Pre- and Post-Flood Macroinvertebrate and Substrate Conditions of the Wissahickon Creek

Kristen Brandt & Rosa Iott

Chestnut Hill College

Introduction

The condition of a stream prior to a flood is typically quite different from its state following a flood. A flood often produces a dangerous amount of rapid moving water that picks up and moves rocks, mud, and other debris along with it, corrupting the flow of the water for a varied amount of time. Flooding is also capable of completely wiping out the macroinvertebrate populations present in an ecosystem at the time of the event; it is also able to destroy the habitat entirely, removing or adding any vegetation or sedimentation.

The purpose of this study was to research noticeable changes that occurred throughout the Wissahickon after a substantial flood event took place in the summer of 2013. Macroinvertebrate and bedrock samples were collected before and after a flood took place in order to document any modifications that the creek experienced.

Materials & Methods

The study consisted of collecting macroinvertebrate specimens and analyzing stream bed conditions throughout various sites of the Wissahickon Creek. Each of the three sites was located in close proximity to Chestnut Hill College's campus (below). Site 1 was behind Fontbonne Hall, across Tobacco Road, in a lightly wooded area within the Morris Arboretum's property. Site 2 and Site 3 were both situated further downstream in equally forested parts.

A kick net was used at separate shallow points of the river to collect the macroinvertebrate samples. The process was completed in a 1 meter by 1 meter square. Information was collected from each site at two separate times. Each of the sites was examined between May 20 and June 3 before the Wissahickon encountered a flood event (June 6 – June 10) and then again between June 12 and June 24 within a few weeks of the flood occurring.

Samples of cobble from the bottom of the river were then taken from four areas immediately surrounding the perimeter of where the kicking took place (above). A total of one hundred rocks were chosen randomly at each site. The rocks' size and embeddedness were analyzed and given a value based on a predetermined scale.

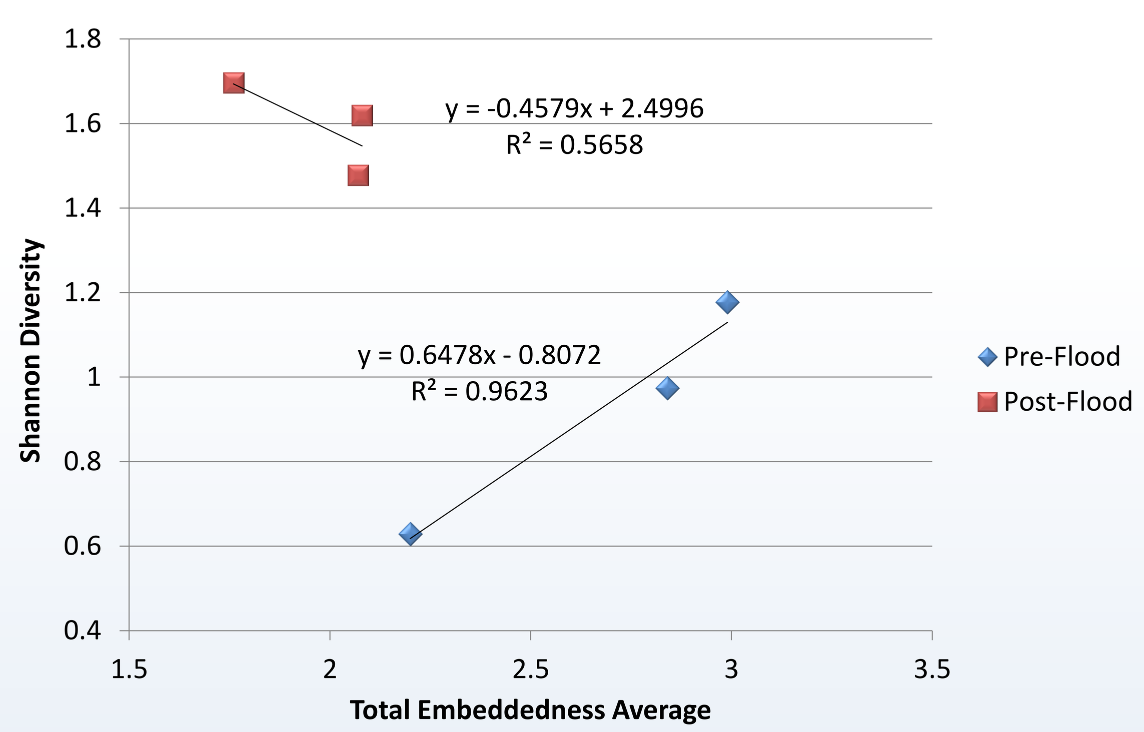
The Shannon Diversity Index, the Hilsenhoff Biotic Index, and various other biotic indices were calculated for each of the three sites. The Shannon Diversity Index calculates overall biodiversity and how the richness of the species is dispersed throughout all the species in the community.

The Hilsenhoff Biotic Index rates the amount of tolerance to organic pollutants that a community possesses. Essentially, the index helps to determine the overall health of the creek. The values range from 0 to 10, with a lower value indicating better health for the river or stream (Hilsenhoff 1987).

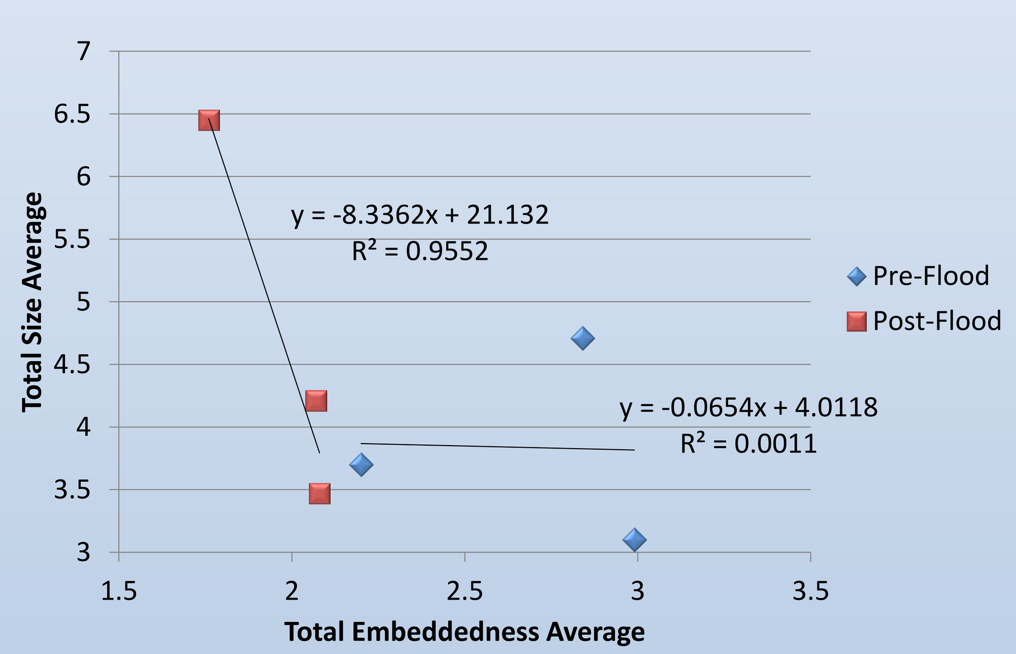
A few other biotic indices were calculated for each of the samples both before and after the flood took place. Because the values found from these indices varied quite drastically, they did not have any significant role in our analysis of the Wissahickon Creek.

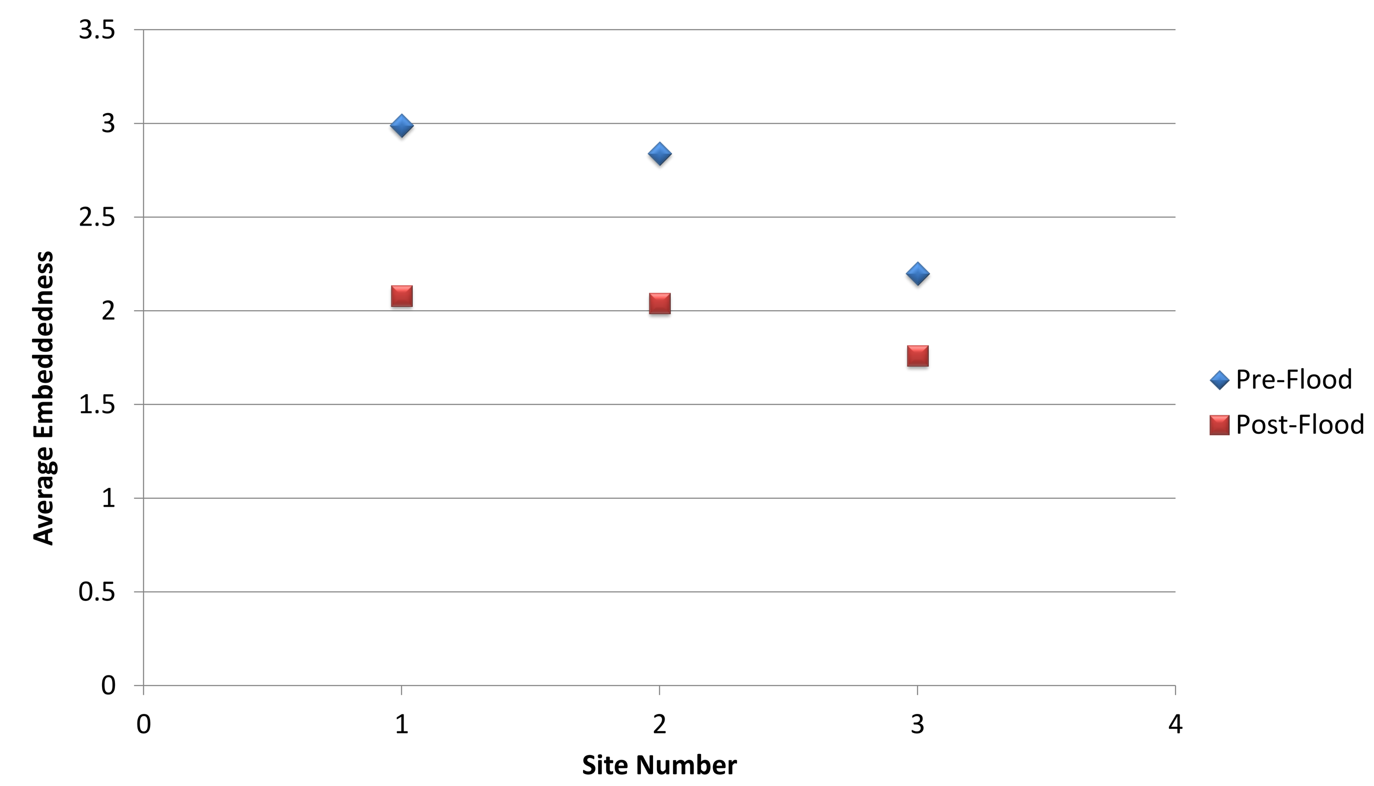
Results

From the data collected, mathematical comparisons were made and certain trends were observed.



A significant positive correlation is shown above between the Shannon Diversity Index and the total embeddedness average before the flood. After the flood no significant correlation remained. The figure below shows that the total cobble size average had a significant negative correlation with the total embeddedness average after the flood event, while no significant correlation existed before the flood event.





In the figure above, the embeddedness decreased possibly due to sediment removal by the flood waters. Site 2's lower embeddedness may also be due to a high increase in cobble size.

	Site 1 (Pre-Flood)	Site 1 (Post-Flood)	Site 2 (Pre-Flood)	Site 2 (Post-Flood)	Site 3 (Pre-flood)	Site 3 (Post-Flood)
Taxa Richness:	12	11	9	12	15	13
Shannon Diversity:	1.177	1.6190	0.974	1.4778	0.629	1.6961
e^H:	3.24	5.0481	2.64	4.3829	1.875	5.4525
Evenness:	0.199	0.6752	0.76	0.5947	0.369	0.6612
Percent Dominant Taxa:	68.142	36.641	33.636	35.841	72.419	52.414

The table above provides a list of parameters before and after the flood. The Shannon Diversity Index and e^H, both increased at each of the sites. Evenness increased at Sites 1 and 3 and decreased at Site 2. The taxa richness decreased after the flood event at both Site 1 and Site 3, while it increased at Site 2. Although not shown, the Hilsenhoff Index remained between values of 5 and 8 at all sites with only a slight decrease after the flood event took place.

As indicated by the graph above, the Shannon Diversity Index increased at each site after the flood event took place.

Conclusion

The Intermediate Disturbance Hypothesis states that a species in an ecosystem reaches its highest diversity at a level of intermediate disturbance. If a disturbance occurs too infrequently or is too mild, the ecosystem is unable to develop past a certain phase because dominant species take over resources and do not allow for inferior species to compete with them. On the other hand, if a disturbance occurs too frequently or is too severe, species intolerant to perturbation will become extinct in the area, and the diversity will then diminish. An intermediate level of disturbance therefore allows the post-disturbance influx of newer, secondary species to increase the diversity by diminishing dominant species. When a community faces a moderate disturbance, the richness will also be maximized at an intermediate time period following the disruption. When secondary succession takes place following a disturbance, species richness will be highest (Collin 1981).

Much of what this research found supported the Intermediate Disturbance Hypothesis. The flood that took place was considered to be an intermediate level of disturbance. Therefore, an increase in the Shannon Diversity Index at each site after the flood follows the pattern of the intermediate disturbance hypothesis. This may be due to a combination of exposure of habitat sites by the removal of sediment along with the diminishment of dominant species as occurred at Sites 1 and 3. The slight decrease of the Hilsenhoff values at each site after the flood further exemplifies the idea of the Intermediate Disturbance Hypothesis. A higher diversity in a community typically makes for a healthier stream.

The taxa richness, however, does not follow the Intermediate Disturbance Hypothesis perfectly. It is expected that the richness would be at its maximum value at an intermediate time span following the disturbance. Site 2 is the only location that saw an increase in the taxa richness. In addition, the macroinvertebrates from this site were collected immediately following the flood event, prior to the other two sites. It would be expected that this site would not experience an instant increase in taxa richness, and that the other two sites would, considering the invertebrates were gathered at an intermediate time period after the flood. One explanation of the increase could be regarding the buildup of macroinvertebrate drift, floating organic material, and inorganic sediment that is commonly a result of flooding in streams and rivers (Imbert and Perry, 2000). These brief alterations in the Wissahickon may have caused the richness to increase immediately following the flood at Site 2. Over the next two weeks, this material would have decreased and could account for the decrease in taxa richness that Site 1 and Site 3 experienced.