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Author(s): Tara Cornelisse, Mark Weckel, Andrew Collins, and Suzanne Macey

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Community Buzz: Conservation of Trees and Native Bees in Urban Areas

Tara Cornelisse[1,2], Mark Weckel[3], Andrew Collins[4], and Suzanne Macey[1]

[1]Center for Biodiversity and Conservation, American Museum of Natural History, New York, USA; [2]Canisius College, New York, USA; [3]Education, American Museum of Natural History, New York, USA; [4]California Academy of Sciences, California, USA

ABSTRACT

The world is increasingly urbanized and yet, even in urban areas, humans remain dependent on the ecosystem services that nature provides. This case study and exercise explore selected aspects of the dynamic between humans and urban ecology in three parts. First, we briefly discuss urban ecosystems and the context of biodiversity conservation in urban areas. Then, through a case study of the Million Trees program in New York City, we provide evidence and start a discussion about the possible benefits—as well as potential negative social, ecological, and economic consequences—of urban trees. And finally, we introduce biodiversity conservation in urban green spaces through an exercise on native bees. After reading about the importance of, and threats to, native bees, students take on stakeholder roles to decide if their neighborhood should accept a grant to create and maintain bee habitat in an urban park. Students are tasked with conducting additional research and participating in a classroom town hall meeting to present and support their argument for or against the creation of native bee habitat.

LEARNING OBJECTIVES

After this case study and exercise, students will be able to:

1. Identify some of the social, economic, and ecological factors that may influence the success of an urban conservation initiative;
2. Summarize and synthesize the opportunities and challenges of biodiversity conservation in an urban setting; and
3. Discuss the trade-offs of urban conservation from diverse stakeholder perspectives.

1. INTRODUCTION TO URBAN CONSERVATION

> *The world is increasingly urban, interconnected, and changing. If current trends continue, by 2050 the global urban population is estimated to be 6.3 billion, nearly doubling the 3.5 billion urban dwellers worldwide in 2010. More than 60 percent of the area projected to be urban in 2030 has yet to be built.*
>
> *Secretariat of the Convention on Biological Diversity (2012)*

What does the growth of cities mean for the conservation of biodiversity? Is there a place for conservation within cities? And if so, what does urban conservation look like? These are important questions on both the local and global scale, with important implications regarding the impact of cities on the earth's ecosystems and the quality of life for humans.

1.1. Cities and Biodiversity

Through the destruction, degradation, and alteration of natural areas, the creation and growth of cities imposes major and often irreversible changes to the landscape and its biodiversity. Nevertheless, it may still be helpful to look at cities as their own type of ecosystem—an ecosystem dominated by humans. The built environment is the defining characteristic of cities, yet more than just remnants of its original biodiversity exist. In fact, many cities are located where they are because of the original biological diversity and productivity of the land. Cities were, and still are, established in areas with navigable waterways and abundant natural resources. An example of this can be seen in New York City's (NYC) Pearl Street. This street is so named because at one time it was the location of lower Manhattan's East River shoreline; once having abundant oyster reefs nearby, this was one of

the locations where the native Lenape people piled discarded oyster shells after harvesting (Feirstein 2001; Kurlansky 2007). Pearl Street is no longer a waterfront street (due to hundreds of years of landfilling that has extended Manhattan approximately 300 meters into the river; see Figure 1) and the present day rivers in NYC no longer have natural oyster reefs (however, see managed oyster reef restoration projects such as the Oyster Research Restoration Project). Today, visitors and residents may not make the connection between a street name and the original biodiversity of the region.

Cities are a patchwork of human, or anthropogenic, habitat (e.g., residential, commercial, industrial zones) and "greenspace" (e.g., recreational parkland, remnant woodlots, post-industrial areas). The biodiversity patterns that emerge "post-urbanization" are a result of the interactions between humans, their industry, trade, culture, and travel, in addition to the traditional environmental factors that often explain patterns of biodiversity in natural areas (e.g., local climate, soil, and vegetation). For example, as centers of trade and transport, cities are gateways for the establishment of exotic species, which is a serious conservation and economic challenge, as exotic species may outcompete native species and can be costly to eradicate or keep at bay (Kiviat & Johnson 2013). There are also certain cosmopolitan flora and fauna that thrive in urban areas and are found consistently in many cities around the world. This pattern suggests that urban development may have a homogenizing impact on biodiversity (Secretariat of the Convention on Biological Diversity 2012), but urban biodiversity is not entirely uniform between cities, throughout a city, or over time (Kowarik 2011). For example, older cities have more species than younger cities and wealthier neighborhoods have more floral diversity than poorer ones (Secretariat of the Convention on Biological Diversity 2012).

Figure 1. Egbert Viele's 1874 map of Manhattan, showing original landmass in green and subsequent landfill in orange. Image below is the left-most (southern-most) portion of the map shown in close up to visualize Pearl Street (Viele, Egbert L. [CC BY-NC-SA 2.0])

1.2. Cities and Ecosystem Services

Urban ecosystem services are vital for the resilience of a city and depend on urban biodiversity (McPhearson et al. 2014). Many city managers are now realizing that the stability of the "human-side" of cities (e.g., neighborhoods, the economic development of commercial districts) benefit from the conservation of urban biodiversity and the construction of green infrastructure[1] to maintain urban ecosystem services. For example, with global climate change leading to rising sea levels and more frequent, stronger storms, restoration ecologists are proposing and manufacturing living reefs off the coasts of urban areas. Oyster reefs, such as those being re-built in NYC waterways, protect shorelines by buffering storm surges while simultaneously promoting habitat for other species. They also provide the additional benefit of increasing water quality, which can have human health benefits (see Figure 2; Piazza et al. 2005; Beck et al. 2011; Grabowski et al. 2012).

Other examples of green infrastructure within cities are green roofs[2] and green streets[3] (Figure 2). In these cases,

green infrastructure not only reduces water pollution (Gregoire & Clausen 2011) and decreases temperatures in cities (Santamouris 2014), but it also creates and connects habitats for a diversity of invertebrates, like native bees[4] (Braaker et al. 2014), birds (Strohbach et al. 2013) and small mammals such as bats (Oprea et al. 2009). Additionally, green roofs have been shown to provide residents with increased apartment value (Ichihara & Cohen 2011) and improved mental well-being (Lee et al. 2015).

1.3. Impact of Cites: Outside the City Limits

Urban areas are growing rapidly, especially areas in close proximity to biodiversity hotspots and in species-rich coastal areas (Secretariat of the Convention on Biological Diversity 2012). This larger urban footprint will have far-reaching impacts, well beyond city limits. For example, even if a natural area is protected from development (e.g., in a nature preserve, national park, wildlife refuge), air and water pollution from a bordering city can enter the protected area. Also, bordering cities can alter that protected area's microclimate by increasing local temperatures and altering hydrology (Bolund & Hunhammar 1999), which in turn can change the local ecology of the ecosystem. The high resource demands of a large urban populace may also incentivize both legal and illegal natural resource extraction from nearby biodiversity hotspots, possibly increasing habitat degradation and increasing the risk of extirpation or extinction of threatened species (Lee et al. 2014). Furthermore, an increase in land prices—as it becomes more economically attractive to develop on cityscape borders—may make the future expansion of protected areas more difficult. For more information on this topic, please see the NCEP module, Sprawl and Biodiversity (ncep.amnh.org).

Figure 2. Oyster reef restoration project in Florida (left); similar projects are underway in urban areas, such as the Billion Oyster Project in New York City. Green roof in New York City (top right). Green street in Seattle, Washington (bottom right). Photo credits: left: Anne Birch. Top right: Jwilly77 (Own work) [CC BY-SA 3.0 [http://creativecommons.org/licenses/by-sa/3.0]. Bottom right: U.S. Environmental Protection Agency, public domain.

Ultimately, with an increasingly urban future ahead, established cities must place a priority on conservation and new cities should be developed with conservation objectives in mind in order to better protect biodiversity and maximize urban ecosystem services for human health and well-being. The following case study (Part A) will dive further into how initiatives to increase vegetation (specifically focusing on trees) in urban areas can affect the urban environment and city residents. In Part B, an exercise will focus on how the implementation of wildlife restoration projects in urban areas involves a diversity of stakeholders[5] and perspectives.

2. PART A: DOES AN URBAN FOREST MAKE FOR A BETTER NEW YORK CITY?

Between 2007 and 2015, one million trees were planted in NYC through the MillionTreesNYC campaign of PlaNYC, an initiative to build a greener, more sustainable city by 2030 (New York City Department of Parks 2015). Part of this plan also includes NYC setting aside 25% of its land for parks and open space (The City of New York 2014) but concrete and pavement, buildings, and roads, will still dominate the rest of the city. Most roads and building roofs are dark and dry, absorbing most of the sun's rays and warming the surrounding air through the process of conduction[6]. Collectively, the change in microclimate around built structures in a city creates an urban heat island where local temperatures can be 1–3°C higher than adjacent suburban and rural areas (Akbari 2005). However, vegetation in urban areas will cool the surrounding air (through direct shading and the process of evapotranspiration[7]) and can mitigate the urban heat island by changing the microclimate of entire neighborhoods (see Figure 3).

Street trees also can influence the microclimate by reducing wind speeds. For instance, a study comparing a residential area with no trees to a residential area with 77% tree density calculated that trees reduced approach wind speeds in the winter by 43% (Heisler 1990). By blocking cold winter winds, an urban forest can help homeowners and landlords reduce heating costs, though care must be paid to where these trees are planted. Planting trees that block the winter sun but none of the winter wind can actually increase heating costs in the winter (Nowak & Dwyer 2007).

Trees also have a variety of ecological, economic, and social benefits for cities beyond regulating the microclimate. During a rainstorm, a single large tree can temporarily capture up to 100 gallons (379 liters) of water via its leaves and trunk alone (Fazio 2010). This phenomenon is known as the "umbrella effect," and it greatly reduces storm water runoff (Figure 4). In NYC, this is an immense service since the city's combined sewer overflow (CSO) system does not distinguish between rainwater and sewage. In some neighborhoods of NYC, water treatment facilities become overloaded after as little as 1/10 of an inch (2.5 mm) rain per hour (Brown & Shapley 2014). After this point, a mixture of raw sewage and clean rain water bypasses treatment plants and is dumped directly into local waterways reducing water quality, damaging fisheries, and closing

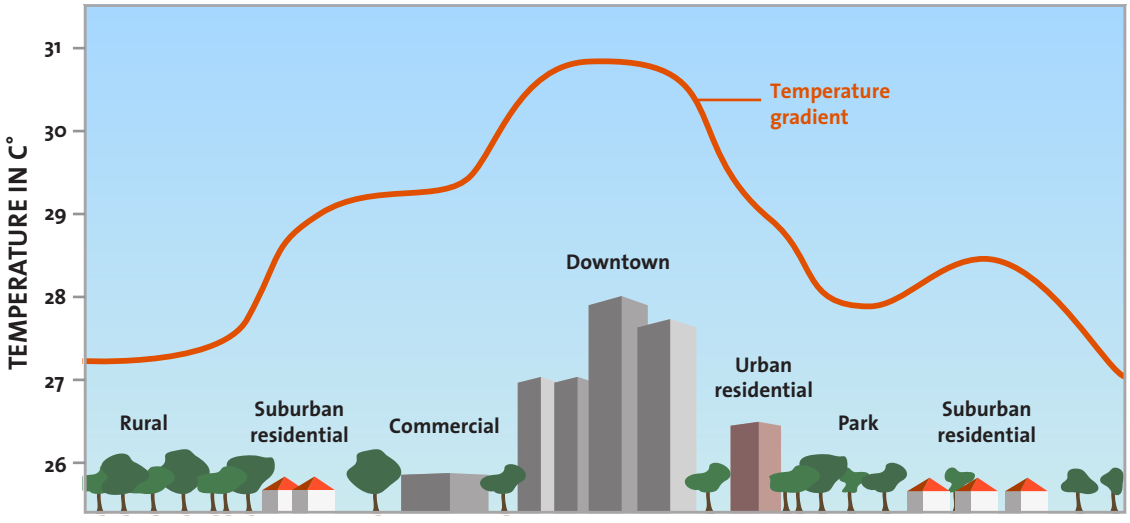

Figure 3. Average temperatures along a gradient of urbanization in landscapes with varying vegetation cover (illustration: U.S. Environmental Protection Agency, Washington, D.C. adapted by Nadav Gazit).

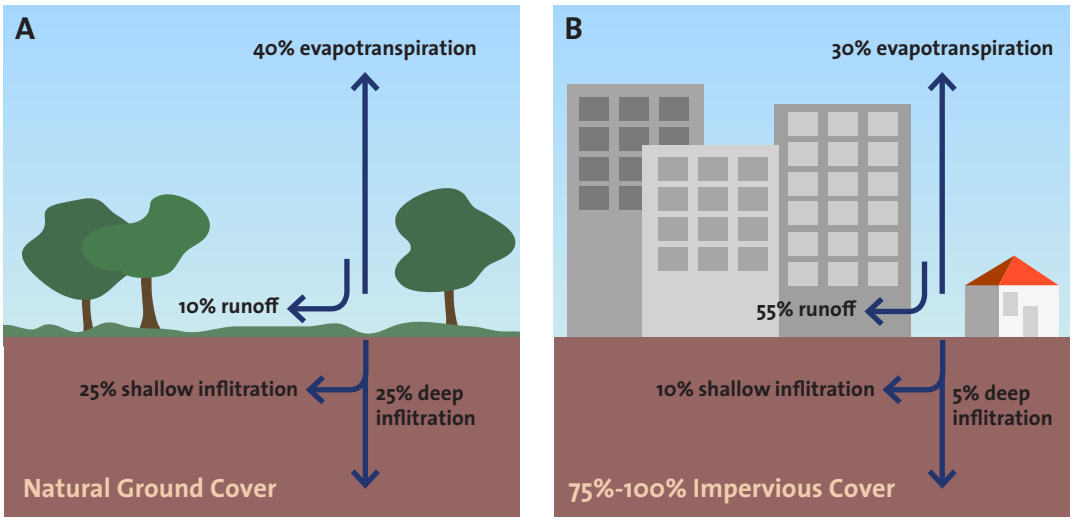

Figure 4. Waste and storm water flow in an area with (A) natural ground cover versus (B) an urban area (75–100% impervious cover) (illustration: U.S. Environmental Protection Agency, Washington, D.C. adapted by Nadav Gazit).

beaches. As of 2006, over 27 billion gallons of untreated sewage entered NYC waters from CSOs annually (Plumb 2007). These CSOs are the largest source of pathogens to the New York Harbor (New York City Mayor's Office of Long-Term Planning and Sustainability 2008). For example, one study linked these CSO events to widespread distribution of antibiotic-resistant bacteria in the Hudson River Estuary (Young et al. 2013). To address this pressing issue, the Mayor's office, through the PlaNYC initiative, implemented a combination of green infrastructure (including street trees) and grey infrastructure (e.g., improved sewer facilities) to capture upwards of 79% of CSO as of 2015 (New York City Mayor's Office 2016).

Trees may also contribute to cleaner, healthier air by intercepting particulate matter via their leaves and bark, and by absorbing gaseous compounds through their leaves' stomata[8] (Pugh et al. 2012). Urban trees have been shown to greatly reduce several compounds associated with lower air quality including ozone (O_3), nitrogen dioxide, and sulfur dioxide (SO_2) (Nowak & Dwyer 2007). The ability of trees to reduce particulate matter has also been hypothesized to help reduce the incidence of asthma in children: a 2008 study compared rates of asthma across different NYC neighborhoods that varied in street tree density and found lower incidences of childhood asthma in neighborhoods with more street trees (Lovasi et al. 2008). However, a follow-up study that used a finer-scale of sampling and looked at the relationships between asthma and overall tree canopy in NYC (from parks, gardens, and street trees) failed to see the same correlation (Lovasi et al. 2013); on the contrary, there was some evidence that increased canopy cover was positively associated with allergic sensitization to tree pollen. There are many factors that contribute to respiratory illnesses and how—and if—street trees have an impact is still uncertain.

In many urban neighborhoods where there are few parks and private gardens, street trees may be the dominant vegetation. Here, trees increase biodiversity both directly and indirectly by providing habitat to a variety of birds and insects (Alvey 2006). Where street tree corridors connect parks, trees may actually serve as ecological corridors[9], providing connectivity between green spaces (Fernandez-Juricic 2001).

Street trees can increase property values: one study in Portland, Oregon, recorded an increase of $8,870 to sales prices and a 1.7 days reduction of time on the market for homes adjacent to street trees (Donovan & Butry 2010). In addition to the economic value, street trees can provide social benefits. For example, urban trees and greenspaces are documented to reduce stress (Tyrväinen et al. 2005) and promote mental well being and social integration (Seamans 2013). Street trees are also believed to play an unexpected role in fostering community empowerment: studies suggest that areas of well-maintained vegetation encourage greater use of outdoor area, monitoring of outdoor areas, foster social interactions, and increased supervision of children (Coley et al. 1997). While in the past, urban vegetated areas have been associated with crime (the vegetation

was believed to conceal criminal activity; Nasar & Fisher 1993), new research has provided evidence that well maintained street vegetation might actually *reduce* crime by signaling to criminals that someone cares and is watching over the neighborhood (Donovan & Prestemon 2012). For example, in Baltimore County, Maryland, a higher percent of overall urban tree canopy cover correlated with lower crime rates (Troy et al. 2012). The relationship between vegetation, crime, and perceived crime risk is not simple and may hinge on vegetation type. The same Baltimore study also identified neighborhoods where the trend was reversed: more vegetation, more crime. Vegetation in these neighborhoods (a mixture of industrial and residential housing and abandoned lots) was characterized by weedy, overgrown, and unattended growth (Troy et al. 2012).

City planners, managers, and citizens need to carefully consider what type of vegetation to plant in an urban area. For example, many species of trees are selected for planting in street tree pits for their ability to survive the challenging sidewalk environment—not because they are native to that area. One example is the Norway maple (*Acer platanoides*), which was widely planted as an urban street tree in the northeastern United States several decades ago. Norway maples have since "escaped" their planned urban environment and can be found in many urban, suburban, and rural forests (Harrington et al. 2003). Owing to its ability to outcompete native red and sugar maples, the Norway maple is now considered to be an invasive species[10] and the subject of intense management (Nowak & Rowntree 1990). Exotic plants that are known to be invasive or potentially may be invasive can no longer be used as street trees in NYC (The City of New York 2014).

Although street trees may benefit a community as a whole, a single street tree most directly impacts the person or people who live adjacent to it. There are naturally many considerations that accompany the tree planting process: for example, care must be taken to make sure a tree has room to grow and is properly pruned. Trees that are too large can buckle sidewalks, potentially leading to injuries and repair costs. If a tree pit is too small, roots may seek out water well beyond its crown and in the process weaken the foundation of buildings or damage pipes and other underground services; tall growing trees may damage overhead services, such as telephone wires (Wang et al. 2014). A sick tree or one that is improperly pruned can lead to falling tree limbs and potentially harm to persons or property (Rae et al. 2011). Furthermore, the installation of tree pits and trees within a narrow sidewalk can reduce surface area for pedestrians to walk comfortably and safely away from the roadway, or complicate municipal services (e.g., garbage pick up). Many of the overall benefits of urban trees are only achieved when there is a sufficient density of tree canopy and the trees are actively maintained and replaced; the maintenance costs of these trees may outweigh the benefits (Wang et al. 2014).

So, if a tree is planted on a public sidewalk in front of your home, to whom does the street tree belong? Who is responsible for the cost of maintenance of the tree? Who actually benefits and who might be negatively impacted? In NYC, the Parks Department is responsible for all trees growing along streets and in parks (Nowak et al. 2007). While the City owns the space between the street and the building owner's property line, building owners are responsible by law for maintaining the sidewalks adjacent to their buildings, including repairing sidewalk defects caused by trees that may impact public safety (Rae et al. 2011). If building owners neglect their responsibilities, they may be fined by the Department of Transportation (New York City Department of Transportation 2008).

Rae et al. (2011) studied public perceptions and responses to the MillionTreesNYC project. Here the authors summarize some of the main issues with the program:

> *Objections to placement location was the biggest complaint about new street tree planting, followed by policy objections where people did not want a tree or had not been notified in advance before their sidewalk was cut or the tree was planted.... In other cases, residents take issue with the type of tree species chosen by the forester, often asking for a different variety to be selected.... These residents are accepting of the possibility of tree planting at this site, but would like more control over the planting since they expect the tree to become a part of their daily lives.... Even though the sidewalk is legally a public right of way with government*

jurisdiction, residents can have a psychological sense of ownership over this place that can have personal meaning (Rae et al. 2011).

In general, stakeholder engagement in conservation or environmental decisions plays an important role in the success—or failure—of a project (Sterling et al. 2017; see NCEP module, Stakeholder Analysis in Environmental and Conservation Planning, available at ncep.amnh.org). Rae et al. (2011) suggest that "...involvement in the planting process could help to transfer a citizen's sense of ownership over the sidewalk through giving them more investment in new street trees," while simultaneously acknowledging that the scale and complexity of the MillionTreesNYC project makes large-scale citizen involvement difficult. Despite these difficulties, the MillionTreesNYC program continues to actively promote community involvement and ensuring the future success of planted trees through their MillionTreesNYC Stewardship Corps and Stewardship Mini-Grants (http://www.milliontreesnyc.org/html/programs/stewardship_corps.shtm ; http://www.milliontreesnyc.org/html/care/grants.shtml).

2.1. Discussion Questions

Through the following discussion questions, students will synthesize and categorize the benefits and drawbacks of an urban tree planting initiative (such as the MillionTreesNYC project) through a general overview lens as well as through the perspectives of hypothetical individual urban residents (stakeholders).

1. What are some benefits and drawbacks of planting urban street trees?

   Fill in Table 1: Identify *eight or more ways* street trees can impact a city. Use the above case study (and Introduction section) as reference

Table 1. Template table for listing and categorizing benefits and drawbacks of planting urban street trees.

	TYPE OF IMPACT		
Impact	**Social**	**Ecological**	**Economic**
Reduce air pollutants	*Health benefits (+)*	*Wildlife/ plant health benefits (+)*	*Reduction in health costs (+)*

for filling in the table, but feel free to think critically about the complex social, ecological, and economic systems in urban areas you know and incorporate your own ideas into the table.

a. Identify whether the type of impact is social, ecological, and/or economic by writing the consequences under the appropriate column heading (note: impacts may fall under more than one category). For example, trees can reduce air pollution—this is a social benefit because it can improve human health; indirectly it may also be considered an economic benefit as the reduction of pollution could reduce public health costs.
b. Indicate if the impact is generally a positive or negative impact for the community, or if it a mixture of both, by placing a "+" or a "-" or a "+/-" within the type of impact column(s). For example, trees reducing air pollution would a positive (+) impact.
c. Once the table is filled in, reflect on the balance of positive and negative impacts as well as the balance of social, ecological, and economic impacts of street trees. Based on the balance of the table, do you think the MillionTreesNYC project was a worthwhile project? What do you think could influence the success of this urban conservation project?

2. Suppose that the city government of Beijing would like to start a MillionTreesBeijing project. Based on the case study and your analysis from Question 1, identify three possible urban stakeholders and speculate why these stakeholders might benefit from or possibly object to an urban tree project. What suggestions might you make to the city government on how to foster support for this project?

Figure 5. Examples of North American native bees. Megachile centuncularis *(top left).* Agapostemon virescens *(top right).* Lasioglossum zephyrum *(bottom left).* Bombus impatiens *(bottom right). Photo credits: top left: Flickr user JRexpo [CC BY-SA 2.0]. Top right: Flickr user Jeff Trei [CC BY-SA 2.0]. Bottom left: Flickr user Lostinfog [CC BY-SA 2.0]). Bottom right: Flickr user E ore Balocchi [CC BY-SA 2.0].*

3. PART B: URBAN BEE CONSERVATION

3.1. Introduction

When you think of bees, you probably immediately think of honey bees (*Apis mellifera*)—but honey bees are only one species of over 20,000! There are more than 4,000 species of native bees in the United States, with over 400 in New York and at least 50 in New York City (Matteson et al. 2008; Moissett & Buchmann 2011). In the U.S., native bees come in many forms and vary in color from all black to metallic blue to stripes of red, orange, yellow, or white. Some common names of U.S. native bees are bumblebees, carpenter bees, mason bees, plaster bees, leafcutter bees, and digger bees (Figure 5).

Honey bees have only been residents in the U.S. since the early 1600s and are native to Europe. Even though honey bees are only a small part of bee biodiversity, they are well known and extremely important to human well-being because they are responsible for pollinating more than 90 crops worldwide. This ecological service is estimated to be worth over $15 billion USD (Calderone 2012; Morse & Calderone 2000). Additionally, honey bees—social insects that live in high densities—produce honey that can be harvested and sold. U.S. honey sales in 2015 were valued at over $327 million USD (NASS 2016).

Native bees in the U.S. are not amenable to keeping in beehives, nor do they make honey; yet, they are still extremely ecologically and economically important. Native bees pollinate and are responsible for the reproduction of 70% of the world's flowering plants, including two-thirds of crop species, and these ecosystem services are estimated to be worth just over $3 billion USD (annual value 2001–2003; Losey & Vaughan 2006). Native bees pollinate the majority of plants in urban gardens (Matteson et al. 2008) and are 2–3 times more productive at pollinating New York State apple orchards than honey bees (Park et al. 2012).

Both honey bees and native bees are threatened due to human activities. Honey bees are primarily threatened by Colony Collapse Disorder (CCD), which is currently thought to be caused by a combination of disease, parasites, and pesticides (Lu et al. 2014). CCD has resulted in (a) widespread acknowledgement that honey bees are responsible for pollinating a large proportion of our food crops and (b) fear that CCD will result in a reduced food supply (Wines 2013). Although CCD does not impact native bees in the U.S., the onset of CCD has also resulted in the recognition of native bees as important pollinators and increasing the awareness of the need for native bee conservation alongside honey bee conservation (Mims 2009).

The largest threat to native bees is loss of habitat, particularly in urban areas. Native bees need floral resources as well as nesting and overwintering sites (e.g., wood piles, rock piles, logs) to survive in urban areas and these resources have been declining with loss of greenspaces and homogenization of urban biodiversity, especially of plants (Jha & Kremen 2013). To support declining populations of urban bees, residents can

Figure 6. Example bee house. A bee can be seen entering the house in its lower-left portion (photo credit: Tom Brandt [CC BY-SA 2.0]).

create native bee habitat in their yards or community parks and gardens by planting a diversity of flowering plants as well as providing logs or even bee "houses" (Figure 6) for breeding and overwintering habitats. There are manuals available to assist in the construction of effective native bee habitat (e.g., http://www.xerces.org/fact-sheets/). With increased habitat, native bees have a chance to survive and even thrive in urban areas, further increasing insect and plant diversity, and providing important pollination services.

3.2. Town Hall Exercise: Native Bee Conservation

Now it's your turn to make an important conservation decision. You will take part in a town hall discussion and vote on a proposed conservation project for your community. As a community member, you must bring your personal and professional goals to the table while also weighing the social, economic, and ecological factors involved.

3.2.1. The Situation

New York City has been awarded a national stewardship grant to fund a local habitat conservation project for native bees in parks across NYC. As a member of the community, you have your own opinion on this project and will help vote on whether or not the project gets approved for your local neighborhood park. A town hall meeting is being held and you must bring your thoughts to the table to share with others; then you will all come together to make final decision.

3.2.2. Preparation for the Town Hall Meeting (~*45 minutes, or as homework assignment*)

You will be assigned a stakeholder role and a short statement of thoughts and questions concerning the project in the voice of the stakeholder (Table 2). As assigned by your instructor (either during class or as a homework assignment), you will read your role description and research additional evidence to form your argument/voice for your stakeholder. When you perform your research, think about the types of evidence your stakeholder would use and how your stakeholder would find sources of evidence. For example, a bee scientist (entomologist) might use primary scientific literature, a concerned parent might use a news source, and a manager might use a report from a governmental agency, such as the U.S. Department of Agriculture. Note: you may be asked to turn in your research sources or a list of references.

After performing your research:

1. Individually, consider the position of your stakeholder role (Table 2): what factors are most influential in your argument around bee habitat creation? After performing additional research:
    a. Fill in your role at the top of Table 3.
    b. Rank each factor with a *unique* number (i.e., no repeated numbers) from 1–8, with 8 being the *most important* factor (to your role) when deciding whether to receive the grant and create native bee habitat. Put each number in the category (social, ecological, or economic) you think *best* represents each factor.
    c. Next, indicate if the factor is a Pro (favors bee habitat) by keeping it a *positive value* (e.g., factor ranked as 2 becomes +2), or a Con (against bee habitat) by making it a *negative value* (e.g., factor ranked as 5 becomes -5).
2. Considering the factors provided in Table 3, describe the three most important arguments in favor of your position on bee habitat creation and provide evidence from your research that supports their importance. Were there any factors that were not listed in Table 3 that you encountered during your research? If yes, list them and explain how they might or might not be important to your stakeholder.

3.2.3. Town Hall Meeting (~*55 minutes*)

During class, each group of students assigned to the same stakeholder role will first have 10–15 minutes to discuss amongst themselves their independent research on their role and come up with the main points they would like to share at the town hall meeting. Then, during the meeting (~45 minutes), the instructor will serve as the moderator/mayor, or the instructor will assign students in the local government representative stakeholder group to serve this role. The moderator

Table 2. Town Hall Stakeholder Roles.

STAKEHOLDER	STANDPOINT	SAMPLE THOUGHTS AND QUESTIONS
Bee scientist/ conservation biologist	Considers native species conservation a priority	*This project will provide important habitat and food sources for native bee species and many other insects. I believe that we need to focus on creating more green spaces for urban animals as increased species diversity is important both for conservation purposes, as well as for the lives of city residents. Native bee pollination services are economically important and can help bolster the productivity of the natural systems that we rely on for our health and well being.*
Beekeeper	Concerned about honey bee colony collapse	*I've been keeping bees in this neighborhood for almost 10 years now. I know the dangers of raising bees in urban areas without habitat for them to forage and stay healthy. I think this project will benefit native bees and the honey bees I am raising, and overall will keep our park spaces healthy and resilient for the future. I understand people have fears regarding bees, but if we provide educational resources and workshops for the community that teach about bee safety ... I think we can solve some of these health concerns and avoid major incidents.*
Parks manager	Concerned with the control and management of other of species, and the maintenance of the park	*As the park manager, I will have to balance my actions making our park safe for residents with keeping it a healthy space for nature. Normally I spray pesticides to control for harmful species like hornets and mosquitos, but if the new habitat is built ... I would have to cut back on spraying so as to not kill any of the native bees we are hoping to promote. Maintaining this new habitat and new flowers will also require more of my time. Does the city have the finances to pay for this or will they be able to hire any additional park staff?*
Concerned parent	Has a child with bee allergy	*I'm worried about the health impacts of creating this habitat for native insects. If the project will increase the number of native bees in to the park, won't this also promote the number of other bees and wasps? Isn't it our children and senior citizens who are most susceptible to stings? My 6-year-old daughter is extremely allergic to bee stings and she loves this park. Am I supposed to tell her she can't play here anymore? I want to know how you can protect all children if this grant goes through.*
Neighborhood resident	Worried about decreased safety and cleanliness of neighborhood	*We spent years cleaning up this neighborhood and we now have a safe park that kids can play in and families can enjoy. It would be nice to have more flowers, but I'm not sure why we would want to promote a potentially harmful species and plant bushes that crowd up the park and give us less space to enjoy. Don't these areas collect trash and provide space for drug use and other activities that are harmful to our neighborhood?*
Local government representative for that neighborhood	Wants to mediate and take into account all opinions (may be assigned to moderate discussion or make final decision based on stakeholder input)	*As an elected representative for this neighborhood, it's my duty to take into account the opinions and needs of all residents. I value both the social and environmental health of our neighborhood, and am ready to weigh all factors involved in this decision. My main concern is making sure everyone gets a chance to speak and that this town hall meeting runs smoothly and democratically.*

*Table 3. Importance of factors concerning native bee habitat creation for my stakeholder role:*_____

FACTOR	SOCIAL	ECOLOGICAL	ECONOMIC
Bees provide pollination			
Bees will require flowers for food			
Bees will require shrubs for overwintering			
Bees will require logs and rock piles to nest			
Bees will require reduced pesticide application			
Some bees can sting if threatened			
May help some native bees that are threatened with extinction			
Honey bees may also benefit from new food sources			

must introduce each group and keep time, making sure all groups have equal time to present and answer questions. Stakeholder groups will each present for five minutes on their concerns and reasons for why or why not they want to accept creating bee habitat in their town, based on their research. Time allowing, the moderator will allow the other stakeholders to ask each group questions for up to five minutes.

For other examples of running town hall meeting scenarios in the classroom, please see NCEP's module, Practicing Stakeholder Analysis Using Current Environmental Issues (ncep.amnh.org).

3.2.4. Post Town Hall Meeting Analysis (~*30 minutes*)

1. Once all stakeholder groups have presented, take 5 minutes to individually re-evaluate your earlier rankings from Table 3 and fill in Table 4: follow the same instructions for Table 3, but take into consideration the discussion during the town hall meeting.
    a. What did you change and why? Write down a brief summary.
2. From Table 4, add up your individual rankings for each category (social, ecological, economic), taking into account the negative sign (i.e., 5 + -3 = 2; -10 + 1 = -9) and record below (note: if column is blank, individual total equals zero for that category).
3. Then reconvene with your stakeholder group and average these individual totals within your stakeholder group (see Table 4).
4. Report the stakeholder group averages from each of the categories (social, ecological, and economic) to the instructor or town hall leaders who will then add up each groups' averages in each category. Record the results (see Table 4).
5. For approximately 10 minutes, discuss and decide amongst yourselves if the community should receive the grant money for the creation of native bee habitat in your local park. Discuss which category (social, ecological, or economic) is most important: a strong positive value means you should take the grant, a strong negative value means you should not take the grant; a weak positive or negative value (i.e., close to zero) means you should discuss it further. Your instructor or the local government representative stakeholder group might act as a moderator for this discussion.

3.2.5. Reflection Assignment (*Homework*)

Following the guidelines of your instructor, respond to the below questions in your own voice:

1. What was the outcome of the town hall meeting? Did the community accept the grant?
2. How were social, ecological, and/or economic issues considered? Did one outweigh the rest?
3. Do you feel each concerned group received equal consideration? Does it matter? Why?
4. Describe two pros and two cons to making decisions considering many stakeholder views.
5. Discuss if you think this example town hall meeting

Table 4. Re-evaluation of importance of factors concerning native bee habitat creation for my stakeholder role:_____

STEP	FACTOR	SOCIAL	ECOLOGICAL	ECONOMIC
1	Bees provide pollination			
	Bees will require flowers for food			
	Bees will require shrubs for overwintering			
	Bees will require logs and rock piles to nest			
	Bees will require reduced pesticide application			
	Some bees can sting if threatened			
	May help some native bees that are threatened with extinction			
	Honey bees may also benefit from new food sources			
2	**Individual Total**			
3	**Your Stakeholder Group Average**			
4	**Class Total**			

matches the process of deciding on a conservation issue for a community.

a. What about the process do you think would be different in the real world?
b. Was this set of six stakeholder groups a realistic representation of a community? Can you think of anyone who might be missing? List them.
c. If factors from your research—other than those in the ranking process—were included in the decision making process, do you think there might have been a different outcome? How so?

6. If you actually lived in this community, would you personally want to accept the grant? Why or why not? What additional information would assist you in making a more informed decision on whether or not to support bee habitat creation?

4. GLOSSARY

1. **Green infrastructure**: a range of design approaches that can increase wildlife habitat, provide flood protection, and improve air and water quality. In an urban setting, green infrastructure often is designed to improve stormwater management. Unlike most urban infrastructure, green infrastructure allows water to infiltrate into the soil, replenish groundwater, and reduce runoff, which in turn reduces the introduction of contaminants and pollution into waterways and processing facilities.
2. **Green roof**: building roofs that are covered in varying amounts of vegetation. Green roofs can be either "intensive"—thick, covered with a variety of vegetation, and requires more maintenance—or "extensive"—shallow infrastructure and soil, which require less maintenance. Green roofs can provide several benefits: reducing stormwater runoff, providing insulation for buildings (reducing energy costs), providing habitat for species, providing open spaces for people, and more.
3. **Green street**: landscaped right-of-ways that include green techniques, such as swales, that can help reduce stormwater runoff. By mimicking the natural water cycle, they allow water to seep into the soil, replenishing groundwater and filtering pollutants. They also provide other benefits, such as green spaces for people.
4. **Native bees**: bees that are indigenous or naturalized to an area.
5. **Stakeholder**: any individual, group, or organization that has a vested interest, or perceives itself to be affected by a project or endeavor and the potential changes it includes.
6. **Conduction**: the transfer of energy between stationary objects, through which heat or electricity is directly transmitted due to a difference in the objects' temperature or electrical potential.
7. **Evapotranspiration**: the sum of water transferred to the atmosphere through evaporation from soil and other surfaces and transpiration from plants.
8. **Stomata** (plural of stoma): openings in a plant's epidermis, usually found on plants' leaves and allow for gas exchange.
9. **Ecological corridor**: an area that connects existing, larger wildlife habitats, parks, ecosystems, etc. to maintain their connectivity and flow of species among them.
10. **Invasive species**: any kind of living organism that is non-native to the region in which it is introduced and via spread of individuals causes damage to the ecosystem, economy, or public health.

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