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# Comparison of 6-Week Benthic Macroinvertebrate Colonization on Hester-Dendy Multiplate Samplers in Early & Late Spring

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## Abstract

Collecting benthic macroinvertebrates is an effective and relatively simple way of determining water quality. While many sampling techniques exist, there has been no proven method or strategy that is necessarily the best. Researchers are constantly looking for new and better ways to sample macroinvertebrates in order to allow the scientific community to get the best and most accurate results as possible. Seasonal variability may determine what kinds of and how many organisms are sampled and can also be used to explain why those results were obtained. Hester-Dendy macroinvertebrate plate samplers were placed in the early and late Spring and were then collected after 6-weeks, where the macroinvertebrate colonization of each was compared. The early and late spring samples had MBI (Macroinvertebrate biotic index) values of 5.72 (poor) & 4.57 (good), respectively. The results showed that there was no significant difference in the number of EPT/Non-EPT taxa between the two samples ($p=.0948$). A significant difference was found between the two sample's number of EPT and number of Non-EPT individuals, as well as between their number of pollution intolerant and number of pollution tolerant individuals ($p<0.001$). The Shannon Diversity Index showed that early spring had decreased diversity while late spring had increased diversity (0.969 & 2.059 on a 0 to 4 scale, respectively). The early sample had an extremely high number of midges (O. Chironomidae Family), as testing took place during their spawning season. Environmental variability in early spring may be too high due to the fluctuating temperatures that are commonly associated with Illinois' climate, leading to the conclusion that further testing is needed.

**Keywords: Water Quality, Hester-Dendy, Macroinvertebrates**

## 1. Introduction

Stream quality can be influenced by a number of factors, including temperature, pH levels, chemical composition, location, elevation, and as focused on throughout this study, season[1,2,3]. Water quality can be determined by sampling aquatic macroinvertebrates, which are used because they are simple to capture, and their community composition reflects the changing conditions of the stream and its quality; as some aquatic macroinvertebrate taxa may be more or less susceptible to pollution than others[4,5]. Aquatic macroinvertebrates are defined as organisms that lack a backbone, live in a water based environment, and are big enough to see with the naked eye.[4] Seasonal variability has been found to have an impact on a stream's taxa richness and its EPT taxa richness, with a potential impact on MBI[6,7]. This is likely due to various macroinvertebrate taxa emerging at different times of the season. Depending on what season stream sampling was conducted in, during or outside of any specific emergence season, this could yield different results within stream quality indexes[8].

A common method of obtaining these macroinvertebrates is the use of artificial substrates. Artificial substrates can provide results that are more detailed and precise results that are better for calculations as they provide a standardized sampling area[9,10]. One such of these artificial substrates is the Hester-Dendy sampler[11]. Hester-Dendy's are composed of multiple plates that are separated by spacers and attached to a cement brick to keep the device submerged. Hester-Dendy's are designed to provide researchers with a device that is relatively easy to handle, construct, deconstruct, remove colonized macroinvertebrates, and easy to transfer[12]. Hester-Dendy's are designed to resemble a natural habitat for benthic macroinvertebrates, while also reducing any unwanted variability and provide a more controlled sampling method and surface than another artificial substrate like the rock basket; which all may yield more precise results.

In Illinois, spring characteristics can largely vary from year to year, especially in comparing early spring to late spring. Early spring in Illinois is generally characterized by having heavy amounts of precipitation and colder temperatures when compared to late spring, which tends to be warmer with less precipitation[13]. The month of March in 2018 in the Chicago metropolitan area had average temperatures that were lower than the normal temperatures for the month, with an average temperature of 36.9°F (2.72°C). March was also found to have a lower amount of precipitation and a much lower amount of snowfall than usual[14]. This year, April was found to have significantly lower temperatures on average than normal, with an average temperature of 41.2°F (5.1°C), 7.7°F below normal. April was found to have a lower amount of precipitation than usual; however, 3.2 inches of snowfall was recorded, which is 2 inches above normal[15]. Throughout May, the average temperature was found to be 66.1°F, 7°F warmer when compared to previous years and had a higher amount of precipitation than usual[16]. Throughout June, up to the 6th, the average weather was found to be slightly warmer than usual, with a very similar amount of precipitation when compared to normal conditions[17].

This study was designed to compare the types and quantities of macroinvertebrates in early spring and late spring, and to compare the overall quality and MBI between the two seasons by using multiple Hester-Dendy samplers in both seasons and looking at their respective results after six weeks. It was predicted that while the early spring and late spring samples will contain largely different results in terms of taxa richness and EPT taxa richness, it was believed that the stream's overall MBI will be similar throughout the entirety of spring.

## 2. Methodology

### 2.1 Study Site

This study was conducted at Lily Cache Creek at Van Horn Woods East in Plainfield, Illinois off West US 55 Frontage Road. The site was characterized by being downstream, with roughly half of it covered by canopy. The site also had a mix of snags, runs, and riffles. The site is located slightly upstream from a natural log jam.

#### *2.1.1 field methodology*

At the site, three Hester-Dendy's (HD) and concrete bricks were placed side by side within the same run for early and late spring. Each of the three Hester-Dendy's were constructed with nine 7.6cm x 7.6cm plates and attached to a 19cm x 19cm x 19cm concrete bricks 13cm x 11.5cm x 19cm center space using a nylon rope. Two HDs were attached to one brick, and one HD attached to another (Figure 1). The early spring sampling began on 17 March. When placed, the water temperature at the time was 43°F (6.1°C), with the water being on average 28cm deep and having a velocity of 0.56m/s. Almost 6 weeks later, on April 28, 2018, the HDs were removed. The water was 47°F (8.3°C) and had a depth of 33cm and a velocity of 0.40m/s. The late spring Hester-Dendy's had also been planted on April 28th in the same spots as the early spring. They were removed almost 6 weeks later on June 6th, where the water temperature was 78.8°F (26°C) and the had an average depth of 33cm with a velocity of .39m/s.

In order to retrieve the samples, each structure was lifted directly into a bucket while two 500-micron D-frame kick nets were placed down-current away from the bucket in order to retrieve any organisms that may have released from the structures while they were being removed. The nets were emptied into the buckets and creek water was added to preserve the samples during transportation. The structures were then disassembled, as were the Hester-Dendy samplers. Macroinvertebrates were then picked and scraped off all of the individual pieces of the structure: the brick, the plates, and the nylon ropes.

Each collected organism was randomly placed in one of two 12 quadrant trays filled with club soda. Once it was determined that all macroinvertebrates had been collected, both trays were placed side by side and subsampling was done due to the very large sample size. Approximately 500 macroinvertebrates were picked using randomly generated numbers from one through twenty-four, which each number corresponded to one quadrant between the two trays. The chosen specimens were then placed in a jar containing 91% isopropyl alcohol and brought to the lab. This procedure was also done for the late spring sample.

Figure 1. Hester-Dendy multi-plate samplers out of and in sampling location, placed in a riffle in Lilly Cache Creek at Van Horn Woods, Plainfield, IL.

### *2.1.2 laboratory methods*

Once brought back to the lab, each of the macroinvertebrate samples were counted and examined under dissecting microscopes, which allowed taxa and quantities to be recorded. This process was done multiple times to ensure completely accurate data. Results were recorded in accordance to the Illinois RiverWatch protocol procedure[18]. The RiverWatch protocol identifies the taxa found into order/family. This procedure records and takes in the total number of organisms sampled ($\Sigma N$), the number of different taxa or taxa richness ($\Sigma$TAXA), EPT taxa richness, non-EPT taxa richness, and ultimately the Macroinvertebrate Biotic Index (MBI)[18]. Once these values have been determined, they are compared to the values and the quality of each individual category is determined, as shown in Table 1.[18]

Shannon Diversity Indexes (SDI) were also calculated for each sample. EPT and non-EPT individuals and taxa, as well as pollution-tolerant (taxa with a tolerance value $\geq$5.5) and pollution-intolerant (taxa with a tolerance value $\leq$5.5) individuals were calculated. These data sets were then statistically analyzed using Chi-Square analysis.

Table 1. Illinois RiverWatch Stream Quality Ratings Index.

| | Taxa Richness | EPT Taxa Richness* | MBI** |
|---|---|---|---|
| Excellent | ≥ 14 | ≥ 5 | ≤ 4.35 |
| Good | 12-13 | 4 | ≥ 4.36 - ≤ 5.00 |
| Fair | 9-11 | 3 | ≥ 5.01 - ≤ 5.70 |
| Poor | 7-8 | 2 | ≥ 5.71 - ≤ 6.25 |
| Very Poor | ≤ 6 | 0-1 | ≥ 6.26 |

** # of Mayfly taxa (Ephemeroptera), # of Stonefly taxa (Plecoptera), & # of Caddisfly taxa (Trichoptera)*

*** MBI = $\Sigma TV/\Sigma N$, ($\Sigma TV$ (tolerance value) = N x TI), where N equals # of individuals within taxa, TI equals the tolerance index of aforementioned taxa. ($\Sigma N$ equals total number of organisms in sample).*

## 3. Results

The late Spring sample contained just over one hundred more individuals than the early Spring sample, despite this, the late Spring sample contained just 3 more taxa than the early Spring sample. The early Spring sample had 1 less

EPT taxa and 2 less Non-EPT taxa than the late Spring sample. The early spring sample was found to have a lower number of EPT individuals (48) when compared to late Spring (339). Early Spring also showed more Non-EPT individuals (442) than late Spring (253). Late Spring had less pollution tolerant individuals (140) and more pollution intolerant individuals (452) than the early Spring sample (441 & 79 respectively) (Table 2.). According to the Illinois RiverWatch Stream Quality Ratings Index, the early Spring's MBI was considered 'Poor', while the late Spring's MBI was considered 'Good' (Table 1). The Shannon Diversity Indices of the two samples varied from one another, with the early Spring sample having a drastically lower value than the late Spring (Table 1)

In early Spring, a higher proportion of the sample was comprised of Non-EPT and pollution intolerant macroinvertebrates when compared to that of the late Spring sample; which contained a greater amount of EPT and pollution tolerant individuals than early Spring (Figure 3, 4). This difference was largely due to the extremely high number of midges (Chironomidae) that comprised 80% of all individuals in the early Spring sample (Figure 2).

Table 2. Results comparing 6-week benthic macroinvertebrate colonization on Hester-Dendy multi-plate samplers in early spring to late spring in Lily Cache Creek, Will Co., IL at Van Horn Woods.

| | Early Spring | Late Spring |
|---|---|---|
| # Organisms | 490 | 592 |
| TAXA Richness | 15 | 18 |
| EPT TAXA | 6 | 7 |
| Non-EPT TAXA | 9 | 11 |
| # EPT Individuals | 48 | 339 |
| # Non-EPT Individuals | 442 | 253 |
| # Pollution Tolerant Individuals | 411 | 140 |
| # Pollution Intolerant Individuals | 79 | 452 |
| MBI Value | 5.72 | 4.57 |
| SDI Value | 0.969 | 2.059 |

Following statistical analysis, it was found that a significant difference existed between the # of EPT and # of Non-EPT individuals when compared between early and late Spring ($p<0.001$). Statistical analysis also showed that there was a significant difference between the # of pollution tolerant and # of pollution intolerant individuals between early and late Spring ($p<0.001$). There was no significant difference, however, when the # of EPT and # of Non-EPT Taxa was compared between the two samples ($p=.948$).

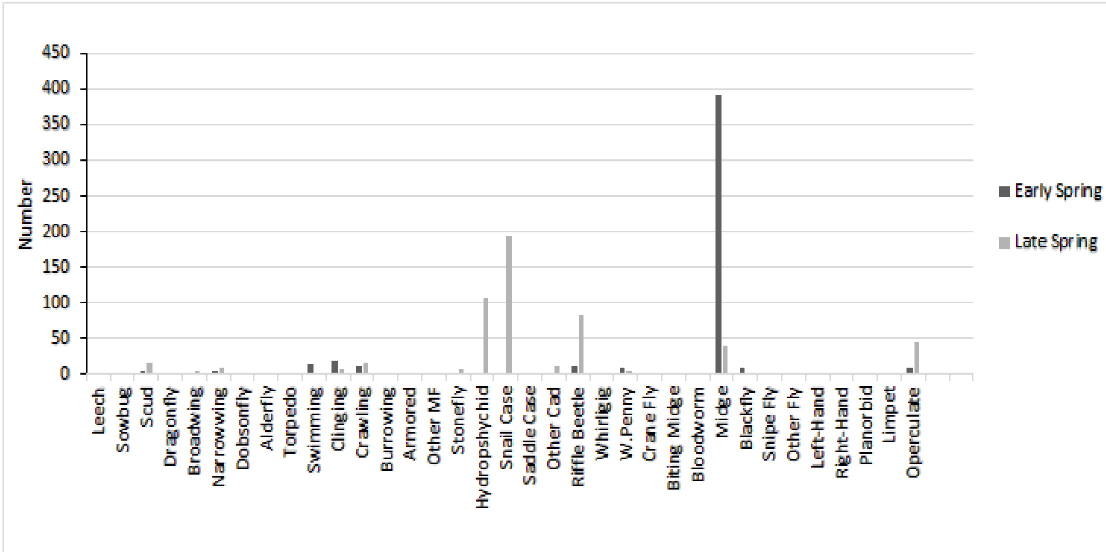


Figure 2. Comparison of number of individuals collected in each taxa at Van Horn Woods between early and late Spring samples, 2018*.

**Flatworm (C. Turbellaria), aquatic worm (C. Oligochaeta), leech (C. Hurudinea), sow bug (O. Isopoda F. Asellidae), scud (O. Amphipoda F. Gammaridae), broadwing damselfly (O. Odonata F. Calopterygidae), narrowing damselfly (O. Odonata F. Coenagrionidae), swimming mayfly (O. Ephemeroptera F. Siphlonuridae), clinging mayfly (O. Ephemeroptera F. Heptageniidae), crawling mayfly (O. Ephemeroptera F. Leptohyphidae), stonefly (O. Plecoptera), hydropsychid caddisfly (O. Tricoptera F. Hydropsychide), snail case caddisfly (O. Tricoptera F. Helicopsychidae), other caddisflies (O. Tricoptera), riffle beetle (O. Coleoptera F. Elmidae), water penny beetle (O. Coleoptera F. Psephenidae), non-biting midge (O. Diptera F. Chironomidae), black fly (O. Diptera F. Simuliidae), left-handed snail (O. Gastropoda F. Physidae), right-handed snail (O. Gastropoda F. Lymnaeidae), operculate snail (O. Gastropoda F. Viviparidae)*

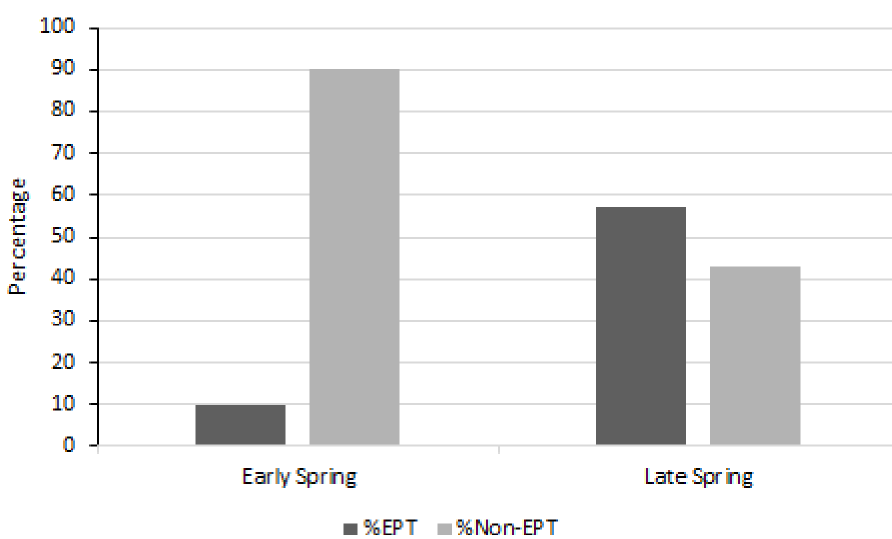


Figure 3. Comparison of distribution percentages of EPT & Non-EPT benthic macroinvertebrates at Van Horn Woods between the early and late Spring samples, 2018.

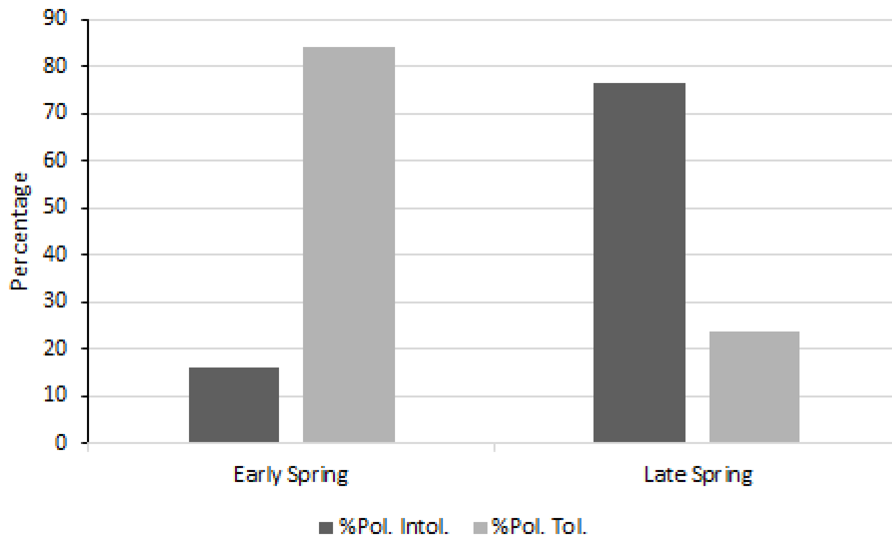


Figure 4. Comparison of distribution percentages of Pollution Intolerant & Pollution Tolerant benthic macroinvertebrates at Van Horn Woods between the early and late Spring samples, 2018.

## 4. Discussion

While these results traditionally would imply that the stream's quality was worse in the early Spring than it was in the late, it should be noted that the early Spring sample was primarily made up of midges and that there was a very small number of predators in the sample. The lower number of midges in the late sample compared to the early sample could explain the decrease in non-EPT individuals found when comparing late to early. Midges traditionally pupate and emerge in large quantities in late March to early April[19], landing in the 6-week sampling time frame used in this study. McCord & Kuhl (2013) regarded increases in chironomid abundance as an impairment to communities. They also reported that when richness and abundance of EPT organisms decreased, the abundance of midges had increased from Spring/Early Summer to Late Summer/Autumn[20]. Clements et al. (1989) found that midges were most abundant on their multiplate samplers in March[21]. The large concentration of midges sampled could have radically changed many of the results attained and would help explain some of the major differences between the two samples, such as the overabundance of Non-EPT and pollution tolerant specimens. In a study by Braccia et. al (2014), it was found that midges made up 85% percent of a forested site's biomass from late June to early August[22].

As previously mentioned, March and April 2018 in the Chicago metropolitan area had average temperatures that were much colder than normal conditions, including a high amount of snowfall in April[14,15]. The colder temperatures could have had an effect on some of the macroinvertebrate spawning patterns and an effect on the population numbers and abundance of certain species, more specifically, midges[19]. Stark and Phillips (2009) found that benthic macroinvertebrate taxa richness was highest in the Spring & Summer, while it was significantly lower in the Winter. Their study also showed that %EPT taxa richness was highest in the Spring and Winter compared to Summer and Autumn. They suggested that seasonally changing macroinvertebrate taxa had no impact on biotic indices[6]. However, this study found that there was a significant difference in terms of quality between the two samples. Soulsby et al. (2001), however, found that seasonally changing macroinvertebrate communities did have a direct impact on biotic indices[23].

Should a follow up test be conducted, it is suggested that the test be conducted in multiple runs in various areas throughout the creek, instead of just having all of the Hester-Dendy's in one location. This would provide future research with more concise data that would yield more accurate data and comparisons between the two sampling periods.

Using macroinvertebrates in research can provide important information regarding water quality and it is important that these methods be refined to determine the best time in which sampling should be conducted. Many factors can affect macroinvertebrates' lives within a stream, and it is very important to take these factors into consideration when choosing a time and season to conduct sampling. While future research is still needed to determine if there is a difference between early and late spring macroinvertebrate colonization, specifically in the Chicago metropolitan area, it could still be concluded that late Spring could potentially be a better testing period for future research, simply due to less chance of external variability affecting results, as was the case with the early Spring's abnormal weather conditions and midge population. Avoiding variables like these would provide more accurate data for future research, as data would have less risk of being compromised, thus providing potentially misleading data regarding the stream's actual quality at that time.

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