

# Ground Beetle (Coleoptera: Carabidea) Community Structure as an Indication of Disturbance in Stoney Creek, Burnaby, BC

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## Abstract

To investigate the impact of constructing an off-channel pond in Stoney Creek, Burnaby, BC to ground dwelling arthropods, carabid beetles were sampled at three sites: the pond site, the adjacent site, and the upstream site. The pond site was the area in which the artificial pond was constructed to create spawning habitat for salmon, and it was the most disturbed site. The other two sites were relatively undisturbed and were used as a comparison. Species observed in all sites were forest generalists consisting of both native and invasive species. This indicates that all sites have experienced recent disturbance since significant time has not passed to allow specialists to become re-established. Species evenness, however, was calculated to be lowest in the pond site, greatest in the upstream site, and intermediate in the adjacent site. This is due to the different characteristics of each site; the pond site had an open canopy as most of its vegetation had been removed, the upstream site was dominated by tall trees and is characteristic of a natural riparian zone in BC, and the adjacent site had a relatively open canopy as much of the understory was dominated by *Hedera helix* (English ivy) and *Rubus ameniacus* (Himalayan blackberry). Unfortunately, statistical analysis could not be performed since a small number of individuals were caught at each site; the impact of the off-channel pond construction is inconclusive. Future studies can, however, use this study as a comparison and further elaborate on these results.

## Key words

*Biological indicators, disturbance, Carabidae, generalists, specialists, invasive, native*

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## Introduction

Ecosystems are dynamic entities that are prone to both natural and anthropogenic disturbances. However, the severity to which an ecosystem is affected depends upon the magnitude of the disturbance and the characteristics of that environment; some environments are

more resilient than others and/or are more able to rebound (Dearden and Mitchell 2009). Once an environment becomes disturbed, the community structure changes to reflect the newly available, or altered, habitat. Stoney Creek, Burnaby, British Columbia has experienced recent anthropogenic disturbances in order to construct an off-channel pond to create spawning habitat for salmon. This study was conducted in order to determine if this disturbance has significantly changed the community structure in Stoney Creek.

Biological indicators are species, or groups of species, that reflect the abiotic and biotic state of an environment and are widely used to reveal environmental change (Rainio and Niemela 2003). The presence of an indicator species describes the characteristics of an environment because it meets their habitat requirements; the absence of a documented bioindicator from one year to the next reveals environmental change. Insects have been utilized as environmental indicators because of their abundance, diversity, and importance in ecosystem functioning (Villa-Castillo and Wagner 2002). One group of insects in particular, the ground beetles (*Coleoptera: Carabidae*), has been proven as a biological indicator due to their sensitivity to temperature and humidity, food conditions, presence and distribution of competitors, and habitat fragmentation (Rainio and Niemela 2003). Consequently, this group of insects will be used in order to determine if the disturbance in Stoney Creek has significantly changed the community structure of ground dwelling arthropods by comparing communities of carabids in the disturbed area with surrounding relatively undisturbed areas.

## **Methods and Materials**

### ***Study sites***

This study was conducted in the riparian zone of Stoney Creek, Burnaby, BC and consisted of three sample sites: the pond, the adjacent site, and the upstream site (Figure 1). In order to create the artificial pond, heavy machinery was brought in and, consequently, this site was heavily disturbed as much of the vegetation was removed. The adjacent site is located on the other side of the stream adjacent to the pond site. This site has an open canopy, as the understory is dominated by *Hedera helix* (English ivy) and *Rubus armeniacus* (Himalayan blackberry), which may be a result of past disturbances such as the construction of the Burnaby Trail. Tall trees dominate the upstream site, and it can be considered the least disturbed site since it most closely resembles a natural riparian zone in British Columbia. However, there is a small trail that runs through this site, so it is not completely devoid of disturbance. A list of flora found at each site can be seen on Table 2.

### ***Capture and identification***

Three pitfall traps were set in each of the three sites on March 14th, and they were removed on April 15th. Holes were dug in areas of accumulated litter using a spade, and the rim of the trap set flush to the soil. Pitfall traps consisted of two plastic cups stacked inside one another where the outer cup had a hole cut in the bottom, and the inner cup had a hole cut in the bottom but was covered by mesh; this allowed water to pass through while the beetles remained inside. While the inner cup was removed and the beetles collected, the outer cup held the soil in

place. Figure 2 provides a visual representation of pitfall traps. Beetles were then taken to the lab and identified using a dissecting microscope and identifications keys.

The species found in the pond site, the most heavily disturbed area, were compared with the species found in the adjacent and upstream sites, relatively undisturbed areas, in order to determine if there is a difference in community structure. Also, the Shannon index was used to allow us to compare species evenness between sites. The comparison of the adjacent site allows us to observe if the disturbance in the pond site has carried over to other areas in close proximity. However, the stream running between the two sites may act as a barrier limiting the influence of the disturbance. The upstream site allows us to compare species we would expect to see in an undisturbed riparian zone with those in the other two sites since it is at a sufficient distance from the disturbance.

## Results

Difference in diversity between sites was observed; however, it was not significant (Table 2). The pond site had the lowest diversity consisting of four species represented by eight individuals. This site also had the lowest species evenness with a Shannon Index of 2.957, where the most abundant species found was *Scaphinotus marginatus*. *Carabus nemoralis*, an invasive species, was also found in this site.

The adjacent site had the same diversity as the pond site, but it was represented by 13 individuals (Table 2). Species evenness was an intermediate between the pond site and the upstream site (3.062) and was strongly represented by *Scaphinotus angusticollis* and *Carabus*

*nemoralis*. *Agonum sp.* and *Scaphinotus marginatus* were found in the other two sites but were not observed in this site.

The upstream site was observed to have the greatest diversity represented by 11 individuals (Table 2). Also, species evenness for this site was the highest (5.131), however species were not present equally; *Scaphinotus marginatus* was the most abundant species. Both invasive species *Carabus nemoralis* and *Pterostichus melanarius* were found in this site; *Pterostichus melanarius* was not observed in the other two sites.

## **Discussion**

### ***Species found***

All species observed during this study consisted of both native and invasive forest generalists. Native species include *Scaphinotus angusticollis*, *Scaphinotus marginatus*, and *Loricera pilicornis*. These three species are associated with forest habitat, but, more specifically, *Scaphinotus angusticollis* are characteristic of riparian forests, as they receive more precipitation (Rykken et al. 2011; De Kesel and Van Den Neucker 2005). Invasive species include *Carabus nemoralis* and *Pterostichus melanarius*, and are also characteristic of forest habitats (Alibert et al. 2001).

Since all sites had some degree of disturbance, the lack of forest specialists found supports the habitat specialist hypothesis: the number of forest specialists found in an area decreases as the area becomes increasingly disturbed (Tothmeres et al. 2011). Disturbed sites are more favourable to generalist species because they are able to tolerate a wide range of conditions, such as environmental change. Specialists, on the other hand, have a restricted

tolerance range, so they are unable to withstand significant changes to their habitats. Therefore, the observed presence of only forest generalists indicates that all sites have experienced recent disturbances.

### *Species evenness*

The three communities observed were similar in species composition, but their distribution/evenness varied between sites (Table 2). Species evenness was lowest in the pond site probably due to the construction of the artificial pond, which can be described as a large scale disturbance. As a result of the construction, the canopy is open as most of the flora was removed to allow heavy machinery accessibility to the site. After a disturbance, time is required for individuals to immigrate from surrounding areas, so it is understandable that only a few species were observed at this site.

Species evenness observed at the adjacent site was intermediate between the pond and upstream site (Table 2). This could be due to the relatively open canopy since the understory was dominated by *Hedera helix* (English ivy) which is uncharacteristic of a natural riparian forest. Also, this site was at a higher elevation with steep slopes that may influence the movement of carabids. One pitfall trap was placed under a large red cedar where there was little litter and was possibly a low traffic area. Therefore, the low species evenness recorded may be a result of both the site characteristic and poor placement of a trap.

The upstream site was observed to have the greatest species evenness (Table 2) probably as a result of having a closed canopy; thus being a more appropriate habitat for carabids. However, this riparian zone is not completely undisturbed since two invasive species

were observed. Also, a trail runs through the middle of the site causing continuous disturbance.

### ***Future studies***

Unfortunately this study was conducted at the end of winter when most beetles are inactive (Rainio and Niemela 2003); as a result, a small number of individuals were caught. The best time of year to take samples would be between June and September, which encompasses their mating season and, therefore, a greater number of individuals can be expected to be captured (Mullen et al. 2008). Setting the traps for a longer period of time and baiting them would also result in catching a greater number of individuals.

Due to the low number of individuals collected, statistical analysis could not be performed; therefore, our results are inconclusive. Although these results are not a proper representation of the area, they can be used as a comparison and elaborated on if future studies are conducted.

### **Conclusion**

Due to the limited number of individuals caught, we are unable to determine how significantly the community structure of carabids has been altered in response to the disturbance in the pond site; however, inferences can be made. One or two invasive species were found in each of the sites, and all species found were forest generalists indicating continuous disturbance in each site; invasive and native generalist species characterize disturbed areas since they have a wide range of tolerances and are thus able to withstand significant environmental change (Tothmeresz et al. 2011). The lack of specialized species found suggests that there has not been a

sufficient amount of time without some disturbance for these species to become re-established (Tothmeresz et al. 2011). Diversity and species distribution was greatest in the upstream habitat which was furthest away from the pond and more characteristic of a riparian forest. Assuming the pond site initially resembled the upstream site, we can observe a difference in community structure as the upstream site had greater diversity. Unfortunately we cannot statistically prove this because our catch was too small and, consequently, not a proper representation of each site. The adjacent site had similar diversity to the pond site, but this could be due to the Burnaby Trail that fragments the habitat, rather than the restoration project since the stream should mitigate any disturbance experienced in the pond site. Future studies would need to be conducted to elaborate on our results and document change as the site recovers and undergoes succession.

### **Management Plan**

Since carabids can be used to indicate environmental change, sampling should continue in order to monitor the progress of Stoney Creek Restoration. Over time biodiversity can be expected to increase as the habitat recovers.

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## Tables and Figures



Figure 1. Provides an overview of the study site. The Loughheed Highway running in between the study area is shown as well as surrounding urbanization.

Table 1. Demonstrates the vegetation present at each sample site to provide comparison of each habitat that could contribute to variation in beetle species present.

Plant Species	Pond	Adjacent	Downstream
<i>Thuja plicata</i> (Western Red Cedar)	X	X	X
<i>Hedera helix</i> (English Ivy)	X	X	X
<i>Rubus armeniacus</i> (Himalayan Black Berry)	X	X	
<i>Acer macrophyllum</i> (Bigleaf Maple)		X	
<i>Rubus spectabilis</i> (Salmonberry)		X	
Mosses	X	X	X
<i>Ilex aquifolium</i> (English Holly)	X		
<i>Acer circinatum</i> (Vine Maple)	X	X	X
<i>Alnus rubra</i> (Red Alder)	X	X	X
<i>Polystichum munitum</i> (Sword Fern)	X	X	
<i>Tsuga heterophylla</i> (Western Hemlock)	X	X	X
<i>Lysichiton americanus</i> (Skunk Cabbage)	X		
<i>Maianthemum dilatatum</i> (False Lily of the Valley)	X		
<i>Sambucus racemosa</i> (Red Elderberry)		X	

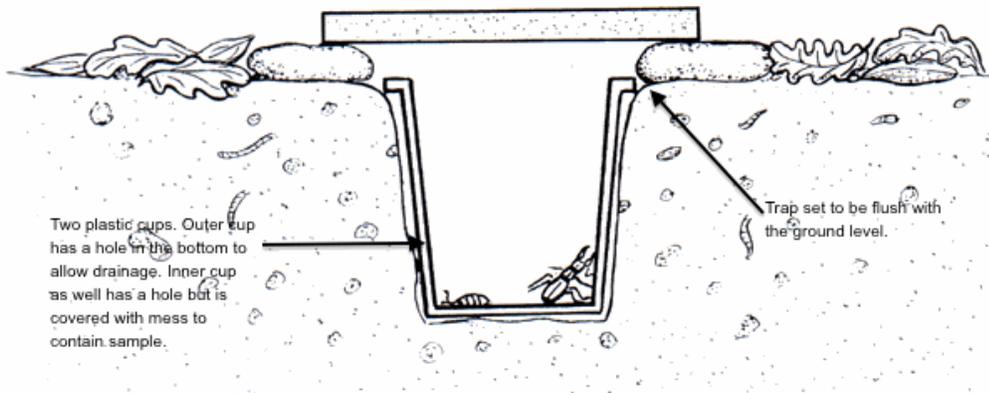


Figure 2. Illustrates the pitfall trap and methods used. This diagram show the use of a cover to protect from precipitation, in our study we chose not to include this step.

Table 2. Provides an overview of the results obtained. The Shannon Index demonstrates the evenness at each site. When the Shannon Index is closer to zero the site has less evenness, consequently a high Shannon Index means higher evenness among the species present.

Species	Pond Site	Adjacent Site	Down Stream Site
<i>Scaphinotus angusticollis</i>	1	6	1
<i>Scaphinotus marginatus</i>	5	0	4
<i>Bembidion sp.</i>	0	1	1
<i>Agonum sp.</i>	1	0	2
<i>Loricera pilicornis</i>	0	1	0
<i>Carabus nemoralis</i> (invasive)	1	5	2
<i>Pterostichus melanarius</i> (invasive)	0	0	1
Total individuals	8	13	11
Total species found	4	4	6
Shannon Index	2.925718	3.061699	5.131408