Noise, NOISE, Noise

Impacts on Plants & Pollinators

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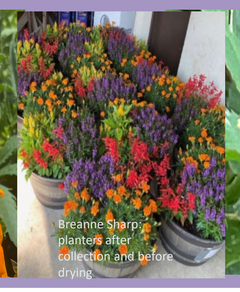
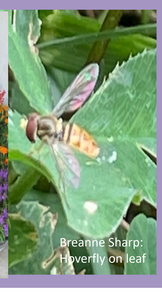
Breanne Sharp: planter microcosms


Breanne Sharp: Honeybee on White Clover


Renee Godard: pictured Breanne Sharp, Zoë Jordan, Shayla King


Breanne Sharp: Skipper


Breanne Sharp: planters after collection and before drying


Breanne Sharp: Hoverfly on leaf

Abstract

Recent studies have shown that anthropogenic noise can have significant impacts on the species composition of ecosystems, plant physiology, and animal behavior. While past studies have examined impacts on different organisms separately and often in the lab, this study compared responses of pollinators and plants exposed to two different locations (HT – high traffic and LT – low traffic) separated by 200 m on the Hollins University campus. Average noise levels at the HT site were 10 dB louder than at the LT site with the average maximum levels greater than 90 db. Unlike previous studies, we found that the above and below ground biomass of plants grown in HT and LT microcosms did not differ nor was there any difference in leaf stomatal density after 58 days. Before harvesting, pollinator activity at the microcosms at the HT and LT site was videotaped simultaneously on five different occasions. Analysis of these videos revealed no difference in visitation rates by pollinators between the LT and HT sites; however, a greater diversity in pollinator taxa was seen on marigolds at the LT site during July. This multilayered field study indicated that noise may have impacts on biological organisms but further study is warranted.

Introduction

- Noise has impacts on biological communities
- Anthropogenic noise can alter the behavior of seed dispersers and ecosystem composition (Francis et al., 2012).
- Noise exposure can decrease growth rates in plants (Kim et al., 2021).
- Higher rates of hummingbird pollination noted in high noise areas due to decreased predator activity (Francis et al., 2012); but larval monarch butterflies exposed to noise have elevated heart rates (Davis et al., 2018) which could decrease success of invertebrate pollinators.
- Insect diversity (arthropod) was lower in noisy areas (Morely et al., 2014).
- Elevated CO2 emissions (associated with noisy traffic), can decrease stomata density in plants (e.g., Kim et al., 2021)

OBJECTIVE

To compare plant growth and physiology as well as pollinator activity in High Traffic (HT) and Low Traffic (LT) areas.

Method and Materials

- 14 Plant microcosms with 4 species of plants: Angelonia (*Angelonia* angustifolia), celosia (*Celosia* argentea), marigold (*Tagetes* erecta), and salvia (*Lamiaceae* coccinea) placed at LT and HT sites (see map) for 58 days, June 1- July 28, 2021.
- After 58 days, plants collected, cleaned, dried for 48 H at 60C. Above and below ground biomass compared. Before drying 3 leaves collected and impressions of undersurface collected for stomatal comparison.
- Pollinator activity recorded (Fig 3) simultaneously for 30 min by camera at LT and HT sites on 5 occasions (see Table 1). Videotapes analyzed for visitation rates/30 min and taxonomic diversity. Still images from the video were used to determine pollinator identity.

Results

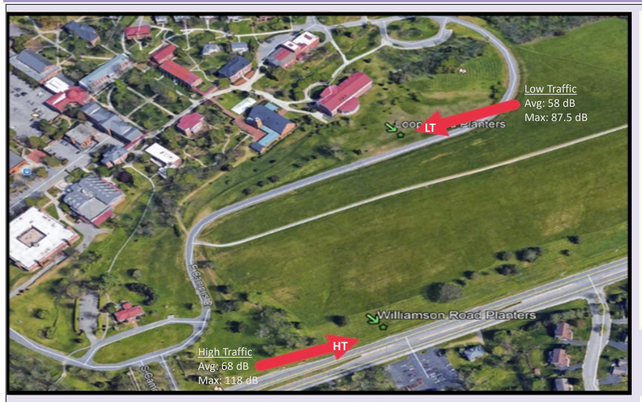


Figure 1 GPS locations of both the high traffic (HT) and low traffic (LT) sites, showing the average and maximum decibels (dB) of each.

Table 1: VIDEOTAPING SCHEDULE

A = Angelonia, 6/23/21 – 6/24/21, 9am – 5pm
CL1 = Clover, 6/13/21 – 6/15/21, 9am – 12pm
CL2 = Clover, 7/5/21 – 7/6/21, 7am – 12pm
M1 = Marigold, 6/29/21 – 6/30/21, 8am – 2pm
M2 = Marigold, 7/26/21 – 7/27/21, 9am – 2pm

Figure 3 Using a camera to record planters for pollinator activity at LT site.

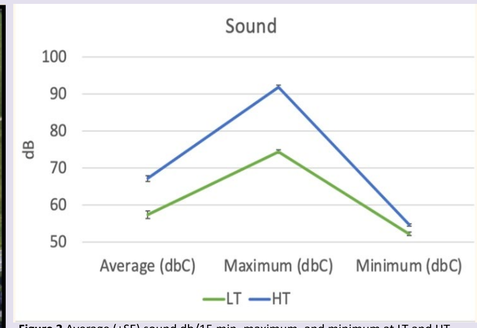


Figure 2 Average (+SE) sound db/15 min, maximum, and minimum at LT and HT sites. All significantly louder at HT site. Average (T-test, t= -16.72, df= 41, p<0.001), Maximum (T-test, t= -12.15, df= 41, p<0.001), Minimum (T-test, t=-3.665, df= 41, p<0.001).

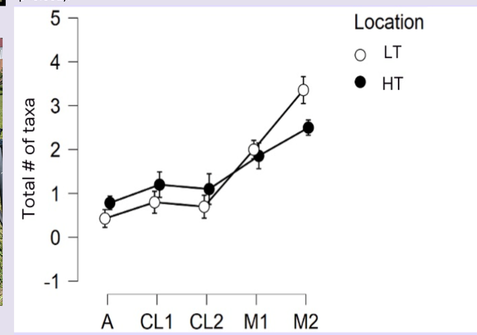


Figure 4 Average ± SE # of taxa visiting/30 min for 5 recording sessions. Diversity significantly different between sessions (2x2 ANOVA, F= 31.14, p<0.001; no overall differences between LT and HT (F= 0.038, p= 0.845); but interaction effect indicating significantly more taxa at LT during M2 session (F= 2.505, p=0.046)

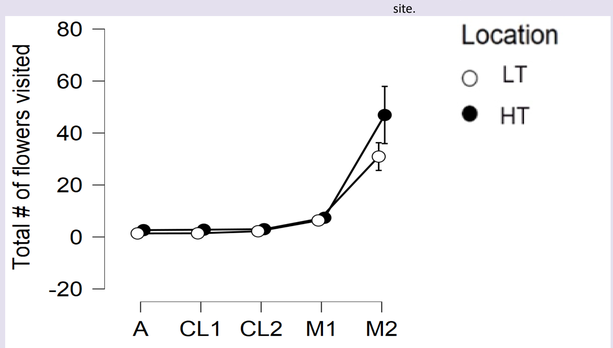


Figure 5: Average (+SE) total number of flowers that were visited during the five observations A 2x2 ANOVA indicated a significant difference between sessions (F=27.408, p<0.001) but no differences between HT/LT (F=2.01, p=0.159) or interactions (F=1.19, p=0.319). Post hoc tests indicated that more pollinators in M2

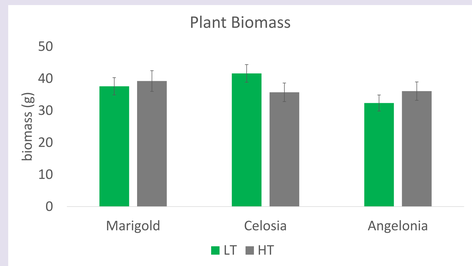


Figure 6 Average (+SE) biomass of marigolds, celosia and Angelonia growth in microcosms in low traffic (LT) and high traffic(HT).

a. Identified to Species

Butterflies - Lepidotera
Colias philodice - Clouded Sulfur
Colias eurytheme - Orange Sulfur
Erynnis juvenalis - Juvenal's Duskywing
Hylephila phyleus - Fiery Skipper
Euptoieta claudia - Variegated Fritillary
Belloria bellona - Meadow Fritillary
Everes comyntas - Eastern Tailed Blue
Beetles (Coleoptera)
Chaulignathus pennsylvanicus - Leatherwing Beetle
Bees (Hymenoptera)
Apis mellifera – European honey bee

b. Other Taxa

Hoverflies - Syrphidae
Temnostoma sp - Calligraphy Hoverfly
Bees (Hymenoptera)
Bombus spp - Bumblebees
Agapostemon spp – Green metallic sweat bees
Halictidae – small sweat bees
Beetles (Coleoptera)
Lampyridae spp - Fireflies

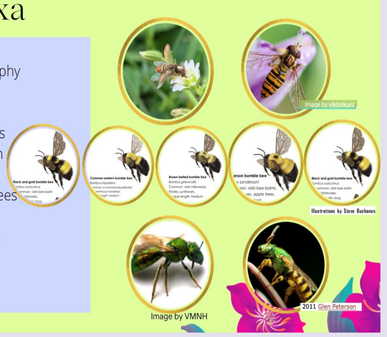


Figure 7 a.) Taxa identified to species, b.) other taxa

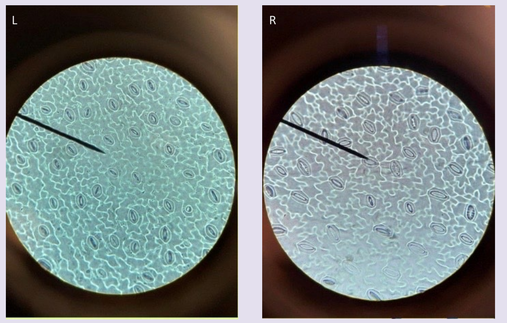


Figure 8 Stomata of celosia (L) and marigold (R). No effect of location (HT or LT) on stomata density (2x2 ANOVA, F= 0.071, p= 0.791); however, marigolds > celosia, (2x2 ANOVA, F= 54.759, p<0.001).

Conclusion

- Unlike Kim et al, 2020, we found no differences in plant growth at the two sites. Our noise levels were less intense but longer in duration than the other study and in addition our plants were grown in community in the field. It would be useful to explore these variations to determine how they contribute to plant growth.
- No difference in stomatal density between sites suggests that CO2 levels may be similar in HT and LT sites. It would be valuable to analyze CO2 levels at both sites.
- Visitation rates did not differ but there was great taxa diversity at LT site in M2 session. Similar to patterns of arthropod diversity which was higher at low noise sites (Morely et al., 2014). For future studies, should identify all pollinators to species by collection or detailed photograph to determine if noise is indeed impacting pollinator diversity.

Acknowledgments

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