algae throughout the Quinnipiac River

Grant Number: 20150147

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Please respond to the following statements:

1. List the specific objectives/outcomes of the project and tell how they were met during the grant period. Also, provide an update on any special conditions of the grant (if applicable).

This project examined the biodiversity of benthic algal communities and the potential for copper contamination in those communities throughout the Quinnipiac River. We conducted an algal biodiversity assessment of the river along salinity and land use gradients, and also tracked seasonal changes in algal populations. Algae are effective in the uptake of nutrients and heavy metals; this study aimed to examine the impacts of ambient copper as measured in tissue content and species distributions. Specifically, the following objectives were addressed:

Objective 1: Conduct the first study of benthic algae throughout the entire length of the Quinnipiac River. Assess the biodiversity of benthic algal communities throughout the watershed and examine changes along gradients of salinity and water quality in addition to seasonality variations.

Outcome: We established 5 main sampling sites that were surveyed monthly during the study: Hamlin Pond, Sindall Road, Hanover Pond, Tilcon, and Clifton Street; additional sampling sites that were surveyed periodically included: Summer Street, Meriden-Waterbury Turnpike, Emerson Leonard Wildfire Area, Wallingford Dog Park, and Toys R Us (Figure 1). We have collected and curated 105 samples over the course of 2015; voucher specimens for all samples are stored at the Algal Biodiversity Laboratory at the University of New Haven and are available for other studies. All samples were examined for morphological features, and 73 were successfully analyzed using molecular barcoding to obtain accurate species identifications and assess any cryptic diversity. There was a clear difference in macroalgal species composition between brackish and freshwater sites, with the Tilcon site appearing to be transitional (Table 1). Sites had varying degrees of species richness (Figure 2); a site adjacent to Sindall Road had a consistently high number of species present. The Sindall Road site is quite heterogeneous in substrate composition and has many microhabitats, likely leading to its higher species richness. The Clifton Street site was consistently the most species rich, likely due to its substrate composition and brackish habitat in close proximity to New Haven Harbor. There were some changes in species composition over the course of the study, with the most macroalgal species collected in May, June, and July (Figure 2). Some species persisted throughout the study, such as *Cladophora glomerata* and *Spirogyra* sp. at freshwater sites and *Ulva* sp. at brackish localities.

Objective 2: Identify algal species that are useful indicator species for water quality and pollution and examine their distribution in the Quinnipiac River.

Outcome: We did not find any variation of note in water quality parameters among the sites. There was a slight difference between pond and stream sites: the ponds generally had increased dissolved oxygen and reduced nutrient concentrations (Figures 3 and 4). This pattern is likely due to the extremely productive algal communities present in the ponds. While we did not measure productivity directly, we did observe a substantial amount of macroalgal biomass in these locations, particularly in Hanover Pond. It is also worth noting that this biomass was the product of only a few species. Since we did not record a great variation in water quality throughout the length of the river, it is difficult to pinpoint a useful algal indicator species for pollution detection in the Quinnipiac River. One species, however, was located at all freshwater sites except for Hanover Pond, and persisted throughout the duration of the study: *Cladophora glomerata*. Loss of this species could indicate a loss of water quality suitable for robust algal communities in the river. Further biomonitoring is needed to track any changes in water quality and consequent species composition along the length of the Quinnipiac River.

Objective 3: Measure the copper content of macroalgae and microbiofilms at various locations throughout the Quinnipiac River. Identify locations of high copper content and possible point sources, along with seasonal variations. Examine differences in copper content among algal species and identify potential species that might be good candidates for bioremediation applications.

This project has shown that Energy-Dispersive X-Ray Fluorescence (EDXRF) is a valid technique to determine the copper content in local algae although the work is still in progress. While determining presence/absence is relatively straightforward using

EDXRF, obtaining copper concentrations is challenging. To this end, we have been working on a quantification method. Samples collected for copper content analysis were repeatedly rinsed in nanopure water on a stir plate for five minutes before draining off the water. The sample was then ground up using a mortar and pestle into a porridge-like substance. After grinding was completed, cobalt (II) chloride solution was added to the sample to act as internal standard allowing for sample comparison (relative abundance) and copper quantification. The sample was dried and then re-ground into a powder. The powder was compacted in an industrial press to form pellets for testing in the EDXRF. For the quantification of copper in the samples, various matrices, including cornstarch, have been used to obtain a calibration curve. The described method has been used on the tissue samples collected over the course of the study. We were not able to locate any specific point sources of copper pollution based on increased presence or relative abundance of copper in the macroalgae; however, algal species that persisted at the freshwater ponds and the brackish sampling sites on the river, *Spyrogyra* sp. and *Ulva* sp. respectively, can be considered potential candidates for future bioremediation studies as both species show high relative copper content.

Table 1. Macroalgal species present at each sample site, verified by molecular data.

	Hamlin Pond	Summer Street	Sindall Road	Hanover Pond	E. Leonard Wildlife Area	Wallingford Dog Park	Tilcon	Toys R Us	Clifton Boat Launch
Blidingia dawsonii									x
Ceramium diaphanum									x
Ceramium rubrum									x
Fucus distichus									x
Gracilaria tikvahiae									x
Gracilaria vermiculophylla									x
Neosiphonia yendoi									x
Pyropia koreana									x
Ulva intestinalis									x
Ulva linza									x
Ulva sp.							x	x	x
Caespitella sp.			x						
Cladophora glomerata	x	x	x		x	x			
Gayralia sp.							x		
Hydrodictyon reticulatum			x	x					
Oedogonium sp.	x		x						
Spirogyra sp.	x			x					
Stigeoclonium sp.			x		x				
Vaucheria sp.			x			x	x		

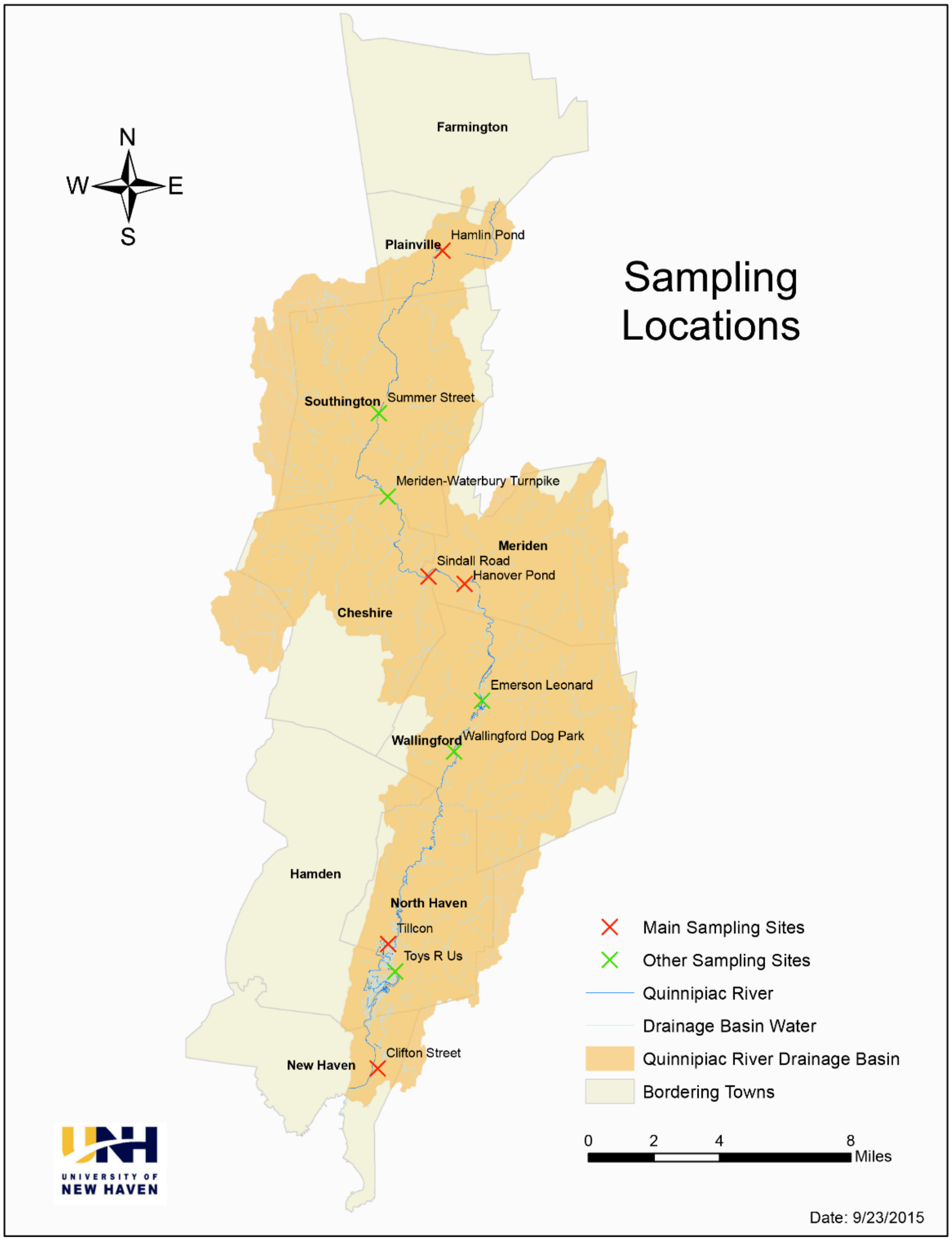

Figure 1. Project sampling sites on the Quinnipiac River. Map generated in ArcGIS by J. Eigenberg.

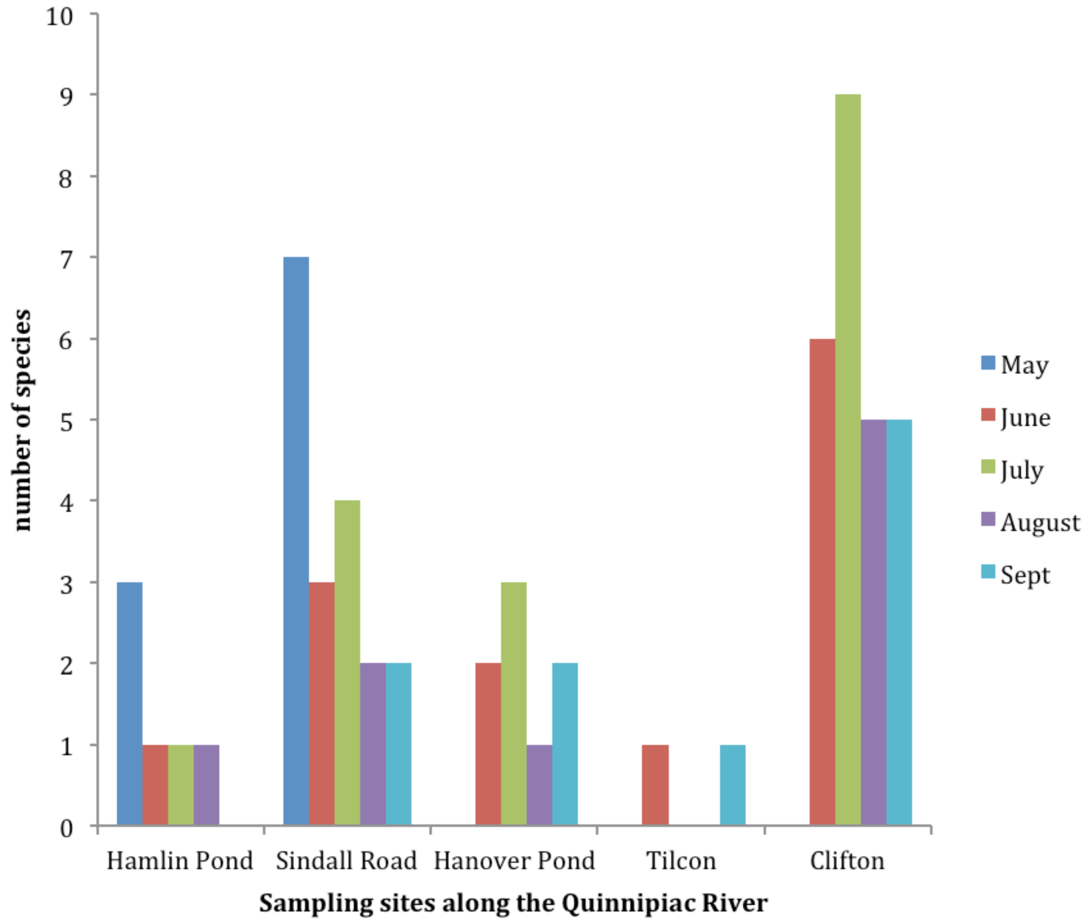

Figure 2. Species richness at the main sampling sites throughout the course of the study.

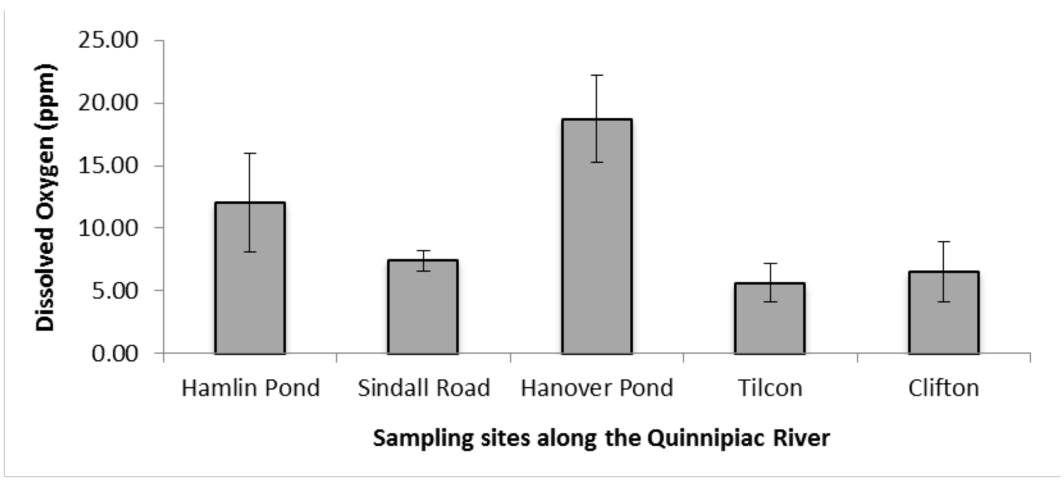

Figure 3. Average dissolved oxygen concentrations at the main sampling sites. Error bars indicate variations in the values over the course of the study.

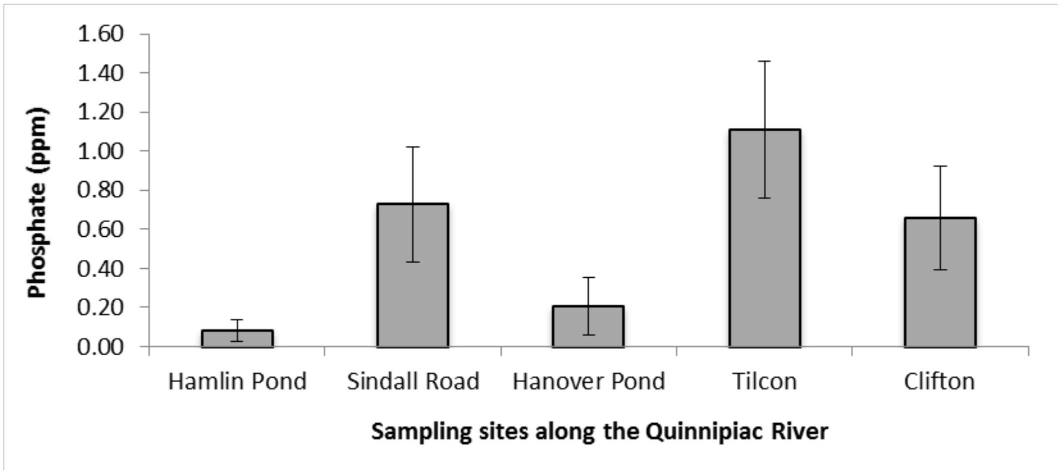

Figure 4. Average phosphate concentrations at the main sampling sites. Error bars indicate variations in the values over the course of the study.

2. Please share your successes, challenges and any lessons learned through the implementation of your project. Were there any unintended consequences or lessons learned that may affect how you operate your program moving forward?

Identification of appropriate sampling sites was initially a challenge, as we strived to sample the river evenly along its length while also establishing sites with substrate suitable for macroalgal growth. We were able to establish regular and occasional sampling sites, and used molecular methods to identify macroalgal species present over the course of five months. We developed a method for copper content detection in macroalgal tissues, although exact quantification of this content remains a challenge.

3. What are the opportunities and needs of your organization as it continues to move forward with its work to positively impact the Quinnipiac River?

This was the first study of benthic macroalgae diversity throughout the Quinnipiac River, and there is much opportunity for further studies in this system. Future work could help us understand biodiversity patterns throughout the river and the factors influencing these patterns, natural or otherwise. As we work to improve our measurement techniques, we will be able to pinpoint fine-scale differences in copper content of algal tissues. This will enable us to increase the resolution of our sampling in an effort to understand the contemporary impacts of latent copper pollution. These projects have the potential to identify species useful for bioremediation of heavy metal polluted sites, as we work to further our understanding of how algae uptake contaminants in their habitats.