



NYC Pollinator Working Group's Formal Recommendations on European Honey Bee Colonies in New York City

NYCPWG EHB Policy Recommendations - References

(Alaux 2019) Cedric Alaux, Yves Le Conte, and Axel Decourtye. "Pitting Wild Bees Against Managed Honey Bees in Their Native Range, a Losing Strategy for the Conservation of Honey Bee Biodiversity". *Frontiers in Ecology and Evolution* Volume 7. 2019-03-13. <https://doi.org/10.3389/fevo.2019.00060>

"[a] high density of managed honey bees may introduce resource competition with wild pollinators and favor the spread of diseases. Indeed, it seems unavoidable to prevent (non-native range) or limit (native range) the access of managed honey bees to areas where wild pollinator species are threatened."

(Angelella *et al.*, 2021) G. M. Angelella, C. T. McCullough & M. E. O'Rourke. (2021). "Honey bee hives decrease wild bee abundance, species richness, and fruit count on farms regardless of wildflower strips." *Scientific Reports*. 11. 3202. <https://doi.org/10.1038/s41598-021-95368-x> (Author Correction to <https://doi.org/10.1038/s41598-021-81967-1>)

"Although wild bee species richness increased with bloom density within wildflower strips, populations did not differ significantly between farms with and without them whereas fruit counts in both crops increased on farms with wildflower strips during one of 2 years. By contrast, wild bee abundance decreased by 49%, species richness by 22%, and strawberry fruit count by 18% across all farms with honey bee hives regardless of wildflower strip presence, and winter squash fruit count was consistently lower on farms with wildflower strips with hives as well. This work demonstrates that honey bee hives could detrimentally affect fruit count and wild bee populations on farms, and that benefits conferred by wildflower strips might not offset these negative impacts. Keeping honey bee hives on farms with wildflower strips could reduce conservation and pollination services."

(Article 161) "Article 161: Animals." NYC Health Code.

<https://www1.nyc.gov/assets/doh/downloads/pdf/about/healthcode/health-code-article161.pdf>

(Ascher *et al.*, 2021) John S. Ascher, Kevin C. Matteson, Parker Gambino. 2021-09-25. "Persistence and turnover of New York City bees 1880s-2020s (Hymenoptera: Apoidea: Anthophila)." Unpublished manuscript. Email communication from John Ascher.

"We compiled and compared records for 266 bee species that have inhabited New York City from the 1880s to 2018 including historical and recent specimen records supplemented with citizen



science data including images identified in online databases. Recent records (1993-2018) from New York City include 217 bee species of which 183 were found during the main study period of 2003-2015, demonstrating persistence of the majority of the wild bee fauna. Of the 49 bee species found only in historical collections (i.e. pre 1993 and mostly pre-1960's), many (28 species) were collected exclusively before 1920, mostly from areas of Brooklyn and the Bronx that are now extensively developed. Faunal turnover detected included loss of species known to be declining regionally across all habitats (not just in cities) and establishment of a large number of exotic bee species many of which are now abundant. ... Central Park in Manhattan was found to support a considerable number of bee species (89), including species specializing on available native host plants, but more were found in Prospect Park (105 species) in Brooklyn, which was better surveyed."

(Bailes *et al.*, 2018) Emily J. Bailes, Kaitlin R. Deutsch, Judit Bagi, Lucila Rondissone, Mark J. F. Brown and Owen T. Lewis. "First detection of bee viruses in hoverfly (syrphid) pollinators." *Biology Letters*. 142018000120180001. Published 2018-02-28. <http://doi.org/10.1098/rsbl.2018.0001>

"Here, we establish for the first time the presence of three important bee viruses in hoverfly pollinators (Diptera: Syrphidae): black queen cell virus (BQCV), sacbrood virus (SBV) and deformed wing virus strain B (DWV-B). ... These results suggest that syrphid pollinators may play an important but previously unexplored role in pollinator disease dynamics."

(Ball 2020) Jennifer Claire Ball. "Why Some Ecologists Worry about Rooftop Honey Bee Programs." *WIRED Science*. 2020-10-02. <https://www.wired.com/story/why-some-ecologists-worry-about-rooftop-honey-bee-programs/>

(Bonmarco *et al.*, 2021) Riccardo Bommarco, Sandra A.M. Lindström, Chloé A. Raderschall, Vesna Gagic, Ola Lundin. "Flower strips enhance abundance of bumble bee queens and males in landscapes with few honey bee hives." *Biological Conservation*, Volume 263, 2021, 109363, ISSN 0006-3207. <https://doi.org/10.1016/j.biocon.2021.109363> (<https://www.sciencedirect.com/science/article/pii/S0006320721004158>)

"We show that adding flower strips benefits bumble bee queen abundance the following year, but this effect is diminished if honeybee hives are added. In sites with flower strips, added honey bee hives reduced male bumble bee abundance. Our relatively small flower strip areas bolstered bumble bee population growth across seasons, probably by relieving a resource bottleneck. Adding honey bee hives in combination with flower strips to [agricultural] landscapes with few floral resources should be avoided as it cancelled the positive effect of flower strips."

(Cane and Tepedino 2017) James H. Cane, Vincent J. Tepedino. (2017) "Gauging the Effect of Honey Bee Pollen Collection on Native Bee Communities." *Conservation Letters*, 10: 205-210. First Published 2016-05-10. <https://doi.org/10.1111/conl.12263>



“We calculate that, from June–August, a strong colony gathers as much pollen as could produce 100,000 progeny of an average solitary bee. ... a hive unit month (HUM) is therefore 33,000 native bee progeny. By this calculation, a 40-hive apiary residing on wildlands for 3 months collects the pollen equivalent of four million wild bees.”

(CHC) Canadian Honey Council: Bee Facts. <https://honeycouncil.ca/industry-overview/bee-facts/>

- A colony of honey bees in early spring can have approximately 10,000-15,000 bees.
- A colony of honey bees in summer has 50-80,000 bees. [Per (Cane and Tepedino 2017), this is the equivalent of ~100,000 wild bees]
- Bees must “tap” 2 million flowers to make 454 g (one pound) of honey.

(Chen 2021) Roselle Chen. “Beehive deliveries keep New Yorkers buzzing on rooftops, backyards.” Reuters. Published in The Christian Science Monitor. 2021-04-10. <https://www.csmonitor.com/Environment/2021/0410/Beehive-deliveries-keep-New-Yorkers-buzzing-on-rooftops-backyards>

“About 2.4 million Italian honeybees waited in a white van to be taken to their new homes early Friday. It was parked near the Dakota Apartments by Central Park ... [Andrew] Coté, who founded Andrew’s Honey, drove up from Georgia to deliver the bees. The van held 200 wood and screen packages, each with about 12,000 bees. A steady stream of beekeepers lines up to pick up their 3-pound packages, which cost \$159 or \$205 depending on when they placed their order.”

(Colla and MacIvor 2016) Sheila R. Colla and J. Scott MacIvor. (2016). “Questioning public perception, conservation policy, and recovery actions for honeybees in North America.” *Conservation Biology* 31(5) September 2016. 1202-1204. <http://dx.doi.org/10.1111/cobi.12839>

“Policy and conservation initiatives often focus on the Western Honeybee, *Apis mellifera* Linnaeus, a domesticated species not native to North America. Although losses of managed honeybee colonies are recorded annually, we argue that honeybee losses are not a conservation problem, but instead a domesticated animal management issue. By focusing attention on honeybees, policies and subsequent resources may undermine native bee conservation and have negative impacts ecologically and socially.”

(Cornwall 2021) Warren Cornwall. “The insect apocalypse is more nuanced than it first appears.” Anthropocene Magazine. 2021-10-20. Accessed 2021-11-29. <https://www.anthropocenemagazine.org/2021/10/the-insect-apocalypse-is-more-nuanced-than-it-first-appears/>

“while habitat loss has a major effect across the board, the kind of damage isn’t the same. In farmed areas, the collective mass of insects showed little change from more natural woods and meadows. But while the total weight of insects held steady, the variety of species fell by nearly



30% when moving from natural areas to farm fields. The number of endangered species plummeted still further – by more than half ... Meanwhile, cities showed a different pattern: Little change in species diversity, but a steep 40% drop in the total insect biomass.

The study can't answer exactly what forces drove these different fates. One possibility is that while farming produces a lot of vegetation where insects might live, the plants growing there are homogeneous. So the countryside can support a lot of insects, but a small variety. Meanwhile, cities have less vegetation, but a bigger variety of habitats such as parks, gardens and strips of grass along sidewalks." - Popular article with interpretation of (Uhler 2021)

(Covington 2014) Linnea Covington. "NYC beekeeping is booming with 261 hives." amNewYork. 2016-09-09. <https://www.amny.com/lifestyle/nyc-beekeeping-is-booming-with-261-hives-1-9269589/>

"Across the city there are 99 registered beekeepers and 261 hives, according to the NYC Health Department — an impressive feat given that urban beekeeping just became legal here in 2010."

(Danforth and van Dyke 2015) Bryan N. Danforth and Maria van Dyke. 2015. "The Wild Bees of New York: Our Insurance Policy Against Honey Bee Decline." *New York Fruit Quarterly*. Volume 23, Number 4. Winter 2015. Pages 17-22. <https://nyshs.org/wp-content/uploads/2016/01/Danforth-Pages-from-NYFQ-Book-Winter.2015-2.pdf>

(Etherington 2017) Cait Etherington. "Beekeeping finds a home throughout NYC's five boroughs." *6sqft*. 2017-07-17. <https://www.6sqft.com/beekeeping-finds-a-home-throughout-nycs-five-boroughs/>

"On June 1, the United Nations joined a growing local trend—they installed three apiary yards, better known as beehives, on their grounds in midtown Manhattan."

(Farah 2018) Troy Farah. 2018. "While We Worry About Honeybees, Other Pollinators Are Disappearing." *Discover Magazine*. 2018-08-03. <https://www.discovermagazine.com/environment/while-we-worry-about-honeybees-other-pollinators-a-re-disappearing>

(Forever Wild) Natural Resources Group, NYC Parks. <https://www.nycgovparks.org/greening/nature-preserves>

"The Forever Wild Program is an initiative of the New York City Department of Parks & Recreation to protect and preserve the most ecologically valuable lands within the five boroughs. There are 135 Parks, with over 12,300 acres of natural areas, that are part of the Forever Wild program, which host towering forests, vibrant wetlands, and expansive meadows."

(Fuller 2007) Richard A Fuller, Katherine N Irvine, Patrick Devine-Wright, Philip H Warren and Kevin J Gaston. 2007. "Psychological benefits of greenspace increase with biodiversity." *Biology Letters*. **3**: 390–394 <http://doi.org/10.1098/rsbl.2007.0149>



“Here we show that these psychological benefits increase with the species richness of urban greenspaces. Moreover, we demonstrate that greenspace users can more or less accurately perceive species richness depending on the taxonomic group in question. These results indicate that successful management of urban greenspaces should emphasize biological complexity to enhance human well-being in addition to biodiversity conservation.”

(Fürst *et al.*, 2014) M. A. Fürst, D. P. McMahon, J. L. Osborne, R. J. Paxton & M. J. F. Brown. “Disease associations between honeybees and bumblebees as a threat to wild pollinators.” *Nature* **506**, 364–366 (2014). <https://doi.org/10.1038/nature12977>

“Honeybee emerging infectious diseases (EIDs) are indeed widespread infectious agents within the pollinator assemblage. The prevalence of deformed wing virus (DWV) and the exotic parasite *Nosema ceranae* in honeybees and bumblebees is linked; as honeybees have higher DWV prevalence, and sympatric bumblebees and honeybees are infected by the same DWV strains, *Apis* is the likely source of at least one major EID in wild pollinators.”

(Garvey 2013) Kathy Keatley Garvey. “The Foraging Force of a Honeybee Colony.” *Bug Squad*, UC Davis Department of Entomology and Nematology. 2013-09-14. <https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=11592>

“During the peak season, a queen bee can lay 2000 eggs a day. ... “In order to meet the nectar and pollen demands to feed all that brood (immature bees) each colony has to have an acre-equivalent of honey bee-attractive bloom within foraging flight range,” [Eric] Mussen says. That's up to four miles from the hive and covers a 50-square mile area.”

(Geldmann and González-Varo 2018) Jonas Geldmann, Juan P. González-Varo. 2018. “Conserving honey bees does not help wildlife.” *Science* Vol 359, Issue 6374, 2018-01-26: pp. 392-393. <https://doi.org/doi:10.1126/science.aar2269>

“There is widespread concern about the global decline in pollinators and the associated loss of pollination services. ... Yet, concern has focused on one species above all: the western honey bee (*Apis mellifera*). This is unfortunate because research shows that managed honey bees can harm wild pollinator species, providing an urgent incentive to change honey bee management practices.”

Authors interviewed in (Schipani 2018) and (University of Cambridge 2021).

(Gerner and Sargent 2021) Eden E. Gerner, Risa D. Sargent. “Local plant richness predicts bee abundance and diversity in a study of urban residential yards.” *Basic and Applied Ecology*, 2021, ISSN 1439-1791. <https://doi.org/10.1016/j.baae.2021.11.004>

“a yard's floral richness, and, to a somewhat lesser extent, its floral abundance, emerged as the most important predictors of a yard's bee community abundance and diversity. ... our research



suggests that improving bee floral resources by increasing the plant species richness and abundance locally is a powerful tool to support bee conservation, regardless of the level of urbanization or tree cover in the surrounding landscape. Our work highlights that the practice of promoting ‘bee-friendly’ plantings in private yards, currently being undertaken by a number of non-profits around the world, can play an important role in restoring and maintaining urban pollinator communities.”

(GreenThumb 2021) Greenthumb, NYC Parks. 2021. “Bees.” In The GreenThumb Gardeners’ Handbook 2021, 40-44. https://greenthumb.nycgovparks.org/pdf/GreenThumb_Gardeners_Handbook_2021.pdf

(Hall *et al.*, 2016) Damon M. Hall, Gerardo R. Camilo, Rebecca K. Tonietto, Jeff Ollerton, Karin Ahrné, Mike Arduser, John S. Ascher, Katherine C. R. Baldock, Robert Fowler, Gordon Frankie, Dave Goulson, Bengt Gunnarsson, Mick E. Hanley, Janet I. Jackson, Gail Langellotto, David Lowenstein, Emily S. Minor, Stacy M. Philpott, Simon G. Potts, Muzafar H. Sirohi, Edward M. Spevak, Graham N. Stone, Caragh G. Threlfall. 2016-09-14. “The city as a refuge for insect pollinators.” *Conservation Biology*, Volume 31, Issue 1 (February 2017): 24-29. <https://doi.org/10.1111/cobi.12840>.

“Research on urban insect pollinators is changing views on the biological value and ecological importance of cities. The abundance and diversity of native bee species in urban landscapes that are absent in nearby rural lands evidence the biological value and ecological importance of cities and have implications for biodiversity conservation.”

(Hall and Martins 2020) Damon M Hall, Dino J Martins. “Human dimensions of insect pollinator conservation.” *Current Opinion in Insect Science*, Volume 38, 2020, Pages 107-114, ISSN 2214-5745. <https://doi.org/10.1016/j.cois.2020.04.001> (<https://www.sciencedirect.com/science/article/pii/S221457452030047X>)

“We review recent literature on the social and cultural dimensions of insect pollinators. People now like bees. We discuss the social challenges and opportunities that accompany this newfound public enthusiasm. These include the generalization of honey bees as representative of bee diversity and pollinator conservation issues, the changing perceptions of pollinators, the paucity of policy research, and how any call to ‘save the bees’ must be a call to stabilize agriculture. We call for greater coordination among biological and socio-cultural researchers to advance insect pollinator conservation practices and policies fit for the Anthropocene.”

(Harper 2019) Nick Harper. “Rise of New York City beekeeping as global bee numbers decline.” *CGTN America*. 2019-06-04. <https://america.cgtv.com/2019/06/04/rise-of-new-york-city-beekeeping-as-global-bee-numbers-decline>

“Bee expert Sarah Kornbluth was worried about the decline of local bee varieties in the New York area. “People keeping hives will put pressure on our native bees, on our wild native bees,” explained Kornbluth, member of the museum’s invertebrate zoology division. “Honeybees are



really efficient and great collectors of nectar and pollen. So in a place like an urban area where those things may not be as plentiful as a green environment, a more green landscape, then you actually do see competition.””

(Kilgannon 2018) Corey Kilgannon. “In Bryant Park, 3 Million Bees, Sold From the Back of a Truck.” The New York Times. 2018-04-13. <https://www.nytimes.com/2018/04/13/nyregion/bees-bryant-park.html>

(Licea 2018) Melkorca Licea. “Beekeeping is all the buzz in New York City.” *NY Post*. 2018-08-18. <https://nypost.com/2018/08/18/beekeeping-is-all-the-buzz-in-new-york-city/>

“Over the last four years, the number of beehives throughout the five boroughs swelled 35 percent, from 277 [2013] to 373 [2018]. The official number of beekeepers ticked up 21 percent, from 99 to 120, according to the Department of Health – though insiders note there are likely many beekeepers off the books. ...

Bee experts say the city is teeming with many more hives and beekeepers than reported. “There’s definitely twice as many hives as there are registered, or more, in the city,” said Hannah Baek, the vice president of NYC Beekeepers Association.”

(Mallinger *et al.*, 2017) Rachel E. Mallinger, Hannah R. Gaines-Day, Claudio Gratton (2017) “Do managed bees have negative effects on wild bees?: A systematic review of the literature.” *PLOS ONE* 12(12): e0189268. <https://doi.org/10.1371/journal.pone.0189268>

“most studies across all topical areas documented the potential for impact (e.g. reporting the occurrence of competition or pathogens), but did not measure direct effects on wild bee fitness, abundance, or diversity. Furthermore, we found that results varied depending on whether managed bees were in their native or non-native range; managed bees within their native range had lesser competitive effects, but potentially greater effects on wild bees via pathogen transmission.”

(Mathiasson and Rehan 2020) Minna E. Mathiasson, Sandra M. Rehan. “Wild bee declines linked to plant-pollinator network changes and plant species introductions.” *Insect Conservation and Diversity*, Volume 13 Issue 6. 595-605. 2020-06-29. <https://doi.org/10.1111/icad.12429>
(<https://onlinelibrary.wiley.com/doi/10.1111/icad.12429>)

“This study characterises [sic] the changes in a northern New England wild bee plant-pollinator network over the past 125 years and reveals a striking increase in exotic bee and plant taxa over time. ... Notable specialist interactions between native taxa that were recorded in historical networks have been lost, most likely due to local extirpation of these now threatened and endangered plant species. Subsequent monitoring and conservation efforts focused on habitat restoration for declining wild bee and plant taxa are fundamental to the future preservation of regional native diversity.”



(Matteson *et al.*, 2008) Kevin C Matteson, John S Ascher, Gail A Langellotto, Bee Richness and Abundance in New York City Urban Gardens, *Annals of the Entomological Society of America*, Volume 101, Issue 1, 1 January 2008, Pages 140–150, [https://doi.org/10.1603/0013-8746\(2008\)101\[140:BRAAIN\]2.0.CO;2](https://doi.org/10.1603/0013-8746(2008)101[140:BRAAIN]2.0.CO;2)

“Relative to other studies, bee richness of the urban gardens is reduced and composition is biased toward exotic and cavity-nesting species. Nevertheless, despite their small size and location within highly urbanized areas, urban community gardens harbor a diverse assemblage of bees that may provide pollination services and opportunities for ecological exposure and education.”

(Matteson and Langellotto 2010) Kevin C. Matteson & Gail A. Langellotto. “Determinates of inner city butterfly and bee species richness.” *Urban Ecosystems* 13, 333–347 (2010). <https://doi.org/10.1007/s11252-010-0122-y>

“We evaluated models including local and landscape factors that might influence the bee and butterfly richness of community gardens located within densely populated neighborhoods of the Bronx and East Harlem in New York City. ... Generally, our findings indicate that sunlight and floral abundance are the major factors limiting local pollinator diversity in this setting. This suggests that rooftop and other “open” urban habitats might be managed to increase local pollinator diversity, even if seemingly “isolated” within heavily developed neighborhoods.”

(McAfee 2020) Alison McAfee. “The Problem with Honey bees.” *Scientific American*. 2020-11-04. <https://www.scientificamerican.com/article/the-problem-with-honey-bees/>

“To many people, honey bees symbolize prosperity, sustainability and environmentalism. But as a honey bee researcher, I have to tell you that only the first item on that list is defensible. Although they are important for agriculture, honey bees also destabilize natural ecosystems by competing with native bees—some of which are species at risk.”

(McMahon *et al.*, 2015) Dino P. McMahon, Matthias A. Fürst, Jessica Caspar, Panagiotis Theodorou, Mark J. F. Brown and Robert J. Paxton. “A sting in the spit: widespread cross-infection of multiple RNA viruses across wild and managed bees.” *Journal of Animal Ecology* 2015, **84**, 615–624. <https://doi.org/10.1111/1365-2656.12345>

“Multiple RNA viruses associated with honeybees are widespread in sympatric wild bumblebee populations. ... Our findings indicate widespread transmission of RNA viruses between managed and wild bee pollinators, pointing to an interconnected network of potential disease pressures within and among pollinator species.”



(Nessen 2012) Stephen Nessen. “Two Years After Legalized Beekeeping, City May be Running Short on Forage.” WNYC 2012-06-25.

<https://www.wnyc.org/story/218358-urban-bees-may-be-running-out-foraging-ground/>

“Urban beekeeping has exploded with nearly 200 registered hives in the city, and experts say there may be another 200 off the books. It’s leading some to question whether the city can sustain the increasing number of hives. ...

[Andrew] Cote [sic] worries there are not enough flowers to support the growing bee populations — especially in certain neighborhoods where beekeeping has blossomed. Cote, who helped write the guidelines for good bee keeping, may be part of the problem, too. He tends about 50 hives in the city. ... his honey yields are down about 50 percent from last year at some hives in the East Village, Union Square, Greenpoint and Williamsburg.

The city requires bee keepers to register their hives, but it doesn’t regulate how many are kept in each neighborhood.”

(NYCBA Practices) “NYCBA’s Best Practices for Beekeeping.” New York City Beekeepers Association (NYCBA). <http://www.bees.nyc/nycbas-best-practices-for-beekeeping>

“Beekeepers are advised to closely observe their apiary locations to determine the carrying capacity of the area—both the immediate area and roughly three miles in all directions— and to limit the number of hives accordingly. Signs of over-saturation in an area include slow colony growth, poor honey production, and excessively defensive behavior.”

(Nichols *et al.*, 2020) Allison A. Nicholls, Graham Bryant Epstein, Sheila R. Colla. “Understanding public and stakeholder attitudes in pollinator conservation policy development.” *Environmental Science & Policy*, Volume 111, 2020, Pages 27-34. ISSN 1462-9011. <https://doi.org/10.1016/j.envsci.2020.05.011> (<https://www.sciencedirect.com/science/article/pii/S1462901120300721>)

“We found very strong support for neonicotinoid regulation, with less than 5% opposed. We also found that the greatest concerns were for bees and pollination services, but that the diversity of pollinating species and the relative contributions of various taxa to pollination was not well understood. ... We conclude that, in order to be effective, broad support will need to be translated into nuanced, evidence-based policy that is focussed on native species and addresses the many threats at-risk pollinators face.”

(Page *et al.*, 2021) Maureen L. Page, Charlie C. Nicholson, Ross M. Brennan, Anna T. Britzman, Jessica Greer, Jeremy Hemberger, Hanna Kahl, Uta Müller, Youhong Peng, Nick M. Rosenberger, Clara Stuligross, Li Wang, Louie H. Yang, Neal M. Williams. “A meta-analysis of single visit pollination effectiveness comparing honeybees and other floral visitors.” *American Journal of Botany*. 108(11): 2196– 2207. 2021-10-08. <https://doi.org/10.1002/ajb2.1764>



“Although high visitation frequencies make honeybees important pollinators, they were less effective than the average bee and rarely the most effective pollinator of the plants they visit. As such, honeybees may be imperfect substitutes for the loss of wild pollinators, and safeguarding pollination will benefit from conservation of non-honeybee taxa.”

(Parks 2019) Natural Resources Group, NYC Parks. “Native Species Planting Guide for New York City, 3rd Edition.” 2019

(Prendergast and Ollerton, 2021) Kit S. Prendergast, Jeff Ollerton. (2021) “Impacts of the introduced European honeybee on Australian bee-flower network properties in urban bushland remnants and residential gardens.” *Austral Ecology*. First published: 2021-05-19. <https://doi.org/10.1111/aec.13040>

“Competition is occurring between the introduced honeybee and the native bee taxa in bee-flower networks. In conclusion, the introduced honeybee occupies a dominant, distinct position in bee-flower networks in urban habitats in the southwest Western Australian biodiversity hotspot and has a major, potentially disruptive, influence on plant-pollinator network properties in these areas.”

(Prendergast, 2021) Kit S Prendergast, Kingsley W Dixon, Philip W Bateman. “Interactions between the introduced European honey bee and native bees in urban areas varies by year, habitat type and native bee guild.” *Biological Journal of the Linnean Society*, Volume 133, Issue 3, July 2021, Pages 725–743, <https://doi.org/10.1093/biolinnean/blab024>

“Native bee richness was positively correlated with overall honeybee abundance in the first year, but negatively correlated in the second year, and varied with body size. Native bees that had higher resource overlap with honey bees were negatively associated with honey bee abundance, and resource overlap between honey bees and native bees was higher in residential gardens. Relationships with honey bees varied between native bee taxa, reflecting adaptations to different flora, plus specialization. Thus, competition with introduced bees varies by species and location, mediated by dietary breadth and overlap and by other life-history traits of individual bee species.”

(Renner *et al.*, 2021) Susanne S. Renner, Marie Sophie Graf, Zoe Hentschel, Helen Krause & Andreas Fleischmann. “High honeybee abundances reduce wild bee abundances on flowers in the city of Munich.” *Oecologia* 195, 825–831 (2021). <https://doi.org/10.1007/s00442-021-04862-6>

“Most of the [plant] species that experienced a shift to honeybee visits in 2020 were visited mostly or exclusively for their nectar. There were no shifts towards increased wild bee visits in any species. These results from a flower-rich garden have implications for the discussion of whether urban bee keeping might negatively impact wild bees. We found clear support that high honeybee densities result in exploitative competition at numerous types of flowers.”



(Reuters 2016) Reuters Staff. "Beekeeping is all the buzz in New York City." Reuters. 2016-07-27. <https://www.reuters.com/article/us-newyork-bees/beekeeping-is-all-the-buzz-in-new-york-city-idUSKCN1072NX>

"Coté tends hives on a dozen of skyscrapers [sic] throughout Manhattan, including the ones on the 76th floor of the Residence Inn hotel near Central Park ... The hotel started the "Broadway Bees" project as part of their green initiative as bees are the main pollinators of flowering plants, including many fruits and vegetables. The rooftop hosts six hives which totals to about 180,000 honey bees, all in robust condition."

(Richard 2021) Hillary Richard. "Why Beekeeping Is Booming in New York: 'A Hive Is a Box of Calm.'" *The New York Times*. 2021-07-27. <https://www.nytimes.com/2021/07/27/nyregion/beekeeping-nyc.html>

"The New York City Department of Health and Mental Hygiene, which oversees city beekeeping, recorded 326 registered hives in 2020. While beekeepers are required to register their hives, they often don't. [Andrew] Coté, the president of the New York City Beekeepers Association and a fourth-generation beekeeper, believes there are more than 600 active hives in the city."

(Ropars *et al.*, 2019) Lise Ropars, Isabelle Dajoz, Colin Fontaine, Audrey Muratet, Benoît Geslin. "Wild pollinator activity negatively related to honey bee colony densities in urban context." *PLoS One*. 2019 Sep 12;14(9):e0222316. <https://doi.org/10.1371/journal.pone.0222316>

"Regarding the morphological groups of wild pollinators, large solitary bee and beetle visitation rates were negatively affected by honey bee colony densities and bumblebee visitation rates were negatively affected by honey bee colony density. Further, lower interaction evenness in plant-pollinator networks was observed with high honey bee colony density."

(Schipani 2018) Sam Schipani. "How the Honeybee Buzz Hurts Wild Bees." *Sierra*. 2018-05-29. <https://www.sierraclub.org/sierra/how-honeybee-buzz-hurts-wild-bees>

"native bees—of which there are over 20,000 species varying in size, shape, and color—are experiencing incredible losses. Of the nearly 4,000 native bee species in the United States alone, four native bumblebee species have declined 96 percent in the last 20 years, and three others are believed to have gone extinct. In the last 100 years, 50 percent of Midwestern native bee species disappeared from their historic ranges."

(Simon 2020) Stephanie Simon. "Sweet Success: NYC Beekeeper Saves Beehives During Coronavirus Pandemic." *NY1 News*. 2020-08-03. <https://www.ny1.com/nyc/queens/human-interest/2020/08/02/nyc-beekeeper-saves-hives-across-the-city-during-pandemic>



"[Andrew] Coté has rescued 70 hives from buildings and schools that had to close because of the coronavirus pandemic. "The owners of those buildings or the managers asked me to remove those beehives and it all had to be done rather quickly," he said. ... Coté came to the aid of other beekeepers who didn't know how to safely move the hives. "We took beehives from Staten Island, Brooklyn, other areas in Queens and Manhattan." ... Honey bees are worker bees, but the hives still need tending to like other livestock. If Cote hadn't rescued them and brought them to the Queens County Farm Museum, some of the bees could have swarmed all over the city."

(Spitznagel 2021) Eric Spitznagel. "Why the honey bee 'apocalypse' is based on a lie." New York Post. 2021-09-18. <https://nypost.com/2021/09/18/why-the-honey-bee-apocalypse-is-based-on-a-lie/>

"exact numbers are hard to come by, or verify. While the New York City Department of Health and Mental Hygiene, which oversees city beekeeping, has official records for just 326 registered hives in 2020, [Andrew] Coté estimates that the real number is "closer to 1,000.""

(Sponsler *et al.*, 2020) Douglas B. Sponsler, Don Shump, Rodney T. Richardson, Christina M. Grozinger. 2020. "Characterizing the floral resources of a North American metropolis using a honey bee foraging assay." *Ecosphere* 11(4):e03102. <https://doi.org/10.1002/ecs2.3102>

"we devised a "honey bee foraging assay" approach to floral resource surveying, wherein continuous colony weight tracking and DNA metabarcoding of pollen samples are used to capture both the overall availability and taxonomic composition of floral resources. ... our study demonstrates the potential of the honey bee foraging assay as a powerful technique for landscape-scale floral resource surveying, provided the inherent biases of honey bee foraging are accounted for in the interpretation of the results."

(Spotswood *et al.*, 2021) Erica N Spotswood, Erin E Beller, Robin Grossinger, J Letitia Grenier, Nicole E Heller, Myla F J Aronson, The Biological Deserts Fallacy: Cities in Their Landscapes Contribute More than We Think to Regional Biodiversity, *BioScience*, Volume 71, Issue 2, February 2021, Pages 148–160, <https://doi.org/10.1093/biosci/biaa155>

"We identify five pathways by which cities can benefit regional ecosystems by releasing species from threats in the larger landscape, increasing regional habitat heterogeneity and genetic diversity, acting as migratory stopovers, preadapting species to climate change, and enhancing public engagement and environmental stewardship. Increasing recognition of these pathways could help cities identify effective strategies for supporting regional biodiversity conservation and could provide a science-based platform for incorporating biodiversity alongside other urban greening goals."



(Stange *et al.*, 2017) Erik E Stange, Grazia Zulian, Graciela M Rusch, Vaid N Barton, Megan Nowell (2017) "Ecosystem services mapping for municipal policy: ESTIMAP and zoning for urban beekeeping." *One Ecosystem* 2: e14014. <https://doi.org/10.3897/oneeco.2.e14014>

"increases in domestic honeybee densities in urban landscapes has raised concern regarding the potential threat that honeybees might pose to local populations of threatened bumblebee and solitary bee species. This issue constitutes a trade-off between the cultural ecosystem services associated with urban beekeeping and the regulation and maintenance ecosystem services of maintaining nursery populations of rare and threatened species. ... We propose a mapping and assessment approach for informing zoning decisions regarding urban honeybees, utilising a model of an urban landscape's biophysical capacity to support pollinating insects (ESTIMAP). Together with an additional model describing the approximate distribution of honeybees ... we identify areas in the city where domestic honeybees may be more likely to exhaust floral resources. This case also tests the policy relevance of ecosystem service mapping tools beyond awareness raising, with broader general lessons for ecosystem mapping and assessment."

(Theodorou *et al.*, 2020) Panagiotis Theodorou, Rita Radzevičiūtė, Guillaume Lentendu, Belinda Kahnt, Martin Husemann, Christoph Bleidorn, Josef Settele, Oliver Schweiger, Ivo Grosse, Tesfaye Wubet, Tomás E. Murray & Robert J. Paxton. "Urban areas as hotspots for bees and pollination but not a panacea for all insects." *Nature Communications* 11, 576. 2020-01-29. <https://doi.org/10.1038/s41467-020-14496-6>

"Hymenoptera, especially bees, show higher species richness and flower visitation rates in cities ... Appropriately managed cities could enhance the conservation of Hymenoptera and thereby act as hotspots for pollination services that bees provide to wild flowers and crops grown in urban settings."

(Thomson 2004) Diane Thomson. "COMPETITIVE INTERACTIONS BETWEEN THE INVASIVE EUROPEAN HONEY BEE AND NATIVE BUMBLE BEES." *Ecology*, 85: 458-470. <https://doi.org/10.1890/02-0626>

"*Apis* competitively suppresses a native social bee known to be an important pollinator, with the potential for cascading effects on native plant communities."

(Turo and Gardiner 2021) Katherine J. Turo, Mary M. Gardiner. "Effects of urban greenspace configuration and native vegetation on bee and wasp reproduction." *Conservation Biology*. (2021); 35: 1755– 1765. <https://doi.org/10.1111/cobi.13753>

"Native bee and wasp larvae were more abundant in landscapes that contained a large patch (i.e., >6 ha) of contiguous greenspace, in habitats with low plant biomass, and in vacant lots seeded with a native wildflower seed mix or with fine-fescue grass, suggesting that fitness was influenced by urban landscape features and habitat management. Our results can guide urban planning by demonstrating that actions that maintain large contiguous greenspace in the landscape and establish native plants would support the conservation of bees and wasps."



(Uhler *et al.*, 2021) Johannes Uhler, Sarah Redlich, Jie Zhang, Torsten Hothorn, Cynthia Tobisch, Jörg Ewald, Simon Thorn, Sebastian Seibold, Oliver Mitesser, Jérôme Morinière, Vedran Bozicevic, Caryl S. Benjamin, Jana Englmeier, Ute Fricke, Cristina Ganuza, Maria Haensel, Rebekka Riebl, Sandra Rojas-Botero, Thomas Rummler, Lars Uphus, Stefan Schmidt, Ingolf Steffan-Dewenter & Jörg Müller. "Relationship of insect biomass and richness with land use along a climate gradient." *Nature Communications* **12**, 5946 (2021). <https://doi.org/10.1038/s41467-021-26181-3>

"We found the largest difference in biomass between semi-natural and urban environments (−42%), whereas differences in total richness (−29%) and the richness of threatened species (−56%) were largest from semi-natural to agricultural environments. These results point to urbanization and agriculture as major drivers of decline. We also found that richness and biomass increase monotonously with increasing temperature, independent of habitat. The contrasting patterns of insect biomass and richness question the use of these indicators as mutual surrogates. Our study provides support for the implementation of more comprehensive measures aimed at habitat restoration in order to halt insect declines."

(University of Cambridge 2021) University of Cambridge. 2021. "Think of honeybees as 'livestock,' not wildlife, argue experts." ScienceDaily. <https://www.sciencedaily.com/releases/2018/01/180125140910.htm> (accessed November 26, 2021).

Interview with authors of (Geldmann and González-Varo 2018).

(Urban Agriculture) NYC Urban Agriculture. <https://www1.nyc.gov/site/agriculture/index.page>

"NYC Urban Agriculture is a portal created by the Department of City Planning, NYC Parks, and the Department of Small Business Services to inform businesses, property owners, and the public at large about agriculture in New York City. Agricultural uses include personal gardening, community gardening, commercial farming, indoor farming such as hydroponics and aquaponics, rooftop greenhouses, and more. The website serves as a resource to learn about initiatives and programs related to gardening and agriculture, as well as rules and regulations that pertain to agriculture."

(Valido *et al.*, 2019) Alfredo Valido, María C. Rodríguez-Rodríguez & Pedro Jordano. "Honeybees disrupt the structure and functionality of plant-pollinator networks." *Scientific Reports* **9**, 4711 (2019). <https://doi.org/10.1038/s41598-019-41271-5>

"Our results show that beekeeping reduces the diversity of wild pollinators and interaction links in the pollination networks. It disrupts their hierarchical structural organization causing the loss of interactions by generalist species, and also impairs pollination services by wild pollinators through reducing the reproductive success of those plant species highly visited by honeybees. High-density beekeeping in natural areas appears to have lasting, more serious negative impacts on biodiversity than was previously assumed."



(Wallace *et al.*, 2016) Christopher Wallace, Ana Gutierrez, Mohammed Al-Sayegh, Timothy Leslie. "Wild Bee Diversity in Brooklyn Community Gardens." <https://hollenbackgarden.wordpress.com/bees/>, 2016-04. https://hollenbackgarden.files.wordpress.com/2016/04/wild_bee_poster-2.pdf

"Ten community garden study sites were established throughout Brooklyn, NY during the summer of 2009. The gardens varied in several key characteristics that may influence bee diversity, including: patch size, isolation from other green spaces, and floral diversity. ...

270 bees comprising 30 species were collected during the 2009 field season. The dominance distribution of the bee community was highly skewed (Fig. 1), as the top six species [*Melissodes*, long-horned bees and *Peponapis*, squash bees dominating] accounted for nearly 70% of the total bees captured. ...

Bee activity varied significantly among gardens. ... A positive linear relationship between garden size and bee diversity was found ($F=7.86$, $P=0.026$) when the largest garden (East NY Farms) was excluded."

(Weissman *et al.*, 2021) Julie A. Weissmann, Iris R. M. Walldorf, Hanno Schaefer. "The importance of wild bee communities as urban pollinators and the influence of honeybee hive density." *Journal of Pollination Ecology*, 29, 204–230. [https://doi.org/10.26786/1920-7603\(2021\)641](https://doi.org/10.26786/1920-7603(2021)641)

"species-rich wild bee communities in urban areas are important for pollination success in common fruit crops, especially under unstable spring weather conditions. Bee-friendly management of urban spaces should be prioritised to support wild bee communities as well as the increasing number of honeybees in cities. In order to reduce competition with endangered wild bees, the bee keepers should always consider the available floral resources in their surroundings from early spring to late autumn and adapt their number of hives accordingly."

(Wojcik *et al.*, 2018) Victoria A Wojcik, Lora A Morandin, Laurie Davies Adams, Kelly E Rourke. "Floral Resource Competition Between Honey Bees and Wild Bees: Is There Clear Evidence and Can We Guide Management and Conservation?" *Environmental Entomology*, Volume 47, Issue 4, August 2018, Pages 822–833. <https://doi.org/10.1093/ee/nvy077>

"Critique and assessment of the existing body of published literature against our criteria focussing on studies that can support best management resulted in 19 experimental papers. Indirect measures of competition examining foraging patterns and behavior yielded equivocal results. Direct measures of reproduction and growth were investigated in only seven studies, with six indicating negative impacts to wild bees from the presence of managed honey bees. Three of these studies examined fitness impacts to *Bombus* (Latreille) and all three indicated reduced growth or reduced reproductive output."



(Wood *et al.*, 2018) Emma Wood, Alice Harsant, Martin Dallimer, Anna Cronin de Chavez, Rosemary R. C. McEachan and Christopher Hassall. “Not All Green Space Is Created Equal: Biodiversity Predicts Psychological Restorative Benefits From Urban Green Space.”

<https://dx.doi.org/10.3389%2Ffpsyg.2018.02320>

“We present three key results. First, there is a positive association between site facilities and biodiversity. Second, restorative benefit is predicted by biodiversity, which explained 43% of the variance in restorative benefit across the parks, with minimal input from other variables. Third, the benefits accrued through access to green space were unrelated to age, gender, and ethnic background. The results add to a small but growing body of evidence that emphasize the role of nature in contributing to the well-being of urban populations and, hence, the need to consider biodiversity in the design of landscapes that enhance multiple ecosystem services.”

(Xerces 2018) Richard Hatfield, Sarina Jepsen, Mace Vaughan, Scott Black, and Eric Lee-Mäder. “An Overview Of The Potential Impacts Of Honey Bees To Native Bees, Plant Communities, And Ecosystems In Wild Landscapes: Recommendations for Land Managers.” Portland, OR. The Xerces Society for Invertebrate Conservation.

<https://xerces.org/publications/guidelines/overview-of-potential-impacts-of-honey-bees-to-native-bees-plant>

(York 2020) York University. “About 94% of wild bee and native plant species networks lost, study finds.” Phys.org, 2020-07-14. (Interview with authors of Mathiasson and Rehan 2020)

<https://phys.org/news/2020-07-wild-bee-native-species-networks.html?MvBriefArticleId=15197>

“Climate change and an increase in disturbed bee habitats from expanding agriculture and development in northeastern North America over the last 30 years are likely responsible for a 94 percent loss of plant-pollinator networks. ... An increase in non-native species of bees and invasive species of plants, which have displaced some of the native species, is another reason for the decline in networks.”