LEVELS OF INSECT, BIRD, AND MAMMAL ACTIVITY AT SNAG TREES LOCATED IN AREAS WITH VARIABLE AMOUNTS OF HUMAN ACTIVITY AND URBANIZATION

Aly Briere, Kennah Taylor, and Toby Rabten

ABSTRACT

Snag trees are a lesser known important part of a healthy forest ecosystem. Vertebrates such as birds and mammals, and invertebrates such as insects utilize them as habitat, and a place to forage for food. We studied the effects urbanization has on the activity level of invertebrates and vertebrates at snag trees by surveying the abundance of mammals, birds, and insects at three locations at SUNY Purchase College. Our first observational site we called our edge site, had the highest amount of human activity, our second location, our intermediate site had an intermediate amount of human activity, and our final observational site, our forest site had the lowest amount of human activity out of the observational sites. Observational data on vertebrate and invertebrate activity at the three sites was collected over a two-week period. Our findings were that mammal and bird activity was the highest at the forest site and insect (invertebrate) activity was the highest at the edge site. Mammal and bird (vertebrate) activity was the lowest at the edge observational site and insect (invertebrate) activity was the lowest at the forest observational site. Possible reasons for these findings are: many vertebrates such as rodents utilize very degraded snag trees as nesting sites, urbanization decreases the abundance of degraded snag trees due to high rates of snag tree removal in edge habitats vs in less disturbed habitats. Edge habitats are also more open to weather and human disturbances making them less suitable of a habit for vertebrates due to their susceptibility of being harmed from the effects. Invertebrates are less susceptible and sensitive to the effects of human activity and increased exposure to weather disturbances because of their small size, better burrowing and foraging ability compared to vertebrates. We believe more research needs to be done on the specific species of vertebrates and invertebrates utilizing the snag trees to formulate a plan on how to protect these species by protecting these invaluable snag trees in urban areas.

Keywords. Ecosystem, Snag, edge, forest, urbanization

INTRODUCTION

Sustaining the presence of wildlife within natural systems becomes increasingly difficult with the spread of human developments that disrupt the biosphere. The first forest that was cleared for human agriculture and livestock breeding marks the first modification of the ecosystem by Humans Marchant et. al 2018). Today, this modification takes another form; modern urbanization, where human have altered earth's natural structures to the point where there have been global negative impacts on the function of natural systems (Rongfang et al. 2018.) Urbanization affects global species diversity as well by minimizing habitat sizes and shifting the makeup of the ecological community via the creation of edge space (Brearley et al. 2010). These "edges" that border human development and intact ecosystems, correspond to a decrease in wildlife presence within these ecosystems due to noise, light pollution and general disturbance (Goulart et. al). Human development is also associated with deforestation, which is detrimental to woodland ecosystems, as the density of tree cover has been shown to have a strong positive correlation with species abundance (Goulart et. al). This makes it vital to integrate and preserve features in the increasingly urban landscape that can be supportive to long term diversity, and eco-systemic health.

Within forest ecosystems, snag trees are a vital component of the environment and are classified as standing dead trees that are created through old age, fire, wind, insects, and fungi (Barry et al 2017). A broad spectrum of vertebrates utilize the cavities within snags for shelter such as bats, rodents, and bears (Weiss et al. 2018.) Birds and other vertebrates also utilize snag tree cavities, created from tree rot, for shelter and often feed on insects that also utilize the trees (Weiss et al. 2018). Trees that have begun to die may be cut down because they pose a hazard to human developments but some need to be left undisturbed as they still play a major role in the ecosystem. In urban environments they are usually removed before they can degrade and prevent mammals from persisting that are reliant on their cavities (Edworthy and Martin 2014). These trees also offer nourishment for the forest ecosystem as they decompose by re-juvinating the soil and providing nutrients for organisms such as insects (Barry et al 2017). Snag trees in unmanaged forests have more microhabitats, which are cavities within the tree that support biodiversity and maintain the health of the ecosystem, than trees in managed forests (Paillet et al 2017). Snag tree cavities can take up to three years to develop, therefore snag trees must be left in the ecosystem and not disturbed by forest managers (Zarnoch et al 2013.) Snags are capable of storing carbon, and when left in forests undisturbed, release nutrients back into the soil matrix, further promoting the long-term health of the local biome (Oberle et. al 2018). They can also offer important data on tree ring chronologies which are useful in ecological studies (Weiss et al. 2018).

The Purchase college campus has many patches of forests that house different abundances of species depending on location. In this study, we investigate how the activity of animals on snag trees changes in different habitats that have a variation of disturbance levels. We investigated trees in forest, intermediate, and edge habitats We hypothesized that snag trees located in areas with low levels of human activity and urbanization would have a higher visitation rate for insects, mammals, and birds compared to snag trees located in areas with high levels of human activity and urbanization.

METHODS

To begin our study, we surveyed areas on campus to find snag trees in locations that had different amounts of disturbance from human activity and urbanization. For our first location, we looked for an area with an intact forest interior, small amounts of fragmentation and low levels of human activity. The second location we chose has moderate human presence and is closer to a main dorm so we used this area as our intermediate site. The third location is the most fragmented and has the highest amounts of human activity and urbanization. The observational site we choose with low amounts of human activity and urbanization is located 1 mile from the main campus and a half of a mile in all directions from all human developments. We labeled this observational site our "Forest" site. The observational site we chose with intermediate levels of human activity and urbanization is located a quarter of a mile from alumni and all other human developments which we labeled "Alumni". The observational site we choose with high amounts of human activity and urbanization is located less than a 10th of a mile from human developments in very close proximity to the dance building and a concrete road and walkway, we classified this as our "Edge" site.

The Forest site was found at the South-West corner of the campus, and bordered the South West edge of the loop. The intermediate observational site was found at the North-Eastern corner of Purchase Campus and was located in between the Alumni and the Commons. The Edge observational site was found near the Western Edge of Purchase campus and was directly West of the Garden in front of the Dance Building and directly North of the West 2 parking Lot.

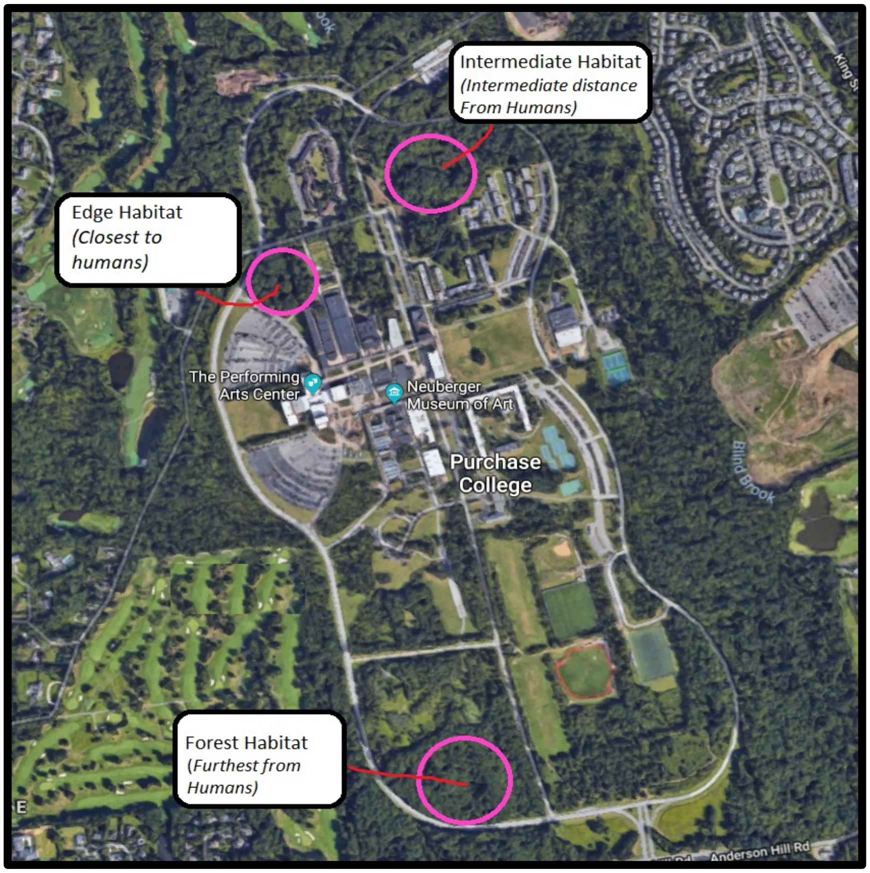


Figure 1. Map of our three sites

At each site, we chose three snag trees to observe within a 40 foot proximity from each other, this ensures that all the trees have the relative distance from human activities and other distances. For the purposes of our study we focused on the presence of birds, squirrels, chipmunks and insects that were visible with the naked eye. We defined activity of these organisms as foraging, climbing, perching, nesting, or breeding on the snag trees. To record our data, each group member (in our three-person group) was assigned one site and recorded their observations of snag tree utilizations for each organism type.

Each group member went to their designated site twice per week and observed each tree at the observational site for an hour over a period of two weeks. The length of time we chose, seemed to be optimal for minimizing the effects of our presence on how the animals were acting. We first observed the insects, as that required getting very close to the trees and counting as many as we could see without any equipment. We then watched the trees from a distance of approximately 15 feet. This allowed us to keep a close eye, while also being far enough away to not alter "normal" animal habits. While performing these observations we used iNaturalist to identify unknown organisms as well as our built in Phone cameras to keep track of the snags that we were observing and to photographically capture any organisms of interest.

RESULTS

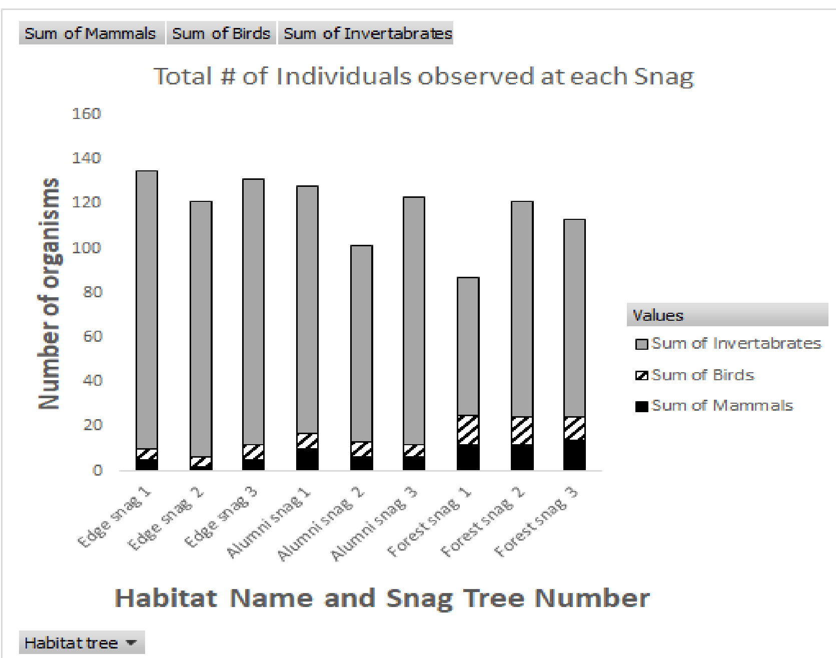
Figure 1 below is a graph of our raw data which display's the number of birds, mammals, and vertebrates we observed in total at each tree in each observational site over the two-week data collection period.

At the "Edge" site (high level of human activity) 93% of snag activity recorded was caused by invertebrates (percentages of organismal activity per habitat are found in figure 3 below), and an average of 14.1 invertebrate individuals were observed (average organismal activity for each site found below in table 1, and figure 2). 5% of snag activity was caused by birds at this site with an average of 0.6 individual birds. Lastly, 2% of activity was caused by mammals, and an average of 0.5 individual mammals were recorded.

At the "Alumni" site (intermediate level of human activity) 88% of snag activity recorded was caused by invertebrates, and an average of 12.9 individual invertebrates were recorded. At this site birds were responsible for 5% of activity and had an average of 0.8 individuals. Finally, 7% of activity was caused by mammals, and an average of 0.9 individuals were recorded at this site.

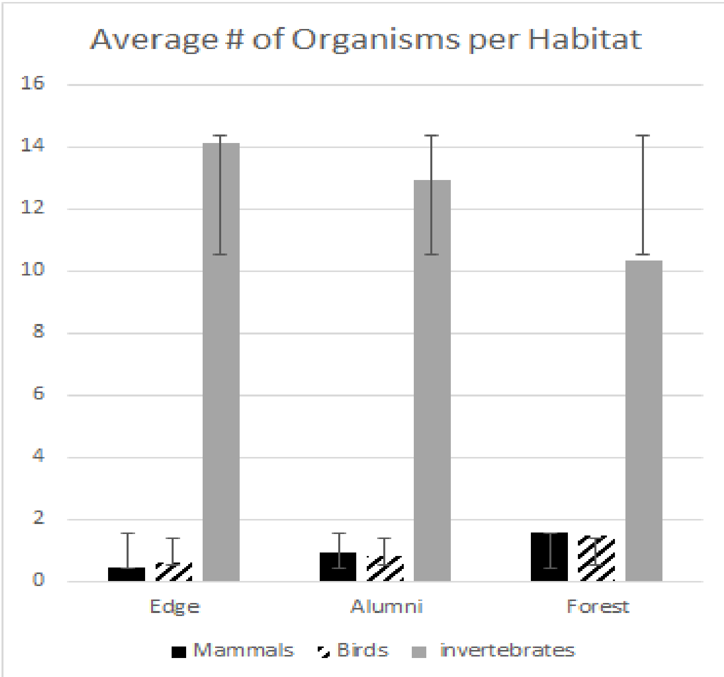
Lastly, the "forest" site (lowest level of human activity) 78% of snag activity recorded was caused by invertebrates, and an average of 10.3 individuals were recorded. 10% of activity at this site was caused by birds, and an average of 0.5 individuals were recorded. Lastly mammals were responsible for 12% of activity, and an average of 1.6 individual mammals were recorded.

The standard deviation for our habitat sites below in table 2 displays that the "edge" site had a standard deviation of 42, the "alumni" site had a standard deviation of 39, and the "forest" site a standard deviation of 31.



Levels of human activity
Edge: High
Alumni: Medium
Forest: Low

Figure 1. Total recordings for each Snag. Each bar in the graph above represents the total activity collected for an individual snag).



Levels of human activity
Edge: High
Alumni: Medium
Forest: Low

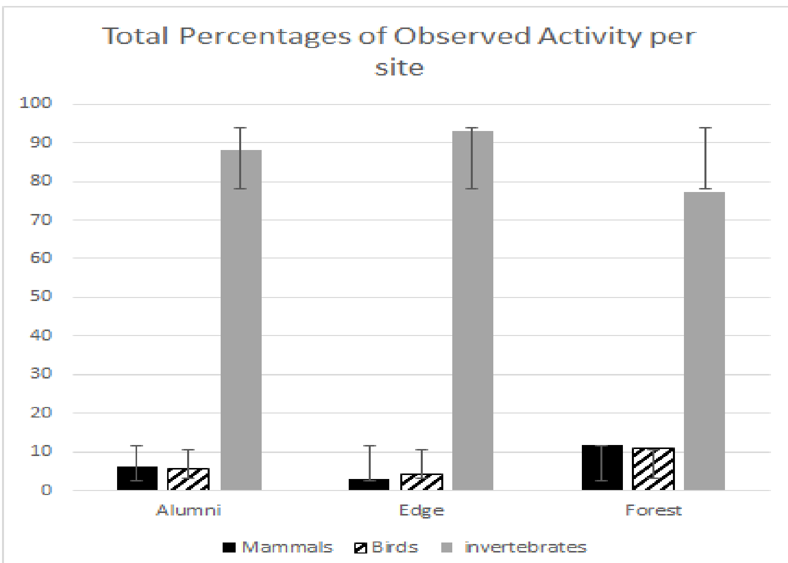
Figure 2. Average number of invertebrates, mammals, and birds per habitat. The graph above shows the average number of individual mammals, birds, and invertebrates observed per habitat site .

Table 1. Average number of individuals observed for each site. This table below lists the numerical averages for individuals of mammals, birds, and invertebrates involved in snag activity over the course of the two-week study

Habitat	Mammals (average)	Birds (average)	Invertebrates (average)
Edge	0.5	0.6	14.1
Alumni	0.9	0.8	12.9
Forest	1.6	.5	10.3

Table 2. Standard deviation for each habitat type. Illustrates the diversion from the average of total organismal activity for each habitat site

Habitat	Standard Dev for each Habitat
Edge	42
Alumni	39
Forest	31



Levels of human activity
Edge: High
Alumni: Medium
Forest: Low

Figure 3. Total Percentages of organism activity recorded over 2 weeks.

The Figure above illustrates the total percentages of the organism types found at each site. At all sites, invertebrates were the most commonly found organism percentage wise. The total percentage of Birds and Mammals observed at each site made up only a small proportion of the organisms observed as invertebrate findings were far more abundant than Bird and Mammal findings.

DISCUSSION

Based on the data we collected, we found that organism activity in snags seems to be affected by proximity and intensity of human activity and that the abundance of invertebrate activity in an area is affected by the abundance of nearby bird and mammal activity. We hypothesized that insect, mammal, and bird activity would be the lowest at the "edge" site, our observational site with the highest amount of human activity and urbanization, and insect mammal, and bird activity would be the highest at the "forest" site our findings partially supported our hypothesis. In the "forest" observational site with low levels of human activity, Invertebrate activity was the lowest compared to the other sites but mammal and bird activity was the highest. This may be because the birds and rodents were acting as predators to the insects and decreased their presence in this area. In particular, birds may be chiefly responsible for this shortage in insects as they have a heavy preference for insects as their main food source above all other sources in woodland areas (Nyfeller et al. 2014). In the Edge habitat the presence of birds and mammals was the lowest, which may be a factor that allowed for Invertebrate colonies to flourish and hold dominance over this Edge site. The higher abundance of Birds and mammals seen in the forest is supported by other studies that have been done around the world. In a study conducted on snag density and abundance of cavity nesting birds in western coniferous forests areas with higher densities of snags also had higher abundances of certain cavity-nesting bird species (Spiering and Knight 2005). In Australia, scientists had a 3.9% success rate at capturing squirrel gliders in deep forest compared to only 1% catch rate in areas within edge habitat (Brearley et. al)

Out of all of the habitats, the edge space promoted invertebrate species richness the most but was the least supportive to birds and mammals such as chipmunks and squirrels. This would make sense as other research has shown that edge habitats allow for more access to wind, light, and sound which can cause huge disturbances to the ecosystem and habits of Birds and Mammals (McGabe et al 2018). Along with this overexposure of wind, light, and sound, the Edge habitat we chose was also lined with pathways used by humans daily and this high amount of Human activity also seemed to have a clear impact on the presence of Birds and Mammals for the snags at this Edge site.

Urbanization has also been seen to have had a negative effect on local populations of Mammals and Birds mainly due to the destruction of common food sources (insects and nuts) and prime habitation spots such as snags and healthy trees (Seress and Liker, 2015). In a study conducted on the abundance of snag trees in relation to urbanization, forest patches with no prior history of forest disturbance have 19 times the density of snags than patches of forest that have been disturbed by complete timber harvest in the past, and 3 times the density of snags of forest areas that have been moderately disturbed from timber harvest (Spiering and Knight 2005). This study shows how urbanization directly affects snag abundance which also affects snag activity levels and biodiversity. In one study, an increased amount of edge space was shown to drive the presence of squirrel gliders significantly downward as these animals are deterred from areas that have been disrupted. Squirrel gliders select for densely forested areas opposed to choosing denning sites close to human developments (Brearley et al. 2010). This type of habitat select is most likely a driving factor for the trends we observed in chipmunks, squirrels and possibly birds as well.

Habitats that are closer to Human sites but not within direct human traffic (Edge site) have been shown in recent studies to be prime spots for Insect habitation. This may be due to the fact that these “edge” habitats provide both sufficient nutrition from human sources (trash and waste) while not being outright exterminated by being in the direct path of human traffic (Lindenmayer and David et al. 2014).

In our study we decided that whether the animal we were observing was an invertebrate or vertebrate was more important than the specific species since vertebrates and invertebrates have similar resource and habitat requirements pertaining to each group. To continue expanding on this study, research would have to be conducted on the specific vertebrates and invertebrates that utilize snag trees in different areas.

Sources of error that could have muddled our findings include not taking enough sightings at each of our snag sites and leaving out other factors that can affect visible organism activity such as temperature, time of day, and precipitation.

To further investigate and support these findings, we would definitely need to spend a longer period of time working with these different sites. Adding more plots to each habitat and sampling more frequently would also help to give our data the accuracy we need to further expand this body of research.

CONCLUSION

Our findings are important because they suggest that urbanization has an effect on vertebrate and invertebrate activity within snags. Understanding how to conserve and manage forests through proper snag management and more carefully scaled urbanization is vital as allows us to prioritize and preserve the denning sites and breeding grounds that serve as vital habitats for many animals and prevent disruptions of local ecosystems. In some areas of the world, birds depend on standing dead trees for reproduction even more than live ones (Davis and Miller 2018). In certain cases snag trees have even been artificially created by forest managers to restore ecosystems and provide shelter for birds, mammals, and invertebrates (Zarnoch et al. 2013). Therefore, the importance of snag trees for the health of woodland ecosystems everywhere is not to be overlooked (Weiss et al 2018). The impacts of converting green space into urban areas differ depending on the level of development. As biota continue to become more vulnerable because of the imposing changes, it's important that animals are able to sustain themselves in the built world.

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