Campus biodiversity assessment using iNaturalist

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Summary

GW is home to a variety of urban species that revitalize our campus plantings and green spaces which are utilized and appreciated by the community. As a research university and a community of change-makers, it is our responsibility to understand our campus ecology and cultivate a more conducive environment for its success. Sustainable GW and faculty have been working together to compile a database for GW's campus biodiversity levels across eight different taxa with a focus on insects and plants. As GW continues its efforts in sustainable grounds and biocontrol methods for plant maintenance, the collection of baseline data allows us to define a metric to measure progress, target areas of priority, define areas of "living labs", and complete our goal of increasing biodiversity. iNaturalist has proven to be a useful, open source tool for biodiversity analyses. We sought to incorporate data collected in this application to support the development of baseline biodiversity levels. There are 180 confirmed species on campus and taxa ranges vary significantly, but tend to cluster in green spaces on campus. Further sampling of missed areas is needed with less bias than iNaturalist data creates, and further measures to understand what are acceptable urban biodiversity levels need to be taken.

Terms of Reference

Biodiversity, species richness, abundance, alpha, beta

Introduction

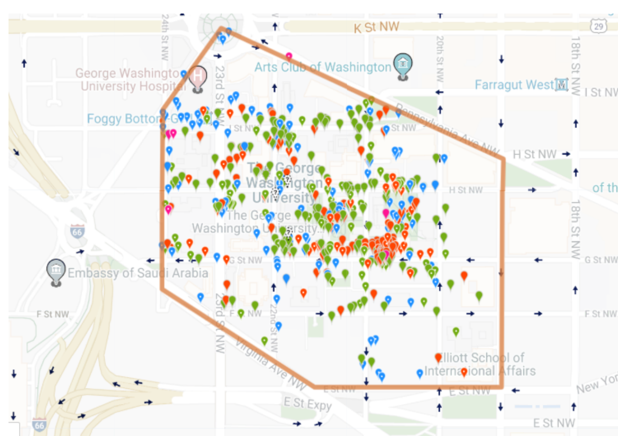
Our campus is for the GW community, but it should also serve the 200+ species that share this space with us. Cultivating an environment that promotes species conservation helps GW's campus keep healthy pollination and other ecosystem services, as well as beautifying our campus with wildlife. The urban environment encompasses the majority of the human population and is undergoing increased development and sprawl, destroying significant amounts of habitat and removing corridors for wildlife success (UN, 2003; Markovchick-Nicholls et al. 2008). Urban environments also tend to homogenize the types of wildlife that are able to succeed, favoring certain species and generalists, rather than those of unique or deeply-developed niches (Groffman et. al 2014). Increasing biodiversity levels is beneficial for environmental health in addition to being a moral obligation. Avoidance of monocultures and the enhanced ecological interactions provided by biodiversity will aid in our cultivation of a greener and more sustainable campus (Krasny et. al 2014). Greater emphasis is being placed on the responsibility of cities to restore urban wildlife and preserve biodiversity in the harsh environments they provide. As a research university in the growing urban environment of DC, GW carries this responsibility and is aiming to address the aspects of its campus that inhibit biodiversity and its restoration as well as develop healthier spaces and better wellbeing for the GW community.

In 2018 the Office of Sustainability released its most recent progress report identifying a series of goals and tasks the university aims to complete in regards to ecology and the natural environment on campus. The ideals of this project most align with Goal 1: Strengthen habitat and natural space and Goal 6: encourage connection to natural environment to help social, physical, and mental wellbeing. Target 1.2 calls to "enhance the biological richness and diversity of campus" by planting native/non-invasive plants that will cultivate further wildlife, using bio-controls and increasing insect diversity on campus with managed releases, and grow our pollinator and bee populations to maintain these ecosystems. These targets were originally measured in the report through expenditures on new biota and cultivating measures, but without baseline information expenditures are not an appropriate indicator of species richness growth. The main purpose of this project is to develop the baseline information of what is on campus, where is it, and how do we grow these populations? Without a baseline we cannot measure our progress and cannot deduce useful information for future steps and actions.

The development of the biodiversity baseline data has been greatly assisted by open source software like iNaturalist, and the participation of citizen science. The use of this program by our university so far is the most efficient method we can implement as little man power and updating is required by staff and faculty of the university.

Methods

This information was produced from downloaded, research grade data from iNaturalist. The open source nature of this species occurrence data allows it to continually be collected, vetted, and updated by participants on campus and remote naturalists. Research grade data was filtered while within "The George Washington University" point of interest bounding box. Research grade material indicated identifications have been vetted by at least two users. Observers, Identifiers, observation totals, and total species were gathered, and individual observation data was downloaded. Further data analysis was completed in Microsoft excel, and maps were analyzed and completed in ArcGIS. These maps were based on observation (or occurrence) data and depict areas of high density through a kernel density function. Mapping the priority blocks used a "closest" proximity analysis based on spatial location, to condense nearest occurrence points within each block.



Results

Research grade observations seemed to occur year-round. There are more identifiers for campus species than observers. A large portion of the observations are by the "GW insects" account. Eight taxa categories have been identified on GW's campus (see figures). The three largest identification categories are birds, plants, and insects in that order. All other taxa make a significantly lower percentage of the observations. Though bird observations are the largest abundance category, they only make up 6% of the species diversity on campus. The two most diverse categories are plants and insects, with plants only carrying slightly more recorded species. Observations seem to be clustered by Bell Hall and Kogan Plaza. The bird range is the most expansive, while mammal coverage seems data deficient and therefore unreliable.

Observation Characteristics (Totals and Research Grade)

Total species identified	215
total observations	610
total observers	46
total identifiers	211
totals research grade species identified	179
total research grade identifications	299

Highest Abundances

Most abundant species Most abundant plant Most abundant insect	House Sparrow (*Passer domesticus*) common groundsel (*Senecio vulgaris*) Western Honey Bee (*Apis mellifera*)

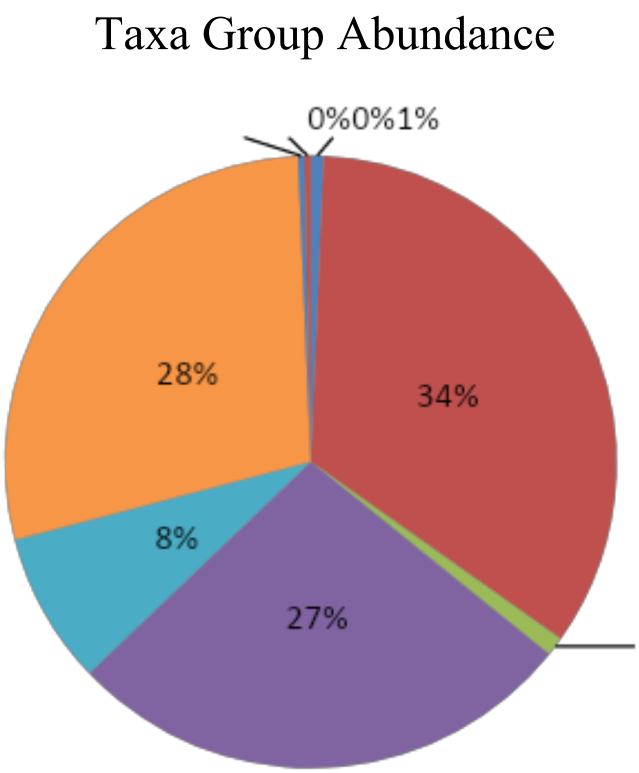


Figure 1. Percentage of the total number of observations that fall within each taxa group

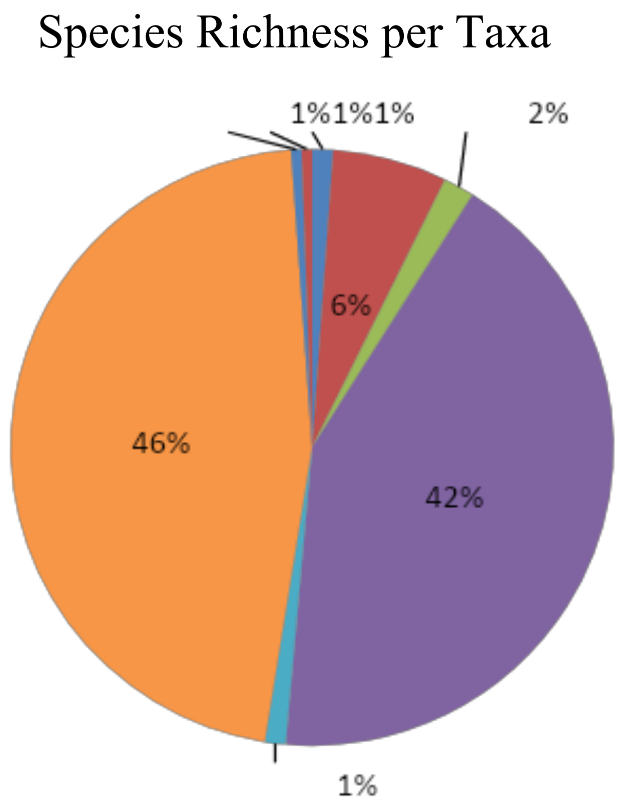


Figure 2. Percentage of the total number of species identified that fall within each taxa group

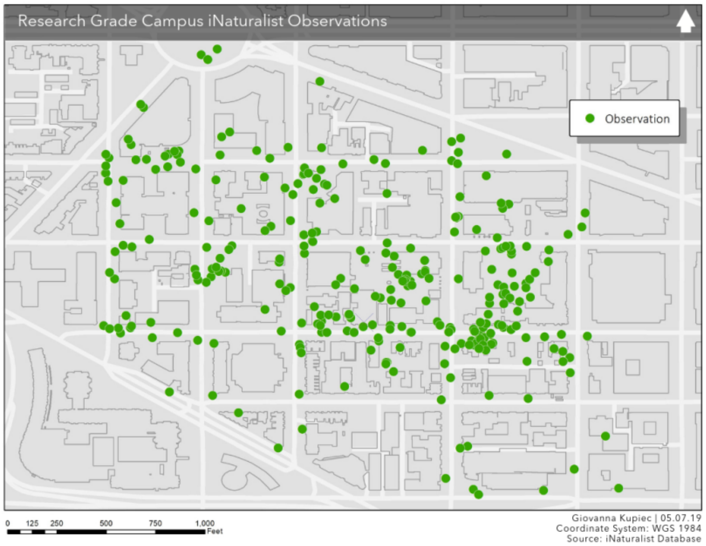


Figure 3. Map of all *research grade* iNaturalist observations on campus.

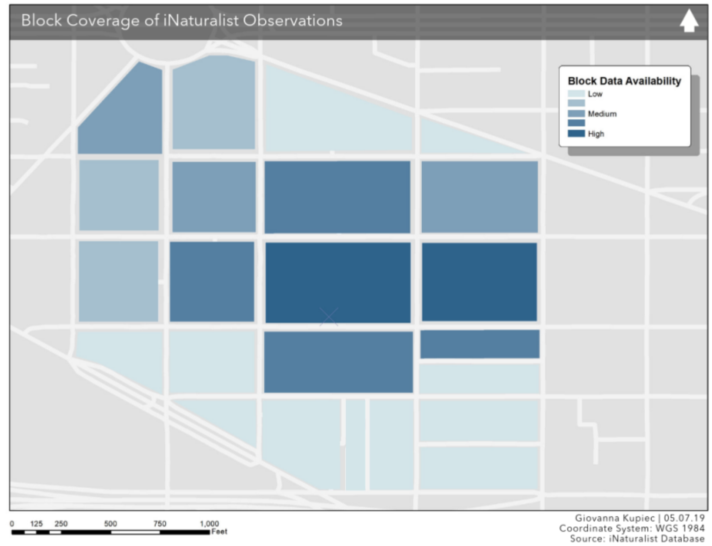


Figure 4. Map of data availability by block on GW's campus. Lighter areas should be prioritized for future assessment.

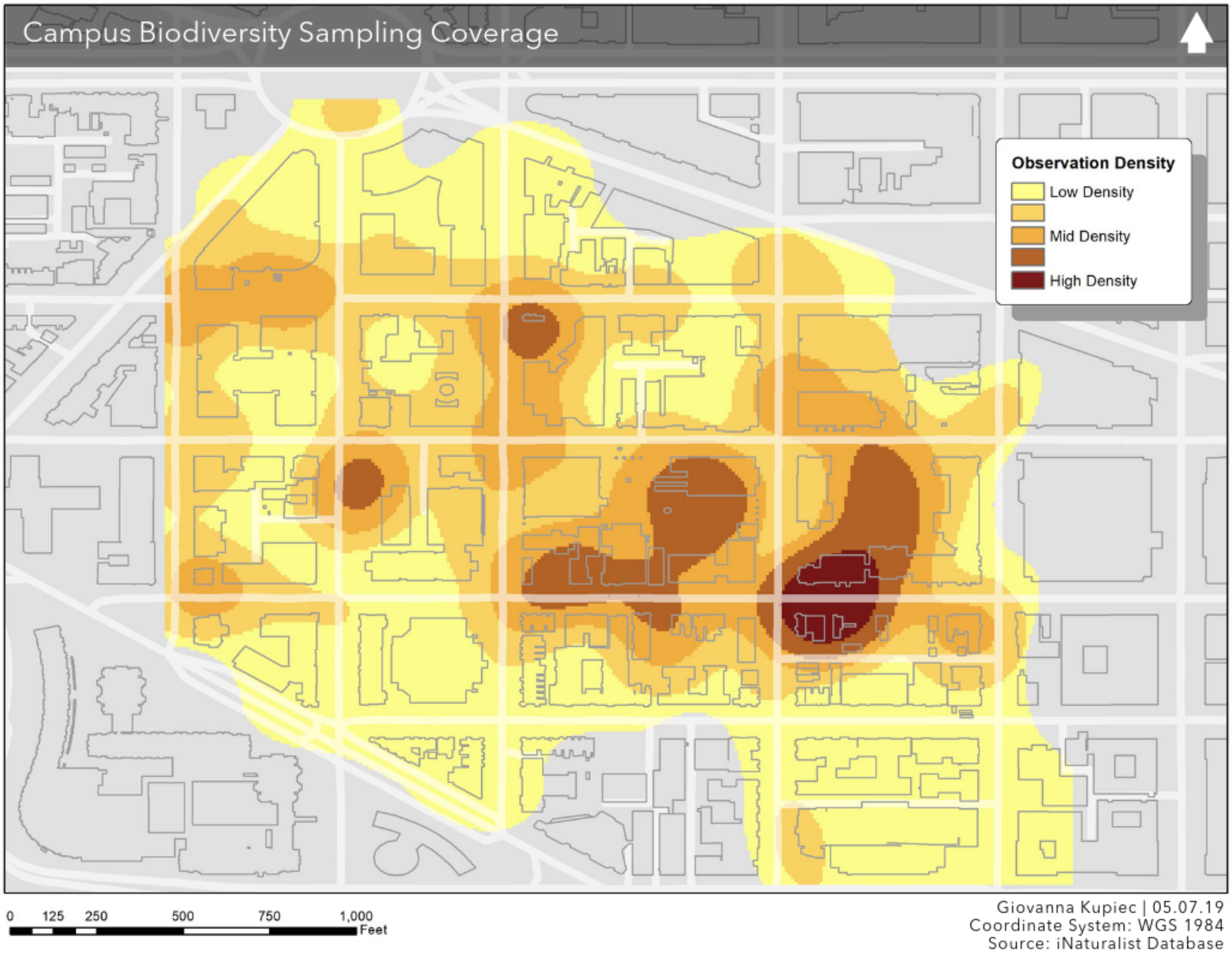


Figure 5. Density map of samples across GW's campus. Hot spots for observations are in deep read while lighter shades depict less dense observations. The highest areas show alignment with many GW green spaces.

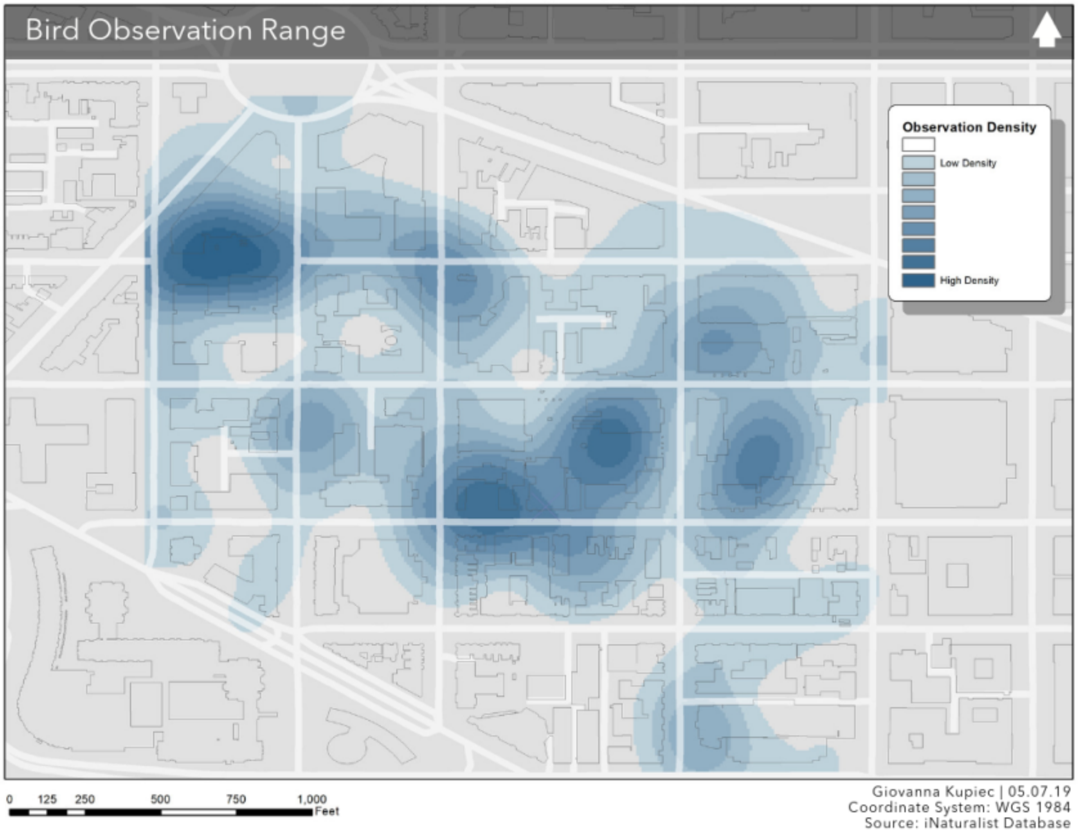


Figure 6. Density map of bird research grade observations from iNaturalist, depicting species location and presence on campus

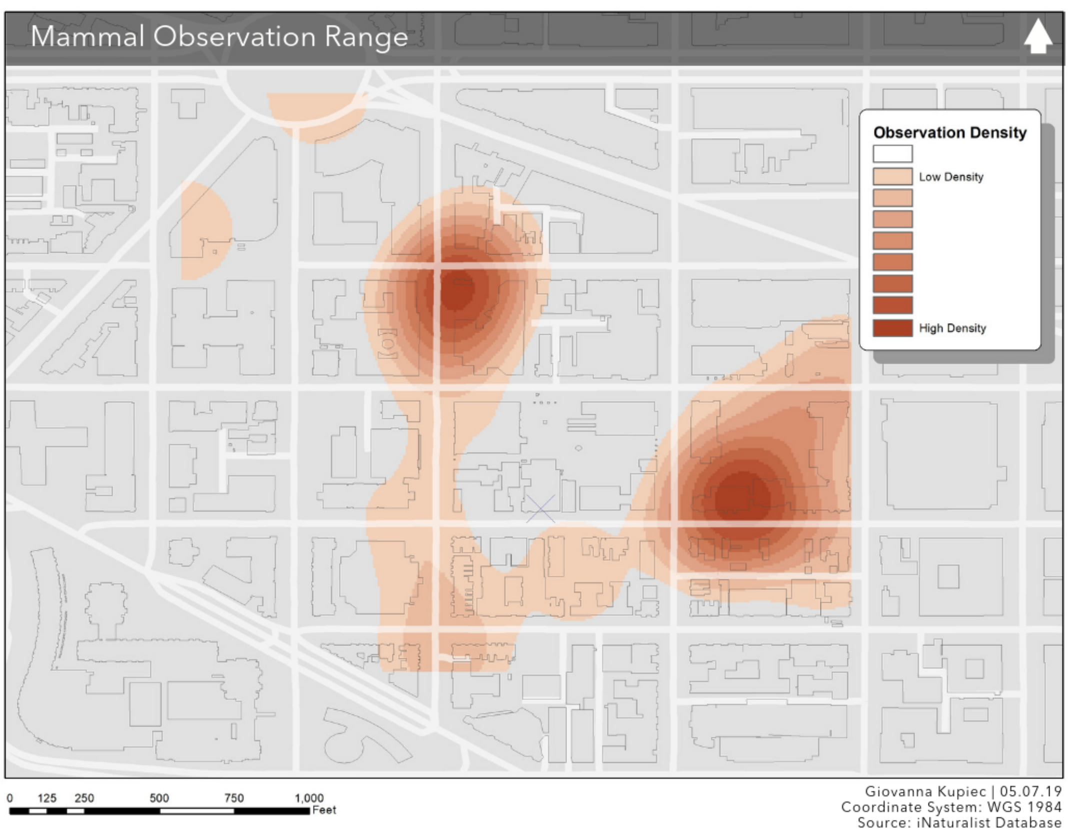


Figure 7. Density map of mammal research grade observations from iNaturalist, depicting species location and presence on campus

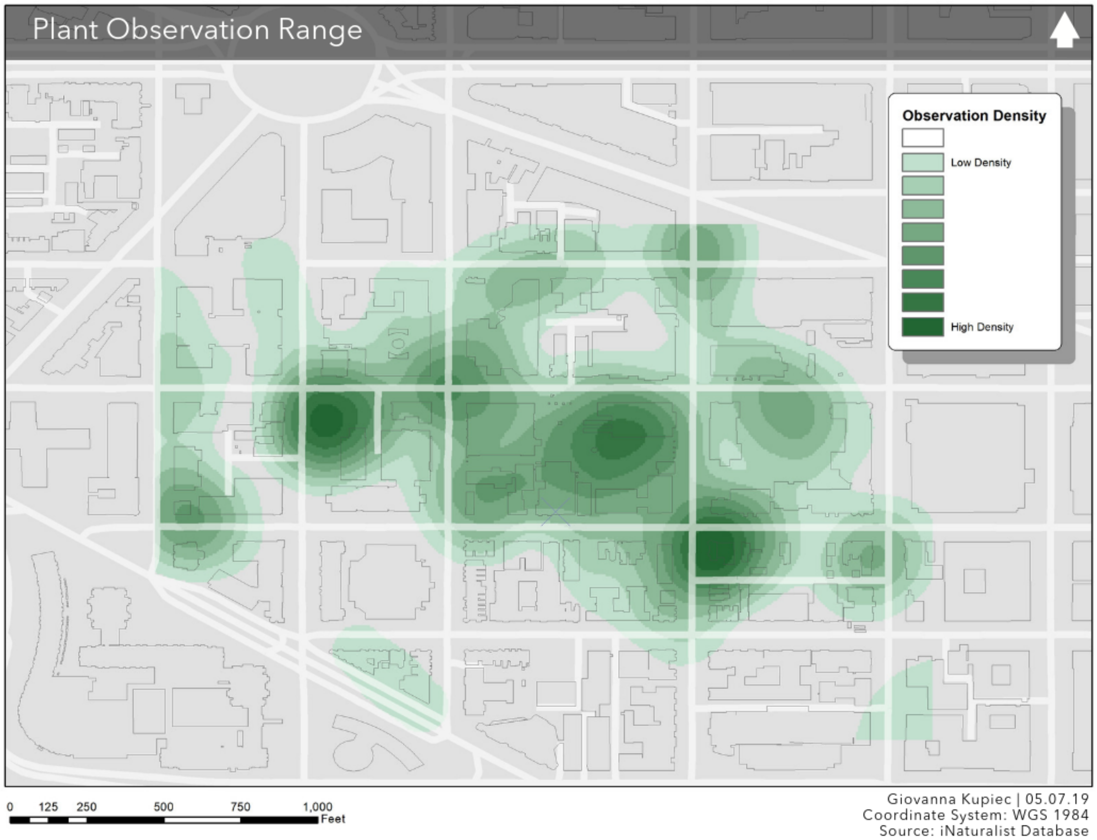


Figure 8. Density map of plant research grade observations from iNaturalist, depicting species location and presence on campus

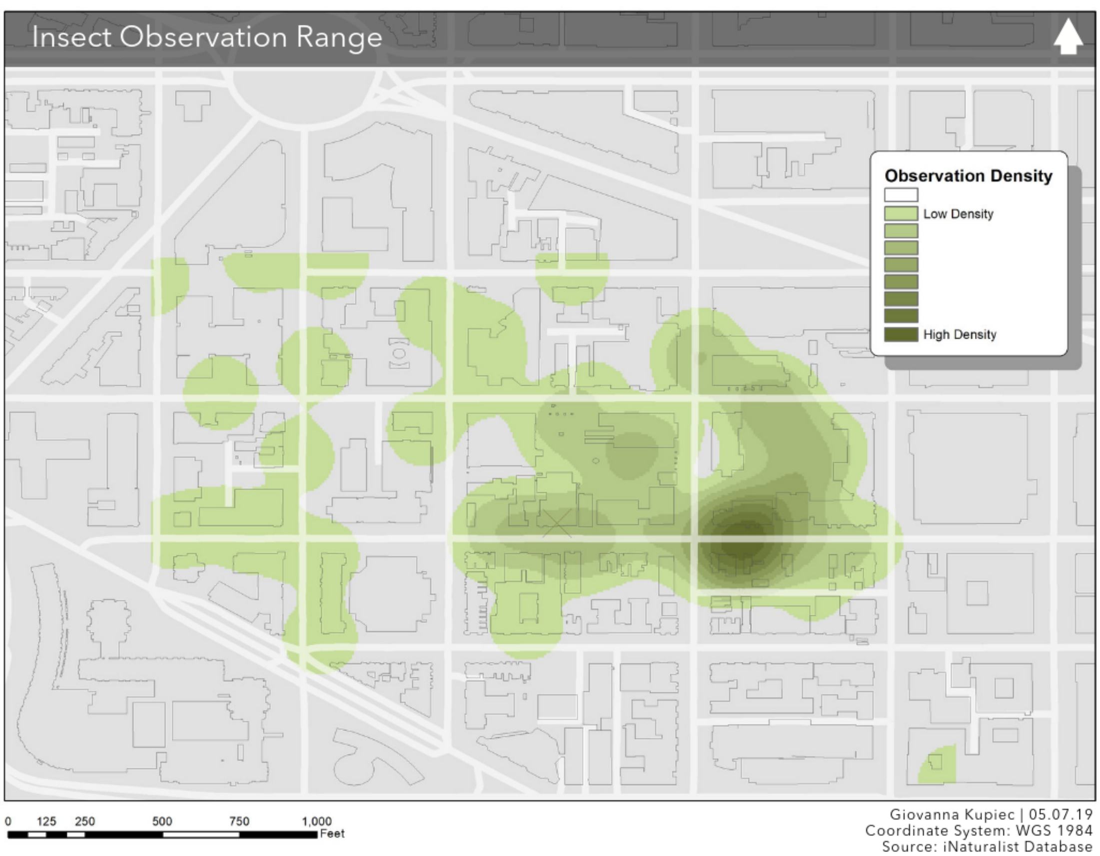


Figure 9. Density map of insect research grade observations from iNaturalist, depicting species location and presence on campus

Discussion & Future Steps

Sampling & Data Analysis

Data obtained from *iNaturalist* has allowed GW to successfully create the database of biodiversity that was needed, confirming baseline species richness of 180 species, and provides sufficient data to study what is on campus. Abundances are heavily influenced by common species like groundsel and house sparrows, which was expected, indicating that species evenness must also be taken into account in addition to richness so we can target protection and cultivation of rarer species habitat. The extent of the accuracy of the composition is a concern. Answering the question of where species are located proved to be difficult through our current methodology.

The occurrence data, while abundant, carries significant bias. Ease of recording, preferred personal interests, and confidence/knowledge of particular species confounds the conclusions in the data and skews the distribution of the kinds of recorded species and their locations. Sole reliance on this application is not advised however, the database does provide useful research grade occurrence data. There also seem to be errors in the iNaturalist location markers inherent within the connection on the app. This slightly confounds the location data, but can be fixed with a frame shift. A combination of iNaturalist data and more robust sampling is required to build a more comprehensive database. iNaturalist data should be downloaded biannually to utilize the immediacy of updates and low data availability areas should be prioritized for increased sampling and stratification to reduce sampling biases. Sampling should be conducted once a month (scheduled bio blitz of a new section), and plots should be assessed with alpha and beta diversity metrics to measure site turnover around campus (e.g. University Yard and G-Street Park).

Further analysis of native and keystone species presence in the collected data would allow us to measure growth of our natives, ecosystem services, and presence of invasives. The cultivation of proxy sites (U-Yard, G Street Park, Bell Hall Rooftop, Corcoran Plantings, etc.) should be used for assessment in addition to general university metrics.

Measuring and Increasing Biodiversity

Though species richness is an essential biodiversity metric, little is known about the extent of urban biodiversity in highly built up areas, and how our campus compares to optimal levels. Further research into Washington DC's biodiversity metrics needs to be conducted to produce accurate indicators of progress on our goals and targets. Further research could also be implemented through an academic course within the sustainability minor or related projects in urban agriculture and biodiversity. The applicability of this work to larger research questions could qualify GW for research funding to carry out this study, action items to improve levels of biodiversity can be taken, such as:

- Increase planting native, adaptive, non-invasive, or drought-resistant beds and practice pro-habitat landscaping practices under the determined criteria (appearance, adaptability, security and survivability)
- Increase number of campus bird houses

- Continue biological controls on campus vegetation
- Maintain campus apiaries to encourage urban pollinator species and increase pollinator-attracting plantings.
- Connect GW campuses to green ways within the region and develop corridors for migratory species (e.g. Monarch Butterflies)
- Partner with local NGOs such (e.g. Casey Trees) to raise awareness about local urban ecosystems, native species, and preservation tactics

Use of Metrics & Communications

Biodiversity metrics from the database should be used to propagate awareness and community cooperation with GW's sustainability goals. Biodiversity metrics of campus green spaces can be used to deem sites as “Living Labs” or “Research Gardens”, allowing priority to be given to their sustainable cultivation when development or unsustainable care practices are situationally or monetarily preferred. Effective communication of these goals will also enhance the ability to achieve other prescribed goals and targets in our 2018 progress report (e.g. Goal 4: support sustainable food production systems).

Through the spatial analysis, we can see the parts of campus are clearly under sampled. Pennsylvania Avenue and E Street Park could be key targets for more species sampling and incorporation of programs based on their low sampling and grant opportunity, as the National Park Service owns these locations. Future partnership with these plots should be established. In these priority plots, projects with marketable purposes could be chosen. Development and certification of our campus as a “Monarch Way Station” is an example of an effective way to communicate these goals and well as further increase biodiversity and presence of a potentially endangered species. With larger plantings of milkweed and other flowering plants on rooftops and in ground plots, GW's campus could support these populations and act as a corridor for species migration.

Conclusions:

The iNaturalist application has proven to be a useful resource with valuable data that could otherwise not be obtained by our office/team solely. The consistent updates and expertise that back the data in iNaturalist is vital for the ease and pace of our studies. The nature of the sampling provides significant confounding variables to the kind of information we are capturing. Therefore, a mixture of both strategic sampling methods and occurrence data from iNaturalist need to be implemented in further biodiversity data collection. Relayed information should be more accurately assessed, spatially aligned, and presented in a format that is digestible to public audiences. Focuses should be on Foggy Bottom as a biodiversity assessment would be unique and more valuable on our urban campus. The importance of this study transcends benefits to our campus, drawing new conclusions for urban communities at large and adding new research to the growing field of urban ecology.

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