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Assessing the Supply of Provisioning and Cultural Ecosystem Services From Urban Forests: A Philadelphia Pilot Study

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Introduction

Urban woody species populations are capable of providing a multitude of ecosystem services to human city residents (Shackleton et al. 2016, Hurley et al. 2015). Ecosystem services are the benefits to humans provided by nature, which include four primary categories. Supporting and regulating services tend to focus on ecological functions that directly support flora and fauna or on the ways ecosystems provide clean air, water, and soil to humans and their agricultural systems, while provisioning and cultural services tend to relate to the ways nature provides material benefits related to personal, family, and cultural well-being. For example, a Wicken may harvest berries for food but also other plant parts to use in practicing their Wicken faith (Hurley et al. In review). Likewise, provisioning services are the source of food and fiber that are necessary for human survival and shelter. By contrast, cultural services provide spiritual and recreational benefits to humans. Studies of provisioning ecosystem services document the production of food and issues surrounding food security with a focus on traditional food plants. In this, paper, we focus on are provisioning services, with secondary interest in the way that harvested materials may relate to cultural reproduction. Other studies acknowledging trees and shrubs have focused on the tropics or make recommendations for management without empirical studies Thus far, UPCES research has focused on passive experiences or non-consumptive uses of nature, such as aesthetic enjoyment, and agricultural production at the urban fringe or within diverse garden types within the city.

While UPCES has begun to acknowledge the material benefits provided by urban forests, research on urban foraging in U.S. cities and beyond has clearly documented the myriad ways in which plants in the city are harvested and put to use by city residents. Foraging is the practice of harvesting plant materials, including fungi, lichens, moss, from species not planted by the forager. In addition to food, foragers may be harvesting plants or plant parts for medicine, crafting, or in spiritual observance. Targeted species for foraging are distributed across urban spaces not specifically managed or intended to support natural resource uses or, in other words, Urban Provisioning and Cultural Ecosystem Services (UPCES). That means that foragers could be harvesting from native woodlands, abandoned areas with invasive species, or ornamental areas where species were not specifically planted for foraging purposes. Thus far, foraging research largely has focused on individual cities, has not considered supply side dynamics, and the extent to which foragers activate potential benefits to which foragers activate potential benefits that are the material manifestations of those cultural and provisioning ecosystem services. All three of these concepts were what we planned to explore with our survey.

To address the gap in understanding about the resource benefits of species can spaces outside gardens, we draw on the foraging perspective to investigate useful species found in U.S. urban forests. In doing so, we take a supply-side perspective that considers the species composition of

urban forests in U.S. cities using forest inventories conducted by the U.S. Forest Service (see e.g., Nowak et al. 2007). Next, we draw on survey data of foraging practices for the City of Philadelphia (Hurley et al. In preparation) to consider in a correspondence analysis, comparing those species present in the city's urban forest and their abundance relative to the frequency of harvest from the survey data. Focusing on the plant materials harvested by Philadelphia foragers, we are able to assess the extent to which particular species are targeted and the ways specific plant materials from these plants are used. These analyses allow us to better understand the ways in which particular the benefits of these species as manifestations of UPCES are activated and how the urban forest supports (or not) these uses. These findings have implications not only for the theoretical understandings of UPCES and the relationship of foraging to these services, but also for policymakers seeking to foster sustainability in cities and through urban forests.

Literature Review

Urban Provisioning and Cultural Ecosystem Services

Studies of urban landscapes and the ways their ecosystems contribute provisioning and cultural services to city residents demonstrate that plants, even those grown in developed cities, are capable of providing humans with far more resources than are activated. For example, in a conservation-based study on the concept of a cultural keystone species, researchers explored species that are especially important to the region in which they are found, in terms of their use in food, medicine, crafting, or spiritual observance, even if the species does not make up a large portion of the area's species population, (Garibaldi, 2004). There are even parts of the world in which trees on one's own property are needed for shelter. In a study on valuing tree species in South Africa, researchers explored the necessity of trees surrounding one's own house for survival-based uses such as building in the case of extreme, destructive weather destroying their existing home, (Shackleton et al., 2015).). Studies of UPCES frequently focus on agricultural species and spaces, such as agricultural product from lands surrounding a city or from the diverse types of gardens where city residents grow food through intensive or relatively intensive management. Moreover, attention to non-food related aspects of urban landscapes remains understudied.

Foraging and Consumptive Use

Previous studies in cities around the world have provided vital background on global foraging activities and research approaches, as well as myriad data on different foraging practices. Also impacting people around the world, the harvest of plants used for medicine was studied in Rio de Janeiro, Brazil, (Brown, 2016). A study on urban food foraging, food security, and ecosystem services explores the sustainability of food from urban forests, (Clark et al., 2013). In Poland, a study on changes in green vegetables harvest through time since the 19th century included cultural changes that led to green vegetable harvest change, (Łuczaj, 2010). In modern-day Europe, the same researcher looked into supplying food from wild sources throughout the continent, (Luczaj, 2012). Non-timber foraging of woody species was studied by (Robbins et al., 2008). Plants can be harvested in a variety of landscapes, as studied in urban and suburban areas of eastern Masachussets (Gianotti, 2016), urbanizing parts of South Carolina (Hurley et al. 2015), and in multiple cities within the U.S. (McLain et al. 2013; Hurley et al. In review), such as Baltimore (Jahnige 2001), Seattle (Poe et al.

2013, 2014), Philadelphia (McLain et al. 2013; Hurley et al. 2015), and New York City (McLain et al. 2013; Hurley et al. In review).

Foraging studies demonstrate the diversity of plants harvested, ranging from invasive species to ornamental species, and the ways in which these plants provide key resources for city residents (Poe et al. 2013), create particular meaning for people in cities and suburbs (Poe et al. 2013, Hurley et al. In review), and bring people closer to nature (Poe et al. 2014). Especially within a city, one may feel as though they are completely separate from the natural world, but an urban forest researcher explored relational ecologies of belonging to find that foragers can sustainably use wild plants and survive as a closer part of nature (Poe et al., 2014). In Berlin, a study on human-biodiversity relations explored concepts such as the contributions of native and non-native species within the city's urban forest, (Palliwoda, 2017). To date, however, these studies have largely taken a single-city or case study approach, while also paying less attention to the ways in which a city's urban forest and associated species may or may not support foraging practices.

Methodological Approach

To address the lack of research focus on individual cities, questions about the supply of useful woody plants (forageable species[1]) available in the urban forests, and questions about the extent to which ecosystem services associated with forageable species are activated, this project involved the creation of a survey for distribution to urban foragers living in the United States and Canada, drew on existing data about the species composition and abundance of the Philadelphia urban forest, and extracted survey responses specific to woody species from an 2016-2017 survey of foragers living in the Philadelphia Metropolitan area. spec. the activation of potential plant uses among identified forageable species, we created a survey.

The development of a survey focuses on designing questions intended to gain an understanding of, the plant parts activated and how they are used, the landscape types in which foraging occurs, and the stewardship activities in which foragers partake while foraging. When compared with existing data on the species composition and abundance of urban forests from 14 previously studied cities, this analysis will allow us to explore the actual harvest and uses of foraged plants and plant parts as compared to the potentially harvested plant parts laid out in the previous study. To do so, the survey will ask thorough questions in order to understand the full range of harvesting activities among foragers. Our survey seeks to explore the activation of these potential plant uses. That is, our survey is specifically aimed at exploring which plant parts people in the cities of focus- although any willing US American or Canadian forager is welcome to participate- use, and the purposes for which they are used. The eventual goal of the survey is to compare the potentially foraged plants and plant parts with the activated, or utilized, plant parts as indicated by survey participants.[1]

Using these results, comparison of actual foraging practices with existing forageable species will be possible for Philadelphia, PA, New York City, NY, Chicago, IL, Minneapolis, MN, Washington D.C., Houston, TX, El Paso, TX , Albuquerque, NM, Phoenix, AZ, Casper, WY, Los Angeles, CA, San Francisco, CA, Seattle, WA, and Toronto, Canada. In a study, (Hurley et al., *In preparation.*) searched through foraging field guides focused on the specific cities as well as the surrounding

[1] A species that was identified in a foraging guide, that has an edibility rating of 3 or greater on a 5-pont scale, or that was indicated as harvested in a previous study.

regions and compiled data on the forageable plants and plant parts within the cities. The creation of this survey is a work in progress, with ongoing input from collaborating scholars currently under way. Given that this survey is a new rendition of a survey on foraging practices for the city of Philadelphia, working off an existing survey was helpful as it allowed us to save some time as the survey did not need to be created from scratch. However, key lessons were learned as part of the Philadelphia survey experience. For example, after being circulated for nearly a year, it turned out that less than half of the 85 respondents that started the survey completed it. Some survey respondents even contacted Dr. Patrick Hurley, who was facilitating the survey, to let him know that the survey was simply too lengthy for them to complete it. One of the biggest struggles in completing the survey within the 8-week Summer Fellows program was that much contemplation was necessary in choosing which questions were most important to be asked and which could be left out. Consulting with Dr. Rebecca McLain, Dr. Marla Emery, and Ms. Rena Lee allowed us to get other very useful opinions, but also slowed down the survey completion process. (Second,) it was also important to choose question formatting that was most efficient and logical for the respondent. This also caused the survey progression to slow down as debating between the best question formatting also required outside input. The survey process will continue beyond the Summer Fellows program period, and we hope to circulate it within the next few months.

Despite issues with completing the national survey and beginning the data collection process for assessing questions of supply and activiation, I was able to draw on the existing data from the Philadelphia survey to develop a process for comparing potentially foraged woody plant species found in the City of Philadelphia and the species documented as actually being harvested by foragers. Moreover, the inclusion of questions on the Philadelphia survey about plant material-uses (the specific parts of plants harvested by foragers and their particular use as food, medicines, craft, or spiritual objects) provided a means to assess the extent of activated plant parts. The specific goal was to create an in-depth analysis of foraging in the city of Philadelphia by comparing the Philadelphia data as collected in the urban forest inventory, a database of potential uses developed by Dr. Hurley associated with these species in the city, and the results from the Philadelphia survey

To begin, we compiled a list of all of the woody species that survey respondents in the Philadelphia study (reported) harvesting. These forged species were then matched up with the species from the Philadelphia inventory. At this point, a discrepancy between the way that some species were listed in the inventory and in the survey was noted. The inventory was specific, listing out several species names for many of the genera. Conversely, in the survey, respondents were able to choose all applicable species from a list of forageable woody species from the region, although these were often general species complexes rather than specific species. For example, in the survey, "Maple" was on the list of species that respondents could choose from, but in the Philadelphia inventory, the *Acer* genus was broken down into Sugar Maple, Silver Maple, and Red Maple. To address this discrepancy, we looked more closely at the specific species in the inventory. Since the inventory includes information about each species such as whether or not the species is found in regional foraging guides and its edibility quality rating, we were able to assess the likelihood that a forager harvesting maple was harvesting from a red maple, silver maple, or sugar maple. Since all three of these species were found in local foraging guides and also had an edibility rating of three or greater on a five point scale, any of these maple species could have been foraged by a maple-harvesting survey respondent. As this was the case, all three types of maple recorded in the inventory were placed into a general *Acer*, or Maple, category for further analysis. This grouping was analyzed as a species complex rather than by each individual species in moving forward. With species such as the Black Walnut (*Juglans nigra*, however, survey respondents could specifically select, and therefore

report harvesting, black walnut specifically. Since Black Walnut was a species on the inventory and therefore there was an exact match, that walnut species "complex" was just made up of one species on which there was concrete data that a forager harvested that exact species.

Next, the number of Philadelphia survey respondents that foraged for each woody species corresponding to the Philadelphia inventory were recorded. Although less than half of the 85 respondents that started the survey completed it, the answers reported by each respondent was reported no matter how far they made it in the survey. This meant carefully searching through each contributor's responses. Respondents could choose from a list of species and select those that they harvested, but also input independent responses on species they harvest. In reading through each response, we were careful to differentiate between possibly confused species, such as the raspberry, black raspberry, blackberry as well as the black locust and black walnut. This ensured that we were analyzing the correct quantitative data.

Third, after tallying the foraged woody species as reported in the survey and grouping them into species complexes, we also went through data on one-on-one, in-depth interviews that took place following the circulation of the Philadelphia survey. We compiled a list of woody species harvested by interviewees that corresponded to species in the Philadelphia inventory. This allowed us to separate species that were indicated as foraged by either a survey respondent or an interviewee- or both- and those that were not harvested by a contributor to any part of the study. The latter group, those species that no interviewee or survey respondent harvested from, were not needed in moving on with data analysis as they could not provide insight into known woody species foraging activities in Philadelphia.

Fourth, we incorporated existing data from the Philadelphia inventory into the reconstructed analysis. The Philadelphia inventory looked at a small fragment of the total urban forested area in the city, and collected data on the percentage makeup of the total studied urban forests area for which each tree accounted. With this data inputted, we were able to add up each species percentage makeup of the studied area to get an overall percentage corresponding to the percentage of the city's urban forest population that each individual tree (of those species foraged in this study) corresponded to.

Finally, we matched up data on the ways in which each plant part- of species in question- was used by survey respondents that harvested it. Using Microsoft Word, we created another table in which we recorded the frequency with which Philadelphia foragers used each plant part, such as the fruit, the leaf, or the bark, and whether these parts were used dietarily, medicinally, for utilitarian purposes, or spiritually.

Results

Species Supply: Correspondence and Abundance of Likely Harvested Species

Drawing on the survey data for foraging practices in Philadelphia, the data from the Philadelphia foraging inventory (Nowak et al. 2007), and a database of useful species (see Hurley & Emery *In review*), we found that 37 species make up 46.8% of tree species in the Philadelphia inventory which are likely to be harvested by foragers (Table 1). Additionally, we found that 46.3% of all individual

trees found within the Philadelphia tree population are "likely harvested". A species is considered likely harvested if it is a species found in the Philadelphia inventory that appears to match survey responses. This means that nearly half of the population of urban trees in the city is considered likely harvested in both the calculation of tree species and of individual trees. Further, 34 survey respondents indicated harvesting mulberry, a species complex that makes up 3.5% of trees in the city (Table 1). At 27 respondents indicating Black Walnut, the frequency is rather close to that of mulberry, yet the population size is about 1/3 that of Mulberry (1.1%), the highest abundance of any individual species documented here. In further comparison, cherry, with the highest abundance of any identified likely harvested species in the city (11.3%), is only foraged by 16 individuals, roughly half the harvesting frequency of Mulberry (*Morus alba*) and Black Walnut, despite its high abundance. The species with the lowest abundance is Spicebush, which is marked as 0.0% of the population. This does not mean that the species is completely absent in the city, but rather that, of the segments of Philadelphia studied, spicebush made up less than 0.1% of the urban tree population.

A standout result from our correspondence analysis is the fact that berry-producing woody species, or brambles, are harvested more frequently than other inventoried woody species. Brambles are not included in the Philadelphia inventory of woody species, nor are they in most inventories of this kind. Their absence is quite notable, however, as the top three bramble species that were included in the survey were indicated as harvested by 40 or more foragers (Table 2), more than the mulberry (34) which is the species with the most foragers indicating their harvest. For this reason, the absence of brambles is rather noticeable (Table 1, Table 2). Other species included in this study that presented issues were the Blueberry (*Vaccinium spp.)* and the Gngko (*Gingko biloba*). Although included in the table under "Not documented in the Philadelphia Urban Forest", Blueberry is not technically a bramble. With its frequency of harvest tied for second with the black walnut at 27 indications, though, it was important to add, albeit with this caveat. As for the Gingko tree, a species that survey respondents indicated harvesting, its low abundance within the studied segment of the Philadelphia urban forest was too low for it to be included in the inventory.

Table 1. Species Harvested by Foragers in the Philadelphia Metropolitan area by order of Frequency of Mention and Correspondence with Philadelphia Urban Forest Inventory (Nowak et al. 2007). Frequency of harvest reported only for responses to the survey of practices. *Denotes species mentioned by participants in interviews. If the species was only mentioned by interviewees and not in the survey, the frequency appears as 1, irrespective of number of respondents in interviews mentioning this species (See text for further discussion).

Species Complex/Species	***Frequency of Harvest***	***Corresp. Per. Pop.***
Documented as present in the Philadelphia Urban Forest		
Morus alba (Mulberry)	34	3.5%
Juglans nigra (Black walnut)	27	1.1%
Malus spp.(Apple/Crabapple) • *M. alba* (Crab apple) • *M. domestica/pumila*[1]	23	7.5%
Prunus spp. (Cherry) • *P. avium* (Sweet) • *P. serotina* (Black) • *P. spp.* (Unspecified)	16	11.3%
Robinia pseudoacacia (Black locust)	11	1.5%
Carya spp. (Hickory) • *C. glabra* (Pignut) • *C. tomentosa* (Mockernut) • *C. cordiformis* (Bitternut) • *C. spp.* (Unspecified)	9	0.9%
Acer spp. (Maple) • *A. rubrum* (Northern red) • *A. saccharinum* (Silver)	9	8.2%

• *A. saccharum* (Sugar)		
Pinus strobus (Eastern white pine)	5	1.1%
Sassafras albidum (Sassafras)	4	1.7%
Quercus spp. (Oak)[2] • *Q. alba* (White) (2) • *Q. palustris* (Pin) • *Q. rubra* (Northern red) • *Q. spp.* (Unspecified)	3	3.1%
Betula spp. (Birch) • *B. alleghaniensis* (Yellow) • *B. lenta* (Black) • *B. pendula* (European white)	1	0.4%
Broussonetia papyrifera (Paper mulberry)	1	0.2%
Cornus spp. (Dogwood)[3]	1	0.2%
Crataegus spp. (Hawthorn, unidentified)	1	0.7%
Fagus grandifolia (American beech)	1	1.4%
Gleditsia triacanthos (Honey Locust)	1*	0.5%
Hamamelis spp. (Witch hazel)	1*	0.2%
Ilex opaca (American holly)	1	0.9%
Lindera benzoin (Spicebush)	1	0%
Liquidambar styraciflua (Sweetgum)	1*	0.5%
Picea spp. (Spruce)	1*	1%

• *P. abies* (Norway spruce) • *P. mariana* (Black spruce) • *P. pungens* (Blue spruce)		
Rhus spp. • *R. typhina* (Staghorn sumac)	1*	0.1%
Tilia Americana (American linden)	1*	0.3%
Not documented in the Philadelphia Urban Forest		
Rubus phoenicolasius (Wineberry)	43	
R. spp. (Blackberry)	41	
R idaeobatus (Raspberry)	40	
Vaccinium spp. (Blueberry)	27	
R. occidentalis (Black raspberry)	21	

[1] Survey respondents indicate making applesauce []. Corresponding possible apple species include M. domestica/pumila

[2] Survey respondents indicated harvesting acorns [N=2]. Corresponding possible oak species include white oak.

[3] Interviewee identified *C. kousa* (Kousa dogwood).

Utilization Extent: Patterns in Plant Material-Uses

In comparing the supply of forageable species and plant parts in Philadelphia to their activation by foragers, several trends were apparent. The primary plant part harvested is the fruit, berry, or nut- the propagule-, with the primary use being for food or in a beverage. However, propagules can be used in making a variety of medicinal products, as well as in crafting as dyes can be made of berries. Similarly, leaves can be used in a vast variety of ways, such as for food or beverage, such as in teas, for medicine, or in crafting for use in basket weaving or other utilities. As seen in Table 2, the Maple species complex, under the genus *Acer*, had at least one respondent indicate harvesting every plant part (whole plant, fruit/berry/nut, seed, leaf, flower/flower blossom, sap, bark, root), and was indicated as harvested in every use category (food/beverage, medicines, craft/utility/spiritual). In fact, sap from a maple tree was indicated as being used in each use category on its own.

Table 2. Species Materials Harvested by Foragers in the Philadelphia Metropolitan Area by order of Frequency of Mention and Correspondence with Philadelphia Urban Forest Inventory (Nowak et al. 2007).

Species Complex/Species	***Food & Beverage***								***Medicines***								***Craft / Utility / Spiritual***							
Documented in the Philadelphia Urban Forest	WP	FN	Se	Lf	Bl	Sp	Bk	Rt	WP	FN	Se	Lf	Bl	Sp	Bk	Rt	WP	FN	Se	Lf	Bl	Sp	Bk	Rt
Morus alba (Mulberry)	1	17	1							1								1						
Juglans nigra (Black walnut)	2	12	1							2	1							4	1					
Malus spp.(Apple/Crabapple) • *M. alba* (Crab apple) • *M. domestica/pumila*[1]		11																						
Prunus spp. (Cherry) • *P. avium* (Sweet) • *P. serotina* (Black) • *P. spp.* (Unspecified)		6													1									
Robinia pseudoacacia (Black locust)											1													
Carya spp. (Hickory) • *C. glabra* (Pignut) • *C. tomentosa* (Mockernut) • *C. cordiformis* (Bitternut) • *C. spp.* (Unspecified)		5		1																				
• *Acer spp.* (Maple)*A. rubrum* (Northern red) • *A. saccharinum* (Silver) • *A. saccharum* (Sugar)		1		1		1			1	1				1			2	2	1	4	1	2	2	1
Pinus strobus (Eastern white pine)	*X*																							
Sassafras albidum (Sassafras)	X																							

Quercus spp. (Oak)[2] • *Q. alba* (White) (2) • *Q. palustris* (Pin) • *Q. rubra* (Northern red) • *Q. spp.* (Unspecified)	*X*																							
Betula spp. (Birch) • *B. alleghaniensis* (Yellow) • *B. lenta* (Black) • *B. pendula* (European white)	*X*																							
Broussonetia papyrifera (Paper mulberry)	*X*																							
Cornus spp. (Dogwood)[3]	*X*																							
Crataegus spp. (Hawthorn, unidentified)	*X*																							
Fagus grandifolia (American beech)	*X*																							
Gleditsia triacanthos (Honey Locust)	*X*																							
Hamamelis spp. (Witch hazel)	*X*																							
Ilex opaca (American holly)	*X*																							
Lindera benzoin (Spicebush)	*X*																							
Liquidambar styraciflua (Sweetgum)	*X*																							
Picea spp. (Spruce) • *P. abies* (Norway spruce) • *P. mariana* (Black spruce) • *P. pungens* (Blue spruce)	*X*																							
Rhus spp. • *R. typhina* (Staghorn sumac)	*X*																							
Tilia americana (American linden)	*X*																							
Not documented in the Philadelphia Urban Forest																								

Rubus phoenicolasius (Wineberry)	1	15		1						1							2	2		2				
R. spp. (Blackberry)	3	14	1	2																				
R idaeobatus (Raspberry)	1	18	1	2	1					1		3								1				
Vaccinium spp. (Blueberry)		8																						
R. occidentalis (Black raspberry)	1	9	1																					

KEY: WP: Whole Plant; FN: Fruit, Berry, Nut; Se: Seed; Lf: Leaf, Stem, Shoot; Bl: Flower/Blossom; Sp: Sap; Bk: Inner/Outer Bark; Rt. X: no foraging data

[1] Survey respondents indicate making applesauce []. Corresponding possible apple species include M. domestica/pumila

[2] Survey respondents indicated harvesting acorns [N=2]. Corresponding possible oak species include white oak.

[3] Interviewee identified *C. kousa* (Kousa dogwood).

Discussion and Conclusions

This study was the first attempt at comparing the foraging practices of Philadelphia foragers with species presence and abundance in the city of Philadelphia. We found that there are 37 likely harvested species within the city, representing 46.3% of all individual trees found within the city. The plant part most frequently used was the propagule, or the fruit, berry, or nut. The propagule was most commonly harvested for use as food or in a beverage. This information may help park managers and urban tree planners to understand the most desirable species for urban residents, while pointing to the many plant materials and uses associated with these species that are not targeted for harvest by foragers.

Still, there are species, such as blueberry and gingko (see above) that are harvested but not in the inventory, so the actual percentage of the urban forest that is forageable is likely much higher. We've found that berry-producing species account for a majority of foraged woody species in Philly even though they are not included in this and other inventories. These fruits, berries, and nuts are used primarily for food. This is important as it sheds light on some important yet missing components of the Philadelphia inventory.

Implications for our Understanding of Urban Provisioning and Cultural Ecosystem Services

The city of Philadelphia, along with many other cities around the world, is filled with multi-functional woody species. Besides helping with climate regulation, serving as habitat or food for the city's wild fauna, these species are also widely useful to humans. Parts of the plants, such as the leaves, bark, seed, or root, can be harvested and used for food, medicine, crafting, or in spiritual observance. These materials, when activated by foragers, may fulfill key provisioning ecosystem services aspect of the study, exploring the tangible benefits provided by the plants. As for cultural ecosystem services, the act of simply being in nature can bring people closer to the Earth and to one another. This can be through taking in the sounds and smells of nature while out on a hike, or through interaction with other people through foraging social meet-up groups.

Implications for Future Research

As with any study, our results left us with several questions for future research. First, we would like to look into other cities, namely those included in the survey but others as well, and analyze whether our findings of 37 likely harvested species, making up 46.3% of all individual trees in Philadelphia, are consistent with statistics in other cities. How much do other cities vary in the services they provide through their species composition? How do rates of harvest associated with these species compare to the Philadelphia findings? For example, do people harvest similar volumes of plant material from trees, shrubs, and brambles? How important are native, ornamental, or ruderal species to foraging practices in different regions of the United States and in Canada?

Second, focusing specifically on the types of materials that are activated relative to species abundance, is the trend of berry- but, more generally, propagule- popularity found in Philadelphia

consistent with trends in other cities? To what extent might these specific materials be harvested in cities at similar rates as these items? Might other materials be harvested in cities at greater rates? What effect does the species compositions versus the social composition of foragers play a role in which materials are most frequently harvested? For example, in cities in which there are larger or a greater number of social meet-up groups, does that impact the provisioning or cultural ecosystem services associated with the activity of foraging?

Third, we would like to look into whether the food-and-beverage-centered plant use is consistent among other cities. How do rates and extents of activation of particular services associated uses compare to the Philadelphia findings? That is, do people in other cities harvest woody species mostly for food or beverage, or if some other use such as medicine, crafting, or spiritual observance is more popular in some cities. What might these insights tell us about the ecological supply of services versus the social demographic dynamics that shape our understandings of UPCES?

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Appendix A. Excerpt from National Woody Species Survey

Ursinus College

Thank you for your willingness to participate in this **research study** about the **foraging** of tree, shrub, and berry-producing bushes (woody species) in **U.S. and Canadian cities**.

By foraging, we mean the **harvesting of plant or fungi materials for food, medicine, and crafting or other utilitarian purposes as well as for use in spiritual or religious observances**. Foraging includes harvesting from wild species as well as from ornamental species that were planted by someone other than the forager.

By answering the questions in this survey, you will help us to better describe the **diversity of species** people harvest, how these materials are **used,** what these **mean to foragers,** and which **locations are important** to the practice in cities and surrounding metropolitan areas.

The completion time for this survey will vary **between 15 and 30 minutes**, depending on how many species you wish to provide information about. You can return over multiple visits to finish your answers. If you are using a mobile device to take this survey, please note that you may need to scroll right or down to see the full set of options.

Your participation in this study is **voluntary**, and by continuing on with the survey, you agree that your responses may be included in the research study and acknowledge that your answers may appear in future publications. **All responses are anonymous and no identifiers of survey participants will be maintained**.

This research is conducted by Dr. Patrick Hurley at Ursinus College. Should you have any questions about this survey or this research study, please contact Dr. Patrick Hurley (phurley@ursinus.edu or 484-762-4323).

If you have any questions about the way this study is being conducted, you may also contact the Ursinus College Institutional Review Board (irb@ursinus.edu).

Ursinus College

What is the name of the city and state/province where you primarily forage (or the name of the closest large city to the areas where you primarily forage)?

Which best describes the location of your primary foraging? Please select all that apply.

- Only within the city identified above.
- Only in the areas outside the city identified above (i.e. suburbs).
- In the city and in the areas outside the city identified above.
- Other (e.g. suburban outskirts).

Ursinus College

Thinking about your foraging activities, of the trees, shrubs, and/or berry-producing bushes (brambles) from which you commonly harvest, which 5 are the most important to you? For these purposes, foraging does not include harvesting from one's own garden or yard, with the exception of individual trees, shrubs, or brambles that were not initially planted for harvest/use but come to be used for this purpose. If you harvest fewer than 5 species, that's not a problem: simply fill in the names of those that you do harvest.

We will ask you separately about other things you forage, such as greens and mushrooms/fungi, later in the survey. But first we'll ask you to tell us more about the practices that characterize your harvesting and use of the 5 species below.

Species 1

Species 2

Species 3

Species 4

Species 5

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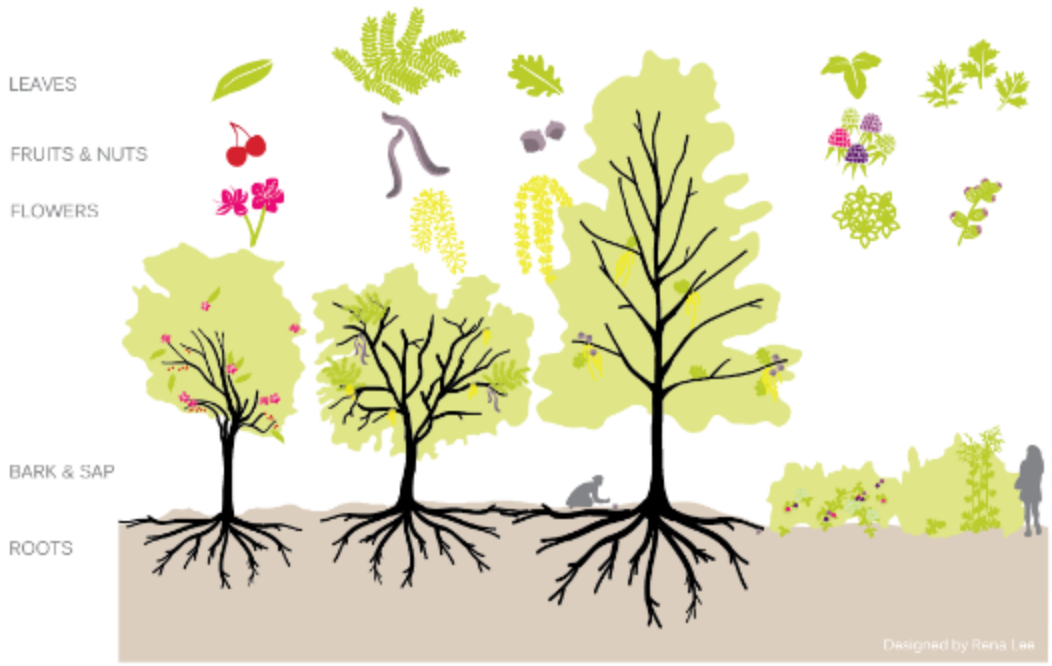
Using the diagram below, which part(s) of Mulberry do you harvest? And how do you use it?



Please be sure to consider all plant parts and use categories.

	Food/Beverage	Medicine	Craft/Utility	Spiritual/Religious
Whole plant	☐	☐	☐	☐
Fruits (Berry) or Nuts	☐	☐	☐	☐
Seeds/Cones	☐	☐	☐	☐
Leaves/Needles/Stem/Shoot	☐	☐	☐	☐
Flower/Flower petals	☐	☐	☐	☐
Sap (Pitch)	☐	☐	☐	☐
Bark (Inner/Outer)	☐	☐	☐	☐
Root /Root bark	☐	☐	☐	☐
Other	☐	☐	☐	☐

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Using the diagram below, please tell us where you harvest Mulberry. Please check all that apply.

Please be sure to consider all location types.

	Location Type(s)							
	Park	My Yard	Other person's yard	Institutional Campus (School, Business, Church)	Street Tree	Roadside	Vacant Lot (not pictured)	Other
Mulberry	☐	☐	☐	☐	☐	☐	☐	☐

If other, please specify.

About how much material do you typically collect from Mulberry on each outing? Please use this graphic as a guide for answering the question below.

Please choose the most appropriate option.

- 1/2 cup
- 1 cup (1/2 pint)
- 2 cups (1 pint)
- 4 cups (1 quart)
- 8 cups (2 quarts or 1/2 gallon)
- 1 gallon (not pictured)
- Other (please specify)

About how many times per year do you forage for Mulberry (in recent years)?

0 5 10 15 20 25

Mulberry

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Of the Mulberry material you collect, which of the following statements best describe who consumes/uses what your harvest?
how much do you typically consume/use yourself, as opposed to sharing, trading, or selling to someone else?

- I use all or most of the material myself.
- I use some myself and share, gift, or trade the rest with others.
- I use some myself and sell the rest to others.
- I use some myself and compost the rest.
- I share, gift, or trade most of the material.
- I sell most of the material.

When harvesting Mulberry, are there any regular stewardship activities you under take? Please select any of the following that apply.

- I limit the amount of material I harvest.
- I minimize negative impacts to the individual plants I harvest.
- I minimize negative impacts to the habitat surrounding the plants I harvest.
- I tend the individual plants that I harvest. [ALT: enhance]
- I tend the habitat surrounding plants I harvest. [ALT: enhance]
- I collect trash/litter from areas surrounding harvested plants.
- I learn from and/or teach other foragers (attend or hold workshops, attend or lead foraging tours).
- I engage with individual plants with reciprocity and/or seek their permission to harvest these beings.
- None of the above.