No Mow May lawns have higher pollinator richness and abundances: An engaged community of citizen scientists protecting pollinators and their floral resources (#50034)

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No Mow May lawns have higher pollinator richness and abundances: An engaged community of citizen scientists protecting pollinators and their floral resources

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No Mow May is a citizen scientist initiative popularized in recent years that encourages property owners to limit their lawn mowing practices during the month of May. The goal of No Mow May is to provide early season foraging resources for pollinators that emerge in the spring, especially in urban landscapes where few floral resources are available. We worked with the city council of Appleton WI to allow No Mow May to take place in May 2020. Four hundred and thirty-five property owners registered in No Mow May in Appleton, with many unregistered participants noted throughout the city. We measured floral and bee richness and abundance in the yards of a subset of homes (n=20) located near regularly mowed urban parks (n=15) with a team of citizen scientists at the end of the month. We found that homes that participated in No Mow May had more diverse and abundant flora than regularly mowed green spaces throughout the city. No Mow May homes had three times higher bee richness and five times higher bee abundances than frequently mowed greenspaces. Using generalized linear models, we found that the best predictor of bee richness was the size of the designated no mow area and the best predictors of bee abundances were the size of the no mow area as well as floral richness. While our findings cannot conclusively attribute increases in bee abundances and richness to the No Mow May efforts, our data does show that bee pollinators make use no mow spaces as key floral resources during early spring in the upper midwestern United States. We also found this experience to be an outreach and educational opportunity for the city of Appleton. A post-No Mow May survey revealed that the participants were also keen to increase native floral resources in their yards, increase native bee nesting habitat, reduce mowing intensities and limit their practices of herbicide, pesticide and fertilizer applications to their lawns. The No Mow May initiative stimulated a community-wide discussion on pollinator protection efforts and educated an engaged community on best practices to improve the state of urban pollinators in future years.

No Mow May lawns have higher pollinator richness and abundances: An engaged community of citizen scientists protecting pollinators and their floral resources

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Abstract

No Mow May is a citizen scientist initiative popularized in recent years that encourages property owners to limit their lawn mowing practices during the month of May. The goal of No Mow May is to provide early season foraging resources for pollinators that emerge in the spring, especially in urban landscapes where few floral resources are available. We worked with the city council of Appleton WI to allow No Mow May to take place in May 2020. Four hundred and thirty-five property owners registered for No Mow May in Appleton, with many unregistered participants noted throughout the city. We measured floral and bee richness and abundance in the yards of a subset of homes (N=20) located near regularly mowed urban parks (N=15) with a team of citizen scientists at the end of the month. We found that homes that participated in No Mow May had more diverse and abundant flora than regularly mowed green spaces throughout the city. No Mow May homes had three times higher bee richness and five times higher bee abundances than frequently mowed greenspaces. Using generalized linear models, we found that the best predictor of bee richness was the size of the designated no mow area and the best predictors of bee abundances were the size of the ~~no mow~~ area as well as floral richness. While our findings cannot conclusively attribute increases in bee abundances and richness to the No Mow May efforts, our data does show that bee pollinators make use of no mow spaces as key floral resources during early spring in the upper midwestern United States. A post-No Mow May survey revealed that the participants were keen to increase native floral resources in their yards, increase native bee nesting habitat, reduce mowing intensities, and limit herbicide, pesticide, and fertilizer applications to their lawns. The No Mow May initiative educated an engaged community on best practices to improve the conservation of urban pollinators in future years.

Introduction

As landscapes become increasingly urbanized, biodiversity is threatened by land use modifications, a changing climate, and poor management practices (Elmqvist, Zipperer & Güneralp, 2016). A notable component of the urban landscape is the traditional, typically monoculture, heavily manicured and chemically managed lawn, which country-wide accounts for a land surface area greater than any cultivated crop (Milesi et al., 2005). In order to protect as much biodiversity as possible, urban landscapes must be a careful balance of natural habitats, managed urban greenspaces (often consisting of large lawn areas), and functional urban spaces that can accommodate many species (Shochat et al., 2010). These urban areas can also be essential for protecting non-native species that provide ecosystem services (e.g. the European Honeybee *Apis mellifera*).

Insects play a large role in a variety of critical ecosystem services that shape and maintain natural and urban landscapes (IPBES, 2016), and there is increasing recognition that their conservation is vital in light of trends of global insect declines. These ecosystems services include provisioning, cultural, supporting, and regulating services ranging from nutrient cycling to pollination (Prather et al., 2013; Noriega et al., 2018). One functional group of interest for protection are native pollinators which are integral to sustaining agricultural food systems (IPBES, 2016) and may play important functional roles in urban settings (Hall et al., 2017). Urban and suburban landscapes have the potential to protect and enhance wild bee pollinator diversity and abundances (Wilson & Jamieson, 2019; Wenzel et al., 2020) via careful policy development (Hall & Steiner, 2019) and promotion of pollinator friendly behaviors among the urban public (Hall et al., 2017; Zattara & Aizen, 2019; Cardoso et al., 2020).

The state of Wisconsin lists nearly 500 species of native bees (Wolf & Ascher, 2008). In the city of Appleton, we have previously documented 89 species of wild bees in urban green spaces and suburban nature reserves (Anderson et al. in review). Some of these are early emerging species, coming out of winter hibernation between the late April and early June, as temperatures go above freezing and daylength increases in Northeast Wisconsin. During this time, there may be limited forage available, especially in fairly homogenous mowed urban lawn environments, where herbaceous vegetation is not given enough time to flower. The flora in these lawn areas may provide abundant forage for urban wild bees (MacIvor, Cabral & Packer, 2014).

The displacement of native wildflower and tree forage by lawns has removed a vital early season nectar and pollen resource for many pollinators, including bees. One initiative that was popularized in the United Kingdom through the organization Plantlife, aimed at allowing flowers to bloom in lawns throughout the month of May to provide the floral nectar needed for pollinators. This initiative has been dubbed “No Mow May” and led researchers to follow up with an “Every Flower Counts” citizen science initiative to document which flowers were common to their blooming lawns. Additionally, previous work has shown that reducing mowing intensity will have positive impacts on urban bee abundance and diversity (Lerman & Milam, 2016) but it remains unclear how generalizable these results are.

The goal of No Mow May was to increase the floral forage resources critical for early emerging pollinator species. A second goal of this initiative was the outreach and education regarding the protection of native wild pollinators in urban and suburban settings. Our main objective was to test whether reduced mowing intensity during the month of May had an effect on bee richness and abundances in the city of Appleton WI, USA. We did this by comparing bee richness and abundances in citizen participant's lawns in the No Mow May initiative, relative to regularly mowed parks in the city. We also aimed to document the presence and abundance of floral diversity in both the mowed parks and the unmowed lawns as these are likely the resources that bee pollinators are using in urban yards. Our final objective was to document community perspectives after participating in the No Mow May initiative to see how landowners plan to manage lawns in the future and enhance pollinator friendly practices.

Materials & Methods

Working with city government and citizen scientists:

The No Mow May efforts in the city of Appleton WI USA (Figure 1) required the approval and close collaboration with the city government and city residents. The city has strict guidelines on lawn care practices including a residential 20 cm (8 inch) allowed maximum lawn height in residential properties and 31 cm (12 inch) maximum lawn height in commercial properties. Local government officials petitioned the city to waive the ordinance for the month of May 2020. After multiple meetings, discussion with city officials, and a vote in the city common council the resolution was approved in April 2020. Citizens of the city of Appleton were asked to register their homes as participants of No Mow May via an online form. A local pollinator advocacy group, The Pollenablers Fox Cities worked on outreach and education to inform the citizens of Appleton of the agreed upon rules and regulations of the No Mow May initiative via instructional videos, social media, and printed materials.

Data Collection:

We selected 20 homes in five neighborhoods of the city of Appleton to sample bee richness and abundance during the final week of No Mow May (May 25 to May 30, 2020), with the help of eight citizen scientist volunteers. At each home we compiled a flowering vegetation species list and measured percent cover in five 1-square meter of flowering herbaceous vegetation relative to lawn or bare ground at randomly chosen points in each lawn. For subsequent analyses we used the mean of these five measurements as a predictor of bee richness and abundance. We also sampled 15 mowed areas in the city of Appleton. We focused our sampling of mowed areas to five local parks where we have previously documented the richness and abundances of bees. The city of Appleton manages these parks by mowing every 5 to 7 days, applying vinegar-based solution as an herbicide and unspecified fertilizers. At each park we sampled 150 square meters for a total duration of 45 minutes to remain consistent with our sampling methods of residential yards. All park plots were a minimum of 100 meters apart from each other to help reduce the probability of recapturing bee specimens in multiple plots. Sampled homes were located within a 1 km radius to each of the parks, to make the observations as comparable as possible.

We used standardized timed sweep netting as our method of bee collection. At each home we measured the area designated by the resident as a No Mow area and standardized our sampling based on square meters. For each sampling plot, we standardized sampling by dedicating one-person hour of sampling per 200 square meters of No Mow Area. Sampling was completed only during fair weathered days when air temperatures ranged from 21°C to 27 °C, mostly sunny and clear skies and low wind speeds <8 kph. As we netted suspected bee specimens, the bees were moved into storage mason jars, where they were identified in the field at the end of the allotted sampling period using a well-established and verified reference collection for the city of Appleton (obtained from Anderson et al. in review) and various keys. When specimens were identified and the sampling period was over, most of the specimens were released to their foraging area. A dozen specimens that were difficult to identify in the field were collected and stored in 70% ETOH, and taken to the laboratory for subsequent identification. Homes were separated by at least 100 meters to reduce the likelihood of resampling individual bees at multiple homes.

Post No Mow May Survey:

Immediately after completing the month of May sampling, we surveyed registered participants regarding their perceptions of the results of No Mow May and how their lawn care practices might change. We asked our participants two questions regarding their perceptions of No Mow May: 1) Did you see pollinators in your yard this year? and 2) Did you see more flowers in your yard this year? We also asked participants how their mowing habits might change as a result of No Mow May and offered a checklist of things they could do in their yards to help local pollinators. The Lawrence University Institutional Review Board (IRB: 5_10Del Toro) approved this questionnaire and all responses were kept fully anonymous and confidential. No identifying or demographic information was collected.

Data Analyses:

All analyses and plots were completed using the R statistical software v. 4.0.0, "Arbor Day"(R Development Core Team, 2014). We compared the medians of observed bee richness (the total number of species present in a given site) and abundance in mowed and no mow lawns using a Kruskal Wallis comparison of means. We used this non parametric alternative due to relatively low sample sizes and variation in the normality of the data. We then used floral richness, percent cover of herbaceous flowering vegetation and size of the sampling area as predictors of bee richness and abundance in a generalized linear model (glm) assuming a "Poisson" family distribution, which is required for count data. The glm was simplified using step-wise variable selection using the function "stepAIC" in the MASS package (Venables &

Ripley, 2002), based on the Akaike Information Criterion (AIC). We report the most informative variables resulting from the reduced model in table 3.

Results

Biodiversity in the city's lawns

We collected a total of 321 bees, consisting of 33 species, during the week of intensive sampling. The five most abundant species were *Lasioglossum cressoni*, *Hoplitis pilosifrons, Melissodes bimaculatus, Apis mellifera,* and *Bombus impatiens* which accounted for 65% of all observed individuals. Bee abundances and richness were higher in No Mow May lawns relative to the regularly mowed green spaces (Kruskal-Wallis chi-squared=19.72, df=1, p=0.00000006 for bee abundance and Kruskal-Wallis chi-squared=16.69, df=1, p=0.00004 for bee richness). Median bee abundances were nearly five times higher and bee richness was three times higher in no mow lawns relative to regularly mowed plots (Figure 2).

Mowed Areas had 36% fewer species and 34% lower flower density than mowed areas mowed areas. The most common and abundant floral resources in lawns and greenspaces are reported in table 1, with *Taraxacum officinale,* the common dandelion, present in all home lawns and at 73% of urban park lawns, making it the most abundant floral resource in lawns. Floral richness and abundance were higher in unmowed lawns relative to mowed greenspaces (Kruskal-Wallis chi-squared=14.49, df=1, p=0.0001 for Richness, Kruskal-Wallis chi-squared=16.82, df=1, p=0.000004 for floral density).

Generalized linear model results suggest that bee abundance is best predicted by the additive effects of total area that remained unmowed and the floral richness at each lawn. However, bee richness was only best predicted by the effect of the total area that was not mowed (Table 3). Floral density, while significantly higher in No Mow May lawns, did not have a significant effect on bee abundance or richness.

Citizen participation:

The No Mow May initiative in the city of Appleton consisted of 435 registered participants (Figure 1). There was also participation in the city by many unregistered participants, but we were not able to quantify what percentage of the city did not register yet still participated in No Mow May. Of the 435 registered participants, 130 responded to the post-no mow may survey, a ~30% response rate. At the subset of 20 homes the mean no mow area was 195 sq. meters, ranging from 91 sq. meters to 446 sq. meters. Based on these estimates, we estimate that between 22 and 40 acres of unmowed habitat were created by the No Mow May initiative in the city of Appleton.

Citizen Post-No Mow May Survey Results

Based on the two perception questions that we asked citizen participants:

1) Did you see pollinators in your yard this year? and 2) Did you see more flowers in your yard this year? About 60% of respondents noticed a few more or a lot more pollinators and flowers in their lawns this year, and about 20% noticed no change or fewer pollinators and flowers than normal in their yards during the month of May.

We also asked participants how they might modify their lawn management practices. 77% of respondents pledged to reduce or eliminate the use of chemical herbicides or pesticides in their lawns, 62% pledged to reduce or eliminate the use of chemical fertilizers in their lawns, 57% planned to increase native pollinator habitat in their yards and lawns, and 48% planned to plant native floral resources as forage for pollinators. Eighty seven percent of participants said they would participate in No Mow May again in future years.

Discussion

The effects on pollinator abundance and diversity are important to better understand in order to protect urban pollinator communities and resources, especially for early emerging bee species during a time of year when food resources may be scarce. Our findings are consistent with Lerman and Milam (2016) who documented bee abundance in suburban landscapes and suggested that spontaneous lawn flowers offer supplemental floral resources that can support pollinators. Lawns can provide important food sources the promote healthy pollinator populations in urban ecosystems, if managed intentionally.

No Mow May lawns have a fivefold higher bee abundance and threefold higher bee species richness compared with regularly mowed areas. This is first study, to our knowledge, to document the specific observed effects of No Mow May practices on bee abundances and richness. Previous studies have detailed that different mowing practices will impact the diversity and abundances of insects (Andreas Unterweger, Rieger & Betz, 2017) including bees (Lerman & Milam, 2016; Lerman et al., 2018). Generally, higher mowing intensity is negatively associated with decreased abundances and diversity. Our rapid assessment offers support for the same effect of mowing practices during early spring in the Upper Midwestern USA on urban bee diversity and abundance. We found that the amount of area that remained unmowed was a key predictor in both bee abundance and richness while plant species richness only helped to explain bee species richness. The relationships between area and species abundance and richness are well documented in the ecological literature (Dengler, 2009) and seem to apply to the patterns detected in urban ecosystems as well (Matthies et al., 2017). From an applied perspective if clusters of neighbors were to participate in No Mow May initiatives then bee species richness and abundance should consequently increase in these yards as a result of having a larger undisturbed contiguous area. The positive effect of plant species richness on bee species richness is consistent with the more heterogenous and diverse landscapes tending to provide increased niche space for hosting more species, another well documented ecological pattern (Ebeling et al., 2008; Abbate et al., 2019).

Bees are amongst the key insect groups that provide essential ecosystem services (IPBES, 2016; Noriega et al., 2018) but their roles in providing these services in urban ecosystems remains poorly understood, even though the agricultural value of bee's providing the pollination ecosystem service has been thoroughly explored (Hanley et al., 2015). It likely that bees also provide a valuable pollination ecosystem service in urban landscapes (Normandin et al., 2017). Previous work has shown that if the conservation goal is protection of species (and consequently the ecosystem services they provide), then cities are likely to play essential roles as they can be home to as many if not more species than "natural" habitats (Baldock et al., 2015).

The No Mow May initiative in the city of Appleton, went beyond the reduction of mowing practices in the community. This initiative also started a community-wide discussion on best practices for pollinator conservation. Even though not all citizens were participants in No Mow May, offered educational opportunities through social media platforms (www.facebook.com/pollenablers) on the benefits of transforming lawns into pockets of urban habitat that can support and harbor native biodiversity. We promoted best practices that have positive effects on our pollinator communities like the planting of native wildflowers (Pardee & Philpott, 2014), increasing wild bee nesting habitat (Harmon-Threatt, 2020) and reducing herbicide and pesticide use (Muratet & Fontaine, 2015; Aronson et al., 2017). Although we did not evaluate how widespread these practices are in Appleton, the community has now been exposed to educational opportunities needed to promote a more sustainable and pollinator friendly community. In general communities tend to be aware of the importance of bees in urban ecosystems but are lacking in education on how to better protect them (Wilson, Forister & Carril, 2017).

In a "snapshot" study of this nature, the role of citizen involvement and buy-in was essential. From a study design perspective, we had the capacity to choose our sampling locations from over 400 sites around the city, allowing for a robust, standardized, and systematic sampling design. Due to logistical constraints, and the necessity for rapid inventory, we subsampled from five neighborhoods around the city. We refer to all participants in this initiative as citizen scientists, as they are all playing a contributing role in a city-wide experiment. More involved citizen scientists were the volunteers who helped in data collection at the sampling locations throughout the city. Our study enhanced awareness of key ecological and conservation issues, improved the general public's understanding of urban ecosystems, provided citizens the opportunity to participate in data collection all of which are common individual and programmatic outcomes of any citizen science project. We hope that our efforts have also enhanced trust and communication between the general public and the local scientific community which is can be a desirable community-level outcome of a project like No Mow May (Jordan, Ballard & Phillips, 2012). We anticipate that, with the resulting data, community involvement in development of pollinator protection policy at the city and regional level is a likely future direction, which is also a valuable outcome of citizen science (Adler, Green & Şekercioğlu, 2020). As many citizen science projects can attest, communities are interested in education and participation in the scientific process. No Mow May is an initiative that exemplifies the adaptability and interest of landowners in moving towards conservation practices that promote healthier and more resilient ecosystems.

Lawns are easily accessed spaces that can serve to protect native biodiversity. We suspect that for a city the size of Appleton at least 100 acres of lawn area can be managed to provide forage for native pollinators by engaging in initiatives like No Mow May. The notable higher abundance and richness in no mow areas suggests that the very least, the resulting floral resources are attracting urban bees. Longitudinal studies are needed to track the temporal abundances of populations as our communities transform into more pollinator friendly landscapes. No Mow May might not be suitable for all urban ecosystems as much of North America enters the spring season earlier that the Upper Midwest, and thus this initiative might be better as No Mow March or No Mow April in warmer parts of the country. We also recognize that this rapid biodiversity assessment is a snapshot of what occurs seasonally in urban ecosystems, but our other work speaks to the broader patterns of urban bee diversity in the Fox Cities area of Wisconsin, across multiple years (Anderson et al in prep). We aim to continue our sampling and outreach and education efforts by expanding this effort to the entire Fox Cities Region in 2021 and promote a state-wide No Mow May effort in subsequent years.

Conclusions

The effect of our No Mow May effort documented increases in both urban bee and floral abundances and diversity. We found that the amount of area that remains unmowed was the strongest predictor of bee abundance and diversity and floral species richness also contributed to explaining bee species diversity in mowed and unmowed areas in the city of Appleton. Based on our survey results, we found strong community enthusiasm regarding this initiative with the majority willing to continue this and other pollinator friendly practices in their homes and neighborhoods. In order to ensure that lawns can maximize pollinator biodiversity protection, then we have to think critically about new norms for lawn maintenance which are more effective when implemented at the neighborhood and community levels (Nassauer, Wang & Dayrell, 2009). In our case, the city of Appleton has a strict lawn height ordinance which requires frequent mowing, and resident's perception is often that well-manicured and low "weed" diversity lawns are preferable. However, from a conservation and ecological perspective these types of lawns may not be in line with the community biodiversity conservation values. One way to overcome this issue is by increasing community outreach and awareness about the importance of protecting urban bees and providing important foraging resources for them.

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Figures

Figure 1: Map of the city of Appleton showing participating homes in No Mow May. Color points indicate lawns and green spaces where bee diversity and abundance was recorded.

Figure 2: Boxplot showing the higher in median bee abundance (A) and richness (B) in No Mow May lawns relative to regularly mowed areas.

Tables:

Table 1: List of the most common flowering plants in home and park lawns.

Name	Common Name	Percent of homes present	Percent of parks present
Taraxacum officinale	Dandelions	100%	73%
Viola papilionacea	Violet	95%	20%
Trifolium repens	White Clover	80%	60%
Glechoma hederacea	Creeping Charlie	75%	13%
Capsella bursa-pastoris	Sheppard's Purse	75%	40%
Plantago major	Plantain	70%	53%
Cirsium arvense	Canada Thistle	30%	7%

Table 2: list of bee species and abundances collected in this study.

Family	Species	Count
Andrenidae	*Andrena crataegi*	12
	Andrena cressoni	11
	Andrena miranda	6
	Andrena wilkella	1
Apidae	*Apis mellifera*	18
	Bombus impatiens	17
	Bombus rufocinctus	1
	Bombus vagans	7
	Ceratina calcarata	4
	Melissodes bimaculatus	19
	Melissodes denticulatus	2
	Melissodes desponsus	1
	Melissodes druinellus	3
	Melissodes rustica	2
	Nomada cressoni	7
Halictidae	*Agapostemon virescens*	10
	Augochlorella aurata	3
	Augochlorella pura	7
	Halictus ligatus	6
	Halictus rubicundus	1
	Hoplitis pilosifrons	34
	Hylaeus modestus	2
	Hylaeus mesillae	3
	Lasioglossum coriaceum	5
	Lasioglossum cressonii	120
	Lasioglossum laevissimum	6
	Lasioglossum pilosum	1
	Lasioglossum zephyrum	3
	Sphecodes cressoni	2
	Sphecodes dichrous	1
Megachilidae	*Anthidium manicatum*	1
	Megachile campanulae	1
	Osmia pumila	4

Table 3: Summary of reduced generalized linear models showing only the most informative predictor variables of bee species richness and abundances.

Response Variable	Predictors	AIC
Bee Abundance	No Mow May Area + Floral Richness	199.51
Bee Richness	No Mow May Area	144.69

Figure 1

Map of the city of Appleton showing participating homes in No Mow May.

Color points indicate lawns and green spaces where bee diversity and abundance was recorded.

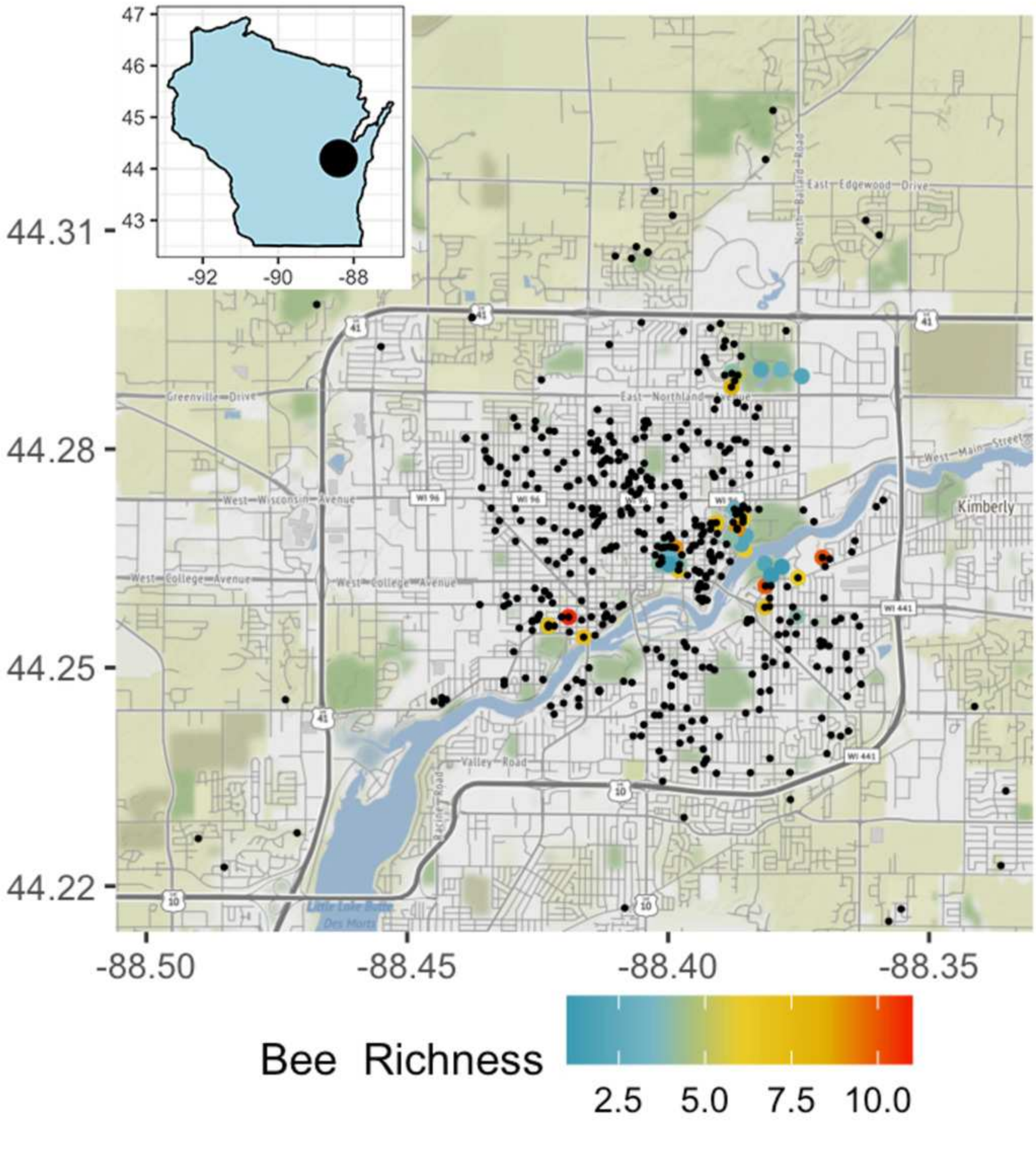
47
46
45
44
43
-92
-90
-88
44.31
44.28
44.25
44.22
-88.50
-88.45
-88.40
-88.35
Greenville Drive
West Wisconsin Avenue
West College Avenue
East Northland Avenue
East Edgewood Drive
North Ballard Road
West Main Street
Kimberly
Valley Road
Racine Road
Little Lake Butte Des Morts
Bee Richness
2.5
5.0
7.5
10.0

Figure 2

Boxplot showing the differences in median bee abundance (A) and richness (B) between Mowed and No Mow sample locations.