Fall 2019

Wood Creek Tidal Marsh Enhancement Project Benthic Macroinvertebrate Monitoring Report 2019

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Recommended Citation

Morrison, Alex T.; Hagerty, Jett W.; and Branson, Claire M., "Wood Creek Tidal Marsh Enhancement Project Benthic Macroinvertebrate Monitoring Report 2019" (2019). *Environmental Science & Management Senior Capstones*. 5.
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Wood Creek Tidal Marsh Enhancement Project

Benthic Macroinvertebrate Monitoring Report 2019

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Applied Ecological Restoration (ESM 455)
Humboldt State University
December 2019

Abstract

The focus of this report was to monitor benthic macroinvertebrate communities on the Freshwater Farms Reserve, which underwent two phases of restoration as part of the Wood Creek Tidal Marsh Enhancement Project in 2009-2010 and 2016-2018. Objectives for the restoration activities were to increase winter rearing refugia habitat for several threatened/endangered fish species such as the tidewater goby (*Eucyclogobius newberryi*), Coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Oncorhynchus mykiss*). The goals of this project were to (1) sample and identify BMIs along a salinity gradient in Wood Creek; (2) assess water quality; and (3) report general trajectory of community composition over time. Results show that the abundance of benthic macroinvertebrates increased dramatically in Wood Creek in 2019 for all sampled sites when compared to previous years of monitoring data. Three taxa accounted for over 99% of the overall composition at each of the sample sites. Increased abundance of benthic macroinvertebrates may provide additional nutritional support for fish present in Wood Creek and Freshwater Creek. Overall, Freshwater Farms Reserve's post-restoration ecological trajectory seems to be improving in relation to the goals of supporting fish refugia for threatened/endangered species.

Introduction

Importance of Wetlands

A dramatic loss of wetland-habitat areas around the world has occurred and continues to the present day. About 70% of Earth's total wetland area has been degraded or destroyed over the past 120 years (Davidson, 2014). Half of that percentage was lost in just the past 40 years (Davidson, 2018; WWF, 2018). Wetlands are some of the most productive ecosystems on Earth (Kennish, 2001). Wetland areas are of vital importance to the survival and wellbeing of various flora and fauna worldwide, including species that are endemic or rare (ADEE, 2019). Climate change scenarios forewarn several stresses on wetlands around the world, which include changes of hydrologic functionality, temperature increases, and sea level rise (Junk et al., 2013). Wetland habitats provide services such as hydrologic buffers, water filtration, pollutant absorption as well as carbon sequestration, which can offset anthropogenically elevated carbon dioxide levels present in the atmosphere (ADEE, 2019; Junk et al., 2013).

Within the United States alone, over half of all original wetlands have been converted since European nations colonized the continent a few centuries ago (Dahl & Allord, 1997). This, in turn, seriously destabilized many populations of flora and fauna that depend on wetlands' various important ecological services. Wetlands in the US and around the globe provide year-round/seasonal habitat for diverse communities of plants, fish, birds, mammals, amphibians, reptiles, insects, fungi, and microorganisms (Flynn, 1996). Over 1/4 of all wetland flora and fauna species are listed on the International Union for Conservation of Nature's Red List of Threatened Species (WWF, 2018). Numerous migratory animals rely upon wetland habitats because they are key stops along migrational corridors.

Salt marshes, in particular, are the most highly productive ecosystems on earth, and provide habitat for a range of terrestrial and aquatic species that rely on these unique coastal zones for food and shelter (Kennish, 2001). These areas exist at low elevation where saltwater is introduced into the landscape via tidal ebb and flow. Salt marshes may function as effective buffers for human populations from coastal erosion, storm surge, coastal catastrophes and sea level rise (King & Lester, 1995). Stewardship of these areas will become even more important as salt marshes begin to shift in territory as sea level creeps inland around the world (Crosby et al., 2016).

In 2005, the Northcoast Regional Land Trust (NRLT) acquired 72 acres of former salt marsh along Myrtle Avenue east of Eureka, California (NRLT, 2019a). Since the completion of salt marsh restoration activities on the property as part of the Wood Creek Tidal Marsh Enhancement Project, the NRLT has focused on monitoring and exemplifying how ecologically-conscious, multi-use land management practices can be incorporated while preserving the use of working landscapes (NRLT, 2019b).

Study Objectives

This study focuses on assessing the post-restoration condition of the Wood Creek Tidal Marsh Enhancement Project by collecting benthic macroinvertebrates (BMIs) at several sites within the project area. Benthic macroinvertebrates can be used to evaluate stream quality and human impacts on waterways (Boňada et al., 2006; US EPA, 2013). These organisms consume plant matter, algal and bacterial organisms; therefore, BMIs are also common food sources for many different species of fish, birds and amphibians (IDNR, 2010).

The objectives of this study were to: (1) sample and identify benthic macroinvertebrates along a salinity gradient in Wood Creek; (2) assess water quality data from 2012-2019; and (3) report the trajectory of the BMI community composition over time from 2009-2019. This report is a continuation of ten years of macroinvertebrate monitoring, started in 2009 and continued by several series of Humboldt State University student project groups.

Methods

Site Description & Restoration Background

The Freshwater Farms Reserve (FFR) is located within the Freshwater Creek watershed and along Myrtle Avenue, a roadway that connects Arcata, CA to Eureka, CA (Figure 1). Historically, the site was tidally-influenced wetland habitat until the early 20th century when the site was diked in order to support animal husbandry and other agricultural activities (NRLT, 2019a). Overall, the Freshwater Creek watershed (Figure 2) drains approximately 36,000 acres of land and contains 58 miles of waterways (USGS, 2019). Wood Creek runs through FFR and is a tributary to Freshwater Creek, which connects with the Humboldt Bay (NRLTa, 2019).

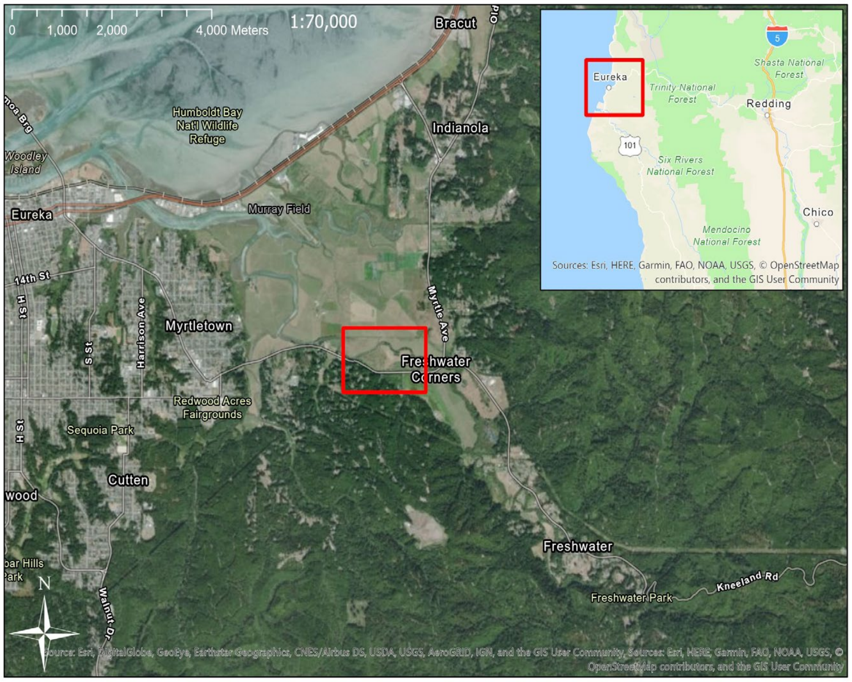

Figure 1: Locator maps of Eureka, California (top right) and Freshwater Farms Reserve (center). Freshwater Farms Reserve is located near Freshwater Corners, just east of Eureka, California. Map created by Alex T. Morrison. Sources: Google, ESRI.

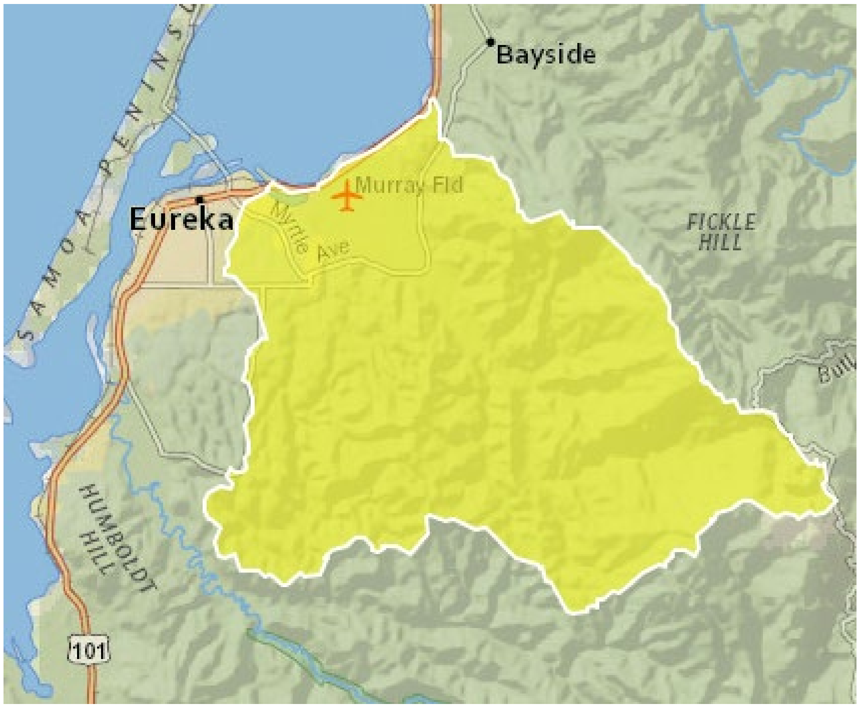

Figure 2: Freshwater Creek watershed encompasses approximately 36,000 acres of land and contains about 58 miles of persistent waterways. The watershed lies east/southeast of Eureka, California and south of Arcata, California. Source: USGS StreamStats program.

Wood Creek Tidal Marsh Enhancement Project

A slough restoration project (Figure 3), called Wood Creek Tidal Marsh Enhancement Project (hereafter referred to as "Project") included two phases; Phase I occurred between 2009 and 2010, and Phase II occurred between 2016 and 2018. The focus for Phase I was to increase brackish winter rearing refugia for several threatened/endangered fish species such as the tidewater goby (*Eucyclogobius newberryi*), Coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Oncorhynchus mykiss*), among other non-threatened/endangered species (NRLT, n.d.). In Phase I, a tide flap was removed at the confluence of Wood Creek and Freshwater Creek, 3,700 linear feet of slough channels were excavated, two tidally influenced ponds were created, hummocks were established and native plant species were replanted. Phase II of the Project focused on freshwater-dominant channel habitat for the same target species (NRLT, 2019a). In this second phase, 8,000 cubic yards of soil were excavated for slough channels/pools/ponds, 50+ wood structures were installed, additional hummocks were created, native riparian vegetation was replanted and an area was re-graded to improve drainage in the Adaptive Management Area (NRLT, 2019a).

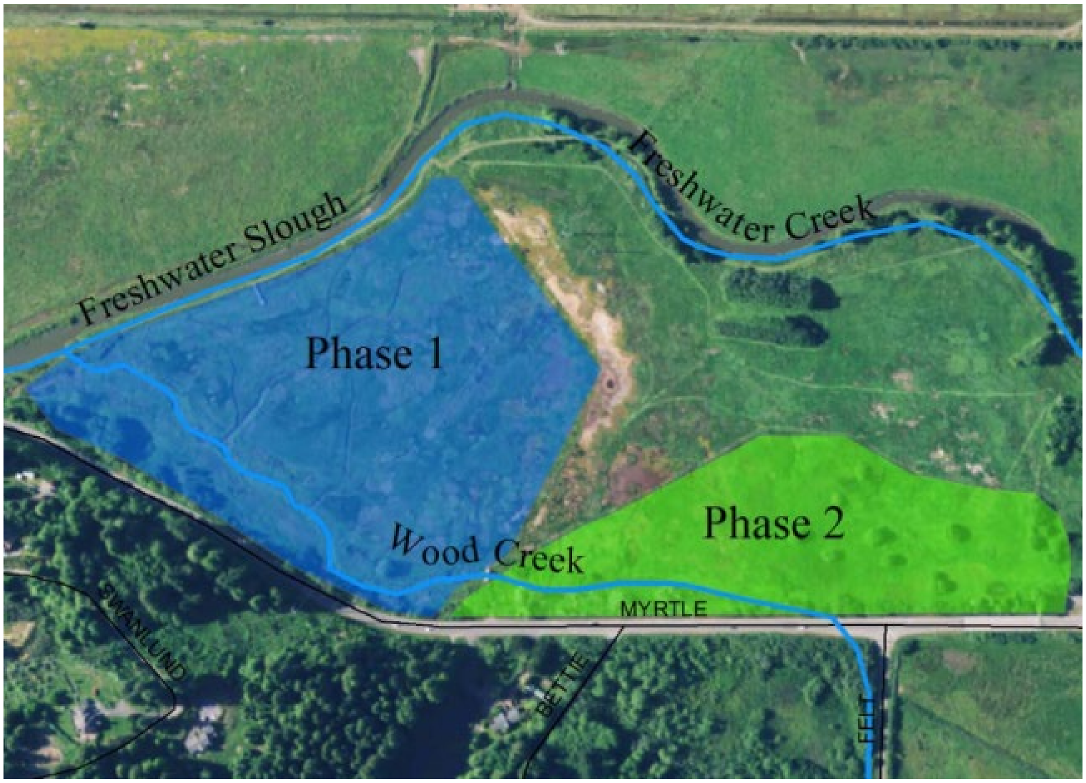

Figure 3: A two-phase restoration plan implemented on Freshwater Farms Reserve. Phase I is indicated by the blue-shaded area and Phase II is indicated by the green-shaded area. Myrtle Avenue is adjacent to the South of the site, and Wood Creek flows through Freshwater Farms Reserve and under Myrtle Avenue. Map created by Dana Grevenkamp. Source: (Craw, Graham & Grevenkamp, 2017).

Field Methods

The beginning of the field sampling started two hours after high tide on 13 September 2019, which was consistent with previous monitoring efforts. For the collection of water quality data and macroinvertebrate populations at each site, one person in waders entered the slough at four predetermined sampling locations (Table 1). A second person operated the physical water quality instruments slightly upstream of the sample location. A third person on the bank recorded site descriptions, water quality data and kept time during each sampling period where the person wading with the D-frame dip net, equipped with a 500µm mesh screen, would brush the vegetation in the slough back and forth for 60 seconds. Macroinvertebrates, soil and plant debris were removed from the net and placed into a 500 μm sieve. Samples were then preserved in 90% ethanol. Preserved samples were transported to the laboratory for further examination.

Table 1: Site number, location description and dominating vegetation for each of the four sites sampled on 13 September 2019. Vegetation characteristics were determined at various taxonomic levels by the samplers.

Site	Location relative to landmarks	Coordinates	Vegetation present
1	20 meters upstream of tide gate connected to Freshwater Creek	40°47'07.6"N 124°06'01.0"W	Both banks: sedge (*Carex*)
2	5 m downstream from metal pole	40°47'05.7"N 124°05'57.1"W	Both banks: sedge
3	3 m upstream from flatbed bridge	40°47'02.3"N 124°05'47.5"W	Left bank: sedge Right bank: sedge, salt grass (*Distichlis*), pickleweed (*Salicornia*), grasses (*Graminoids spp.*)
4	6 m upstream of the tidally influenced pool inlet	40°47'02.2"N 124°05'42.0"W	Both banks: cattail (*Typha*)

Laboratory Methods

Laboratory work was conducted over the next three months, with the purpose of assessing community composition for the four sampled sites. Training of laboratory procedures, taxonomic classification and analysis of BMIs was conducted by Dr. Alison O'Dowd, a Professor in the Department of Environmental Science and Management at Humboldt State University. Dissection microscopes and quadratic petri dishes were used to separate taxa with forceps into labeled vials filled with 70% ethanol solution for each site. Vials were externally labeled with an ethanol-resistant permanent marker and colored tape; vials were internally labeled with a graphite pencil and slips of printing paper, which were submerged in the ethanol solution with the macroinvertebrates. A quality control check was performed to correct erroneous sorting for each site. Once all taxa were thoroughly separated and identified, each organism was counted in the quadratic petri dishes using a tally counter. Data were recorded into a spreadsheet template that was used for previous monitoring efforts since 2009.

Statistical Analysis

All water quality data were entered into an Excel file for data analysis of water quality properties and benthic macroinvertebrate communities. Data from 2012-2019 was used to track changes in physical water quality. Data from 2009-2012 was used to compare benthic macroinvertebrate communities by comparing differences between taxa richness, organism abundance, and species composition. Charts were made for 2012-2019 pH with linear regressions, 2012-2019 dissolved oxygen with linear regressions, 2019 community composition, 2009-2019 abundance of organisms, and 2009-2019 taxa richness with linear regressions. A table was made to display the frequency of taxa observations for each site.

Results

Water Quality

Water quality changed over the monitoring period since it began in 2012. Results for pH (hydrogen ion concentration) ranged between 7.26 to 7.36 in September of 2019. Previous years of data had a low pH of 6.59 in 2015 and a high pH of 7.60 in 2012 (Figure 4). Dissolved oxygen ranged from 5.56 mg/L to 10.45 mg/L in September of 2019. Previous years of dissolved oxygen data had a low of 0.78 mg/L in 2012 and a high of 7.95 mg/L in 2017 (Figure 5). Both salinity and conductivity were measured at each site, however the instrument used was not precise enough to show differentiating results, therefore those data are not included in this report.

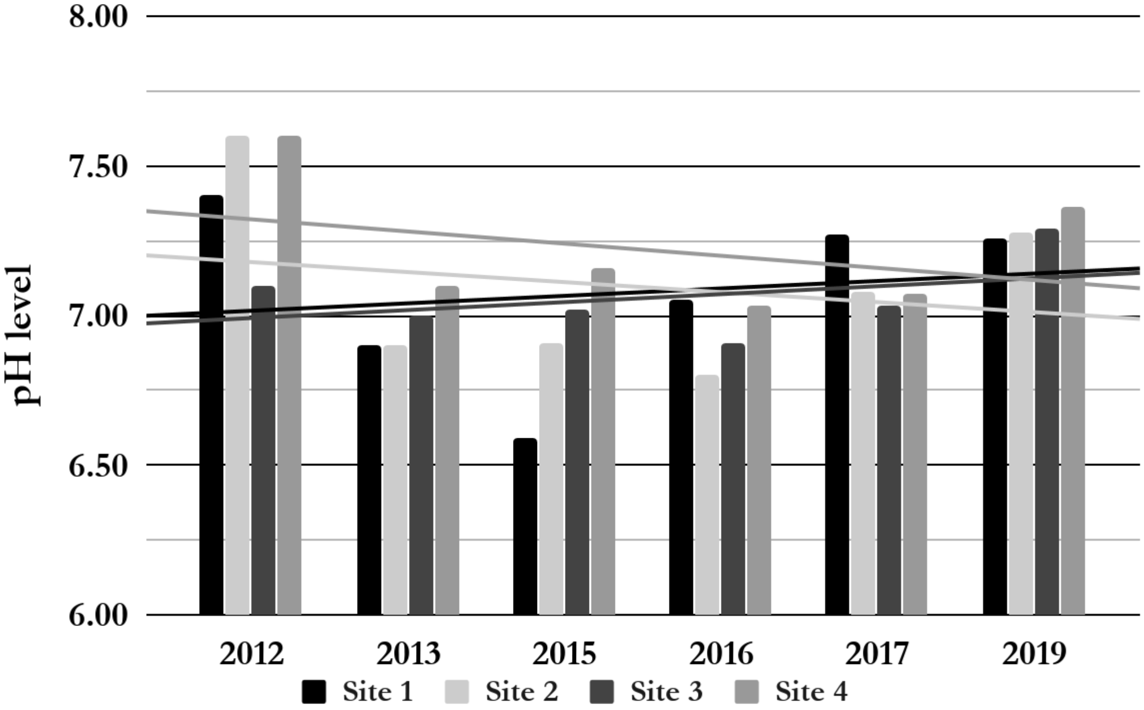

Figure 4: pH levels at sites 1-4 from 2012-2019. Data for 2014 and 2018 are not included.

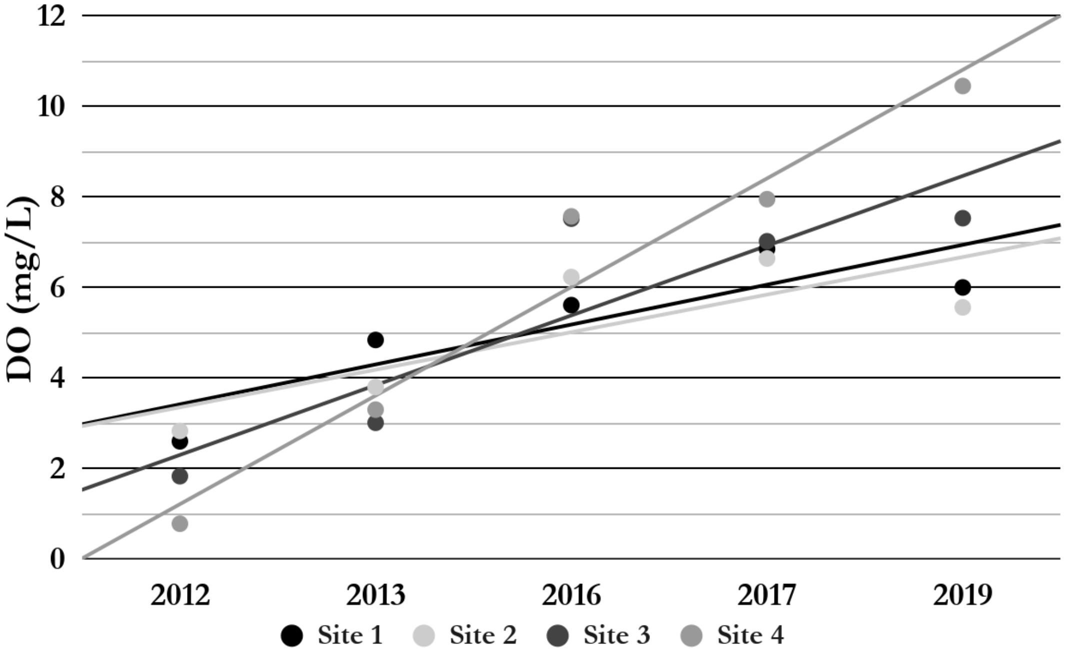

Figure 5: Dissolved oxygen (mg/L) levels at sites 1-4 from 2012-2019. Data for 2014 and 2018 were not collected.

Benthic Macroinvertebrates

Benthic macroinvertebrate communities for each site varied in composition (Figure 6), abundance (Figure 7) and taxa richness (Figure 8). In 2019, Sphaeromatidae (Isopoda) was the dominant species at all four sites. Dominance of Sphaeromatidae (Isopoda) ranged between 45.8% and 77.1% (Figure 6); Gammaridae (Amphipoda) composition ranged between 6.8% and 35.6% (Figure 6); Corophiidae (Amphipoda) composition ranged between 7.5% to 28.3% (Figure 6); and other species' composition ranged between 0.1% and 0.6% in 2019 (Figure 6). Overall, Sphaeromatidae, Gammaridae and Corophiidae accounted for over 99% of taxa composition at each of the four sites (Figure 6). Abundance of organisms in 2019 was substantially greater than previous years of sampling, with a total of 13,137 individuals counted in 2019 (Figure 7). Previous years of data had a low total abundance of 1,449 in 2011 and a high total abundance of 4,744 in 2013 (Figure 7). Taxa richness in 2019 varied from 5 to 10 for each site (Figure 8). Previous years of data have a minimum of 3 and a maximum of 9 taxa per site (Figure 8).

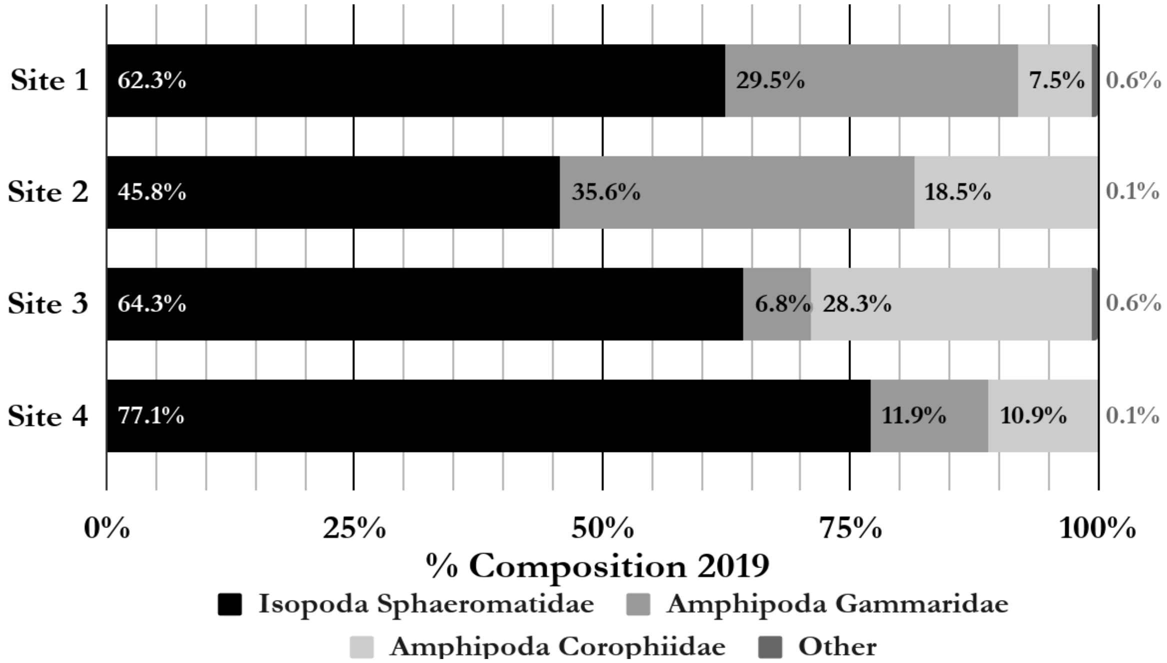

Figure 6: BMI taxa composition at sites 1-4 in 2019.

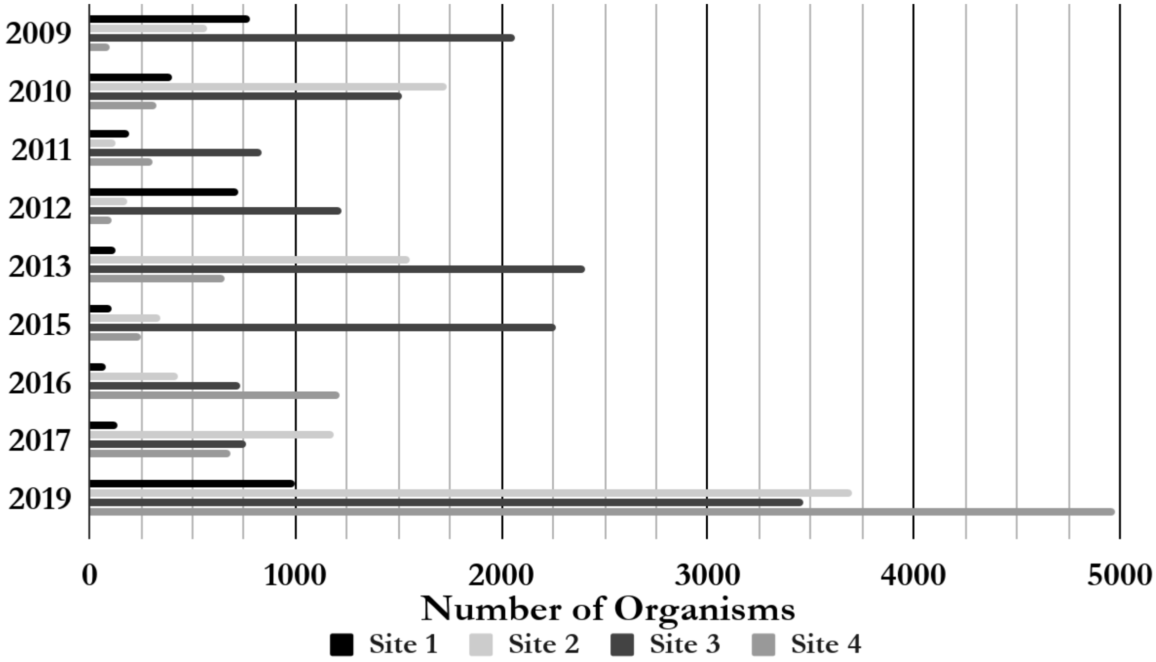

Figure 7: Abundance of all counted BMI organisms from 2009 to 2019. Data for 2014 and 2018 is not included.

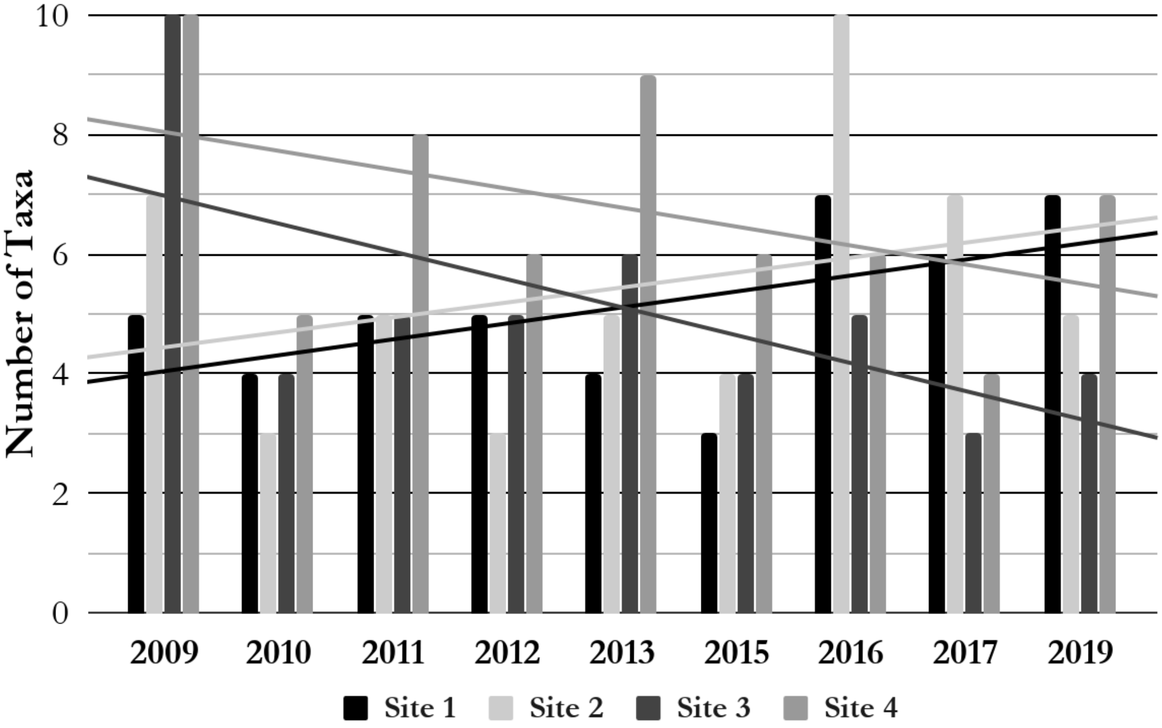

Figure 8: BMI taxa richness from 2009 to 2019. Data for 2014 and 2018 are not included.

All taxa recorded include; *Acari* (subclass of Arachnida), Bryozoa (phylum), Chironomidae (family of Diptera), Collembola (subclass of Entognatha), Corixidae (family of Hemiptera), Corophiidae (family of Amphipoda), Gammaridae (family of Amphipoda), Heptageniidae (family of Ephemoroptera), Oligochaeta (class of Annelida), Polychaeta (class of Annelida) and Sphaeromatidae (family of Isopoda) (Table 2).

Table 2: Taxa present in 2019 at each site indicated by an "X". The number of "X" s in each row correspond with Figure 8, which shows the taxa richness at each site from 2009-2019. Taxa present at all sites are Corophiidae, Gammaridae and Sphaeromatidae. Sites 1 and 4 have taxa which did not appear at any other site.

	Acari	*Bryozoa*	*Chironomidae*	*Collembola*	*Corixidae*	*Corophiidae*	*Gammaridae*	*Heptageniidae*	*Oligochaeta*	*Polychaeta*	*Sphaeromatidae*
1	X				X	X	X	X	X		X
2	X					X	X			X	X
3						X	X			X	X
4	X	X	X	X		X	X				X

Discussion

Based on the data accumulated from 2009 to 2019, FFR has had some changes within the benthic macroinvertebrate community. The results from this project show that composition of Corophiidae, Gammaridae, and Sphaeromatidae was consistent throughout the sites in 2019 (Figure 6). BMI abundance was substantially higher in 2019 compared to previous years of sampling by a factor of 2.77 when compared to the highest abundance count from 2013, and by a factor of 4.76 compared to the previous year of sampling from 2017. Increased abundance of benthic macroinvertebrates may provide additional nutritional support for fish present in Wood Creek and Freshwater Creek.

High levels of dissolved oxygen were recorded throughout the four sampling sites in 2019, pH appears to be trending towards a more basic pH level of around 7.25. Due to high abundance of BMIs, high dissolved oxygen, and increasing pH, FFR's aquatic habitat seems to be improving over time since restoration occurred. Additionally, this inference suggests that local salmonid populations and other fish species, as well as other fauna, benefit from improved access to the slough system, boosted feeding conditions and improved water quality. Overall, this restoration project seems to have achieved the goals of the Project which were to: increase brackish and freshwater winter-rearing refugia for several threatened/endangered fish species such as the tidewater goby (*Eucyclogobius newberryi*), Coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Oncorhynchus mykiss*), among other non-threatened/endangered species. FFR is set upon a trajectory for autogenic repair for many years to come, barring unforeseen circumstances.

Local communities, governments and non-governmental organizations have the opportunity to become primary stakeholders with regard to environmental stewardship and habitat restoration. In this instance, NRLT has demonstrated responsible, multi-use land management practices that incorporate working landscapes for agriculture, recreation, research and education.

As climate change wreaks havoc now and in the future, and as ecosystems become further degraded, the practice of ecological repair and applied environmental stewardship will be key solutions for increasing resistance and resilience of both historical and future-adapted habitats. The rapid growth of human populations, on a global scale, has led to numerous adverse effects regarding the environmental degradation of wetlands and other ecosystem types (Peacock, 2018). Due to this, multi-faceted approaches to ecological repairs will be necessary for the overall success of environmental restoration in highly variable environments. Special considerations will need to be utilized depending on current/past land use, economic benefits, educational and recreational potential, future climate projections and adaptive management practices.

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