EDIBLE GREEN INFRASTRUCTURE IN THE UNITED STATES: POLICY AT THE MUNICIPAL LEVEL

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Edible Green Infrastructure in the United States: Policy at the Municipal Level

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Scholarly Abstract

Urbanization can negatively affect the capacity of ecosystems to provide services that support human life. Edible green infrastructure (EGI) can increase cultural and environmental services in urban and peri-urban communities. Instrumental in the use of EGI are local governments, who are in a position to pass supportive policies. For this research, we completed a qualitative study of EGI policy processes in U.S. cities and a mixed-methods study of EGI challenges and opportunities in small towns.

Our first objective was to understand how and why EGI policy develops. We interviewed twelve policy actors from six U.S. cities that have formalized EGI ordinances. Major drivers of EGI policy were: 1) improving public health; 2) securing land tenure; 3) managing vacant lands; 4) accommodating for population growth; and 5) the local food movement. Common policymaking steps included: 1) local communities initiate EGI policy process; 2) city governments respond by working with communities to draft EGI ordinances; 3) abrupt changes to land use policies result in a policy image supportive of EGI as a public land management strategy; and 4) during emergence of the new land use paradigm, incremental changes reinforce this image. We also learned how certain challenges and policy actor recommendations for minimizing obstacles affect the policy process.

Our second objective was to understand EGI adoption in small towns. We surveyed 68 mayors of small towns (<25,000) in Virginia to study local leader perspectives regarding implementation and policy. The greatest perceived barrier to EGI adoption was long-term maintenance, whereas opportunities included civic benefits such as education and community-

building. Most towns had not intentionally used EGI on public land, nor did they have compatible land use codes. Open-ended responses suggest that mayors have different views about the role policy should play in EGI adoption.

We used mayoral perceptions about the constituent support for public green space, the implementation of edible woody perennial species, and available public space for EGI to group towns into unique types. Four groups were identified in a K-means cluster analysis: 1) *Ambivalent and Resource-Poor*; 2) *Optimistic and Capable*; 3) *Doubtful and Unsupported*; and 4) *Unsure with Potential.* One-way ANOVA and Tukey's HSD post-hoc analysis (α=0.05) showed that *Optimistic and Capable* were significantly more likely than *Doubtful and Unsupported* to intend to plant EGI and benefit from government support for edible, woody perennials on public land. EGI may be more practical for towns with greater backing for public green space, more available land, and higher rates of favorable attitudes.

Edible Green Infrastructure in the United States: Policy at the Municipal Level

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General Audience Abstract

The global movement of people from rural to urban and suburban areas has impacted ecosystem health and human well-being. A land management strategy that can improve environmental and public health is edible green infrastructure (EGI), which is small-scale food production in and around built structures. Local governments can pass policies that increase the use of EGI in public spaces. To learn more about how local governments view EGI and the role that policy might play, we completed two studies.

In our first study, we interviewed 12 people from 6 U.S. cities who were involved in the development of EGI policies. The purpose of this study was to learn how and why cities pass EGI policies. Reasons for policy adoption included: 1) improving public health for their residents; 2) ensuring EGI as a permanent rather than temporary land use; 3) finding a better use for vacant properties; 4) setting aside green space for current and future populations; and 5) increasing local and healthy food access. Cities shared the following policy development steps: 1) local community leaders demonstrated that EGI policy was needed; 2) government leaders worked together with residents to draft an EGI ordinance; 3) ordinances were passed that significantly changed how public land could be used; and 4) they passed other, smaller policies to make the use of EGI easier for residents.

In our second study, we surveyed 68 mayors of small towns (< 25,000 people) in Virginia, U.S. The purpose of this study was to learn what local leaders think about the use of EGI in the public spaces and whether EGI policies would be useful. Long-term maintenance was the biggest barrier and the greatest opportunities included education, recreation, social gathering,

and community building. Mayors had differing opinions on whether policies pertaining to EGI on public land were a good idea for their towns, and several pointed out that residents already had access to private land for food production. Using mayors' responses, we grouped towns based on the following characteristics: 1) how much public land could be used for food production; 2) how supportive residents were of existing green space; and 3) how residents thought about the use of EGI on public land. We found that small towns in Virginia could be described as; 1) Ambivalent and Resource-Poor; 2) Optimistic and Capable; 3) Doubtful and Unsupported; or 4) Unsure with Potential. "Optimistic and Capable" towns were more likely to be supported by municipal policies and budgets and to use EGI for managing public land, whereas "Doubtful and Unsupported" towns were least likely to be supported by local government and to use EGI. In summary, EGI may be more practical for towns with greater backing for public green space, more available land, and more favorable views on food production on public land.

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List of Abbreviations

APA	American Planning Association
EFA	Exploratory Factor Analysis
EGI	Edible Green Infrastructure
MoHuB	Modeling Human Behavior
PET	Punctuated Equilibrium Theory
TPB	Theory of Planned Behavior
UFF	Urban Food Forestry

Chapter 1: Introduction

1.1 Background

Edible green infrastructure (EGI) integrates small-scale food production into built environments. Edible forest gardens, rooftop gardens, edible greenways, and community gardens are a few examples. The primary purpose of EGI is to enhance provisioning ecosystem services (e.g., food, fiber, timber, medicine), but many other benefits are possible (Russo et al., 2017). Civic well-being (e.g., recreational, spiritual, and community-building), economic opportunities, and environmental sustainability also are potential outcomes (Russo et al., 2017; Haaland, 2015; McLain et al., 2012; Lovell, 2010). By improving the conditions of local ecosystems, EGI can positively affect public health and wellness (Belmeziti et al., 2018; Haaland et al., 2015; Altieri, 2002).

Policy can play an important role in EGI adoption (Lafontaine-Messier et al., 2016; Haaland et al., 2015). For example, zoning laws and codes help regulate and direct land use, which can lead to ecological change (Orach & Schlüter, 2016; Fernandez et al., 2013; Altieri, 2009). By providing a legal framework for EGI, municipalities can improve the potential for implementation on public lands and define possibilities for optimizing cultural, social, and ecological benefits.

We use Punctuated Equilibrium Theory (PET) as a framework to study EGI policy processes in cities. According to PET, policies change either incrementally or abruptly. Most of the time, policies change incrementally during periods of stability, but abrupt shifts can occur when issues are defined to fit new policy images—how the policy issue is perceived by the public (Baumgartner & Jones, 1993). We draw from behavioral science theory to understand EGI decision-making in small towns. Theory of Planned Behavior and Modeling Human

Behavior constructs inform our analysis of differences among small towns regarding EGI implementation on public land.

1.2 Problem Statement

Urban populations in the U.S. are growing rapidly (Van der Voorn & Popov, 2013), which has increased competition between land uses in built environments (Lovell, 2010). EGI performs multiple ecological and cultural functions and can be an asset for municipalities seeking to manage natural resources for healthy and productive environments (Russo et al., 2017). However, EGI often is omitted from municipal ordinances and rarely considered among city planners and policymakers in the U.S. (Bukowski & Munsell, 2018; Lovell, 2010). Studying how and why municipalities have or have not established EGI policy will improve our understanding of the opportunities and challenges associated with advancing this form of land use in built environments.

Studies of EGI policy in the U.S. have occurred largely in cities because implementation is more common in population-dense regions. Much less is known about EGI and land use policy in lower-density municipalities. The majority of Americans live in cities (Bukowski & Munsell, 2018), but towns and adjacent lands are home to tens of millions of Americans, and ecosystem and community health in these communities are equally important (Forman, 2019). EGI can strengthen ecosystem services and increase local resilience, but towns may be deterred by long-term maintenance, competition with other land uses, and the liability placed on local governments (Haaland et al., 2015; Lovell, 2010). Understanding the opportunities and challenges of EGI adoption in small towns can inform land use management decisions and increase public health and wellness in the thousands of U.S. municipalities with lower population densities.

1.3 Objectives

This research was conducted to understand: 1) EGI policy processes in U.S. cities where EGI policy is formalized; and 2) the opportunities and challenges for EGI policy and applications in small towns (defined as having less than 25,000 residents). Findings contribute to scholarship on urban greening, urban agriculture, urban agroforestry, land use policy, and local policy dynamics. Results can be used to inform practical efforts to develop policies and implement projects that can improve the productivity and sustainability of towns and cities in the U.S. and worldwide.

Research questions were: 1) How do EGI policies develop and what are the primary drivers? and; 2) What are the challenges and opportunities of EGI adoption in small towns? Our hypotheses for the first question were: 1) EGI policy processes are initiated by local communities, and that local government leaders respond rapidly to community concern by making major changes to land use laws and codes; and 2) EGI policy drivers are improving public health, the environment, and economic opportunities for residents. Our hypotheses for the second question were: 1) opportunities for EGI in small towns involve public health, environmental, social, and economic dimensions; and 2) challenges include land use competition and long-term maintenance and liability.

1.4 Organization

Chapter 2 consists of a review of relevant literature pertaining to EGI and land use policy in the U.S., as well as the theoretical basis for research design. Chapter 3 presents EGI policy processes in U.S. cities that have passed EGI ordinances. This qualitative study involved interviews with EGI policy actors from six geographically and culturally diverse U.S. cities. Chapter 4 covers the opportunities and challenges of EGI adoption in small towns. This study

used a combination of quantitative and qualitative techniques to analyze survey responses of mayors in Virginia, U.S. Chapter 5 summarizes important implications of our study and highlights areas for future research.

Chapter 2: Literature Review

2.1 Urbanization, Population Growth, and Ecosystem Services

Urbanization is a leading contributor of habitat decline, biodiversity loss, and deforestation (McDonald et al., 2013; Grimm et al., 2000; McNeill, 2000, Daily, 1995). Moreover, most urban environments, characterized by high population densities and concentration of impervious surfaces, provide little in the way of ecosystem services (Wu, 2014). Ecosystem services are categorized as: 1) provisioning (e.g., food, timber, water, fiber medicine); 2) regulating (e.g., processes influencing climate, disease, air and water quality); 3) cultural (e.g., providing spiritual, recreational, aesthetic, educational value); and 4) supporting (e.g., processes such as nutrient cycling, soil formation, pollination, photosynthesis) (The Millennium Ecosystem Assessment, 2005). As the ecological impacts of human activities intensify, there is a greater need to increase ecosystem services in urban landscapes.

It is predicted that by 2050, the world's population will be over 9 billion (Evans, 1998), around 70% of whom are predicted to live in cities (Van der Voorn & Popov, 2013). In the U.S., more than 80% of the population currently live in urban or peri-urban areas (Bukowski & Munsell, 2018), yet over half the country's produce is grown in California (CDFA, 2018). The ability of California to continue this scale of production likely will be impacted by increased wildfires and droughts related to climate change (Bedsworth et al., 2018); increasing local production could therefore improve the resilience of our national food system. Greater food production in municipalities could decentralize and thereby distribute food production, and if urban agricultural systems are diverse in nature and design, then provisioning of ecosystem services could likewise increase (Buttel, 2006).

The sustainability and capacity of food production in cities is an important research area, but less attention has been paid to this topic in the context of smaller towns. Half the world resides in towns or villages, and the lands within or adjacent to them also provide ecosystem services that benefit non-residents (Forman, 2019). Towns often are at the intersection of intensive land uses like agriculture, forestry, and animal husbandry, impervious surfaces and industrial activities, and 'nature' or conservation lands (Forman, 2019). Thus, the management of these lands has important implications for human well-being and environmental health.

2.2 Edible Green Infrastructure (EGI) and Agroecology

EGI is a land management strategy that can be used to improve ecosystem multifunctionality and Russo et al. (2017) defines it as sustainable food production in built environments with the primary objective being to increase provisioning of ecosystem services. They also categorized forms of EGI (Table 2.1).

Table 2.1. EGI types according to Russo et al. (2017, p. 55).

Types of EGI
1. edible urban forests and edible urban greening
2. edible forest gardens
3. historic gardens and parks and botanic gardens
4. school gardens
5. allotment gardens and community gardens
6. domestic and home gardens
7. edible green roofs and vegetable rain gardens
8. edible green walls and facades

EGI can result from retrofitting or 'agrifitting' urban and peri-urban spaces like rights-of-way and parks to include food production (Lovell, 2010; House, 2009). Existing urban forests also can be agrifitted by planting edible, shade-tolerant understory species. While incorporating

sustainable food production systems into existing grey or green infrastructure is possible on public and private land, Clark & Nicholas (2013) argue that public lands currently provide the best opportunities for EGI.

EGI involves the application of agroecological principles, which strengthen ability of these systems to provide ecosystem services. The definition of agroecology encompasses the entire food system, not just food production, as its metric for sustainability (Francis et al., 2003). By applying modern ecological concepts to food production, there also may be economic benefits. For one, polycultures can reduce the need for and cost of pesticides and herbicides. They also may integrate species that attract beneficial insects and include nitrogen-fixing species that improve the productivity of other plants, leading to higher yields (Lafontaine-Messier et al., 2016).

Agroforestry is the science and practice of intensive land-use systems that seek to optimize biological interactions through the integration of trees, crops, and/or livestock in a way that is socially, economically, and environmentally sustainable (FAO, 2015). These dynamic systems involve the management of species interactions over space and time (Buck, 1986). The application of modern science to study agroforestry began in the last century, but practices have been used by humans for several millennia both in rural and urban areas (Dagar & Tewari, 2017).

Urban food forestry (UFF) is an agroforestry practice that intentionally integrates food-producing trees and shrubs in urban environments to bolster community resilience (Clark & Nicholas, 2013). Examples include edible forest gardens and community food forests. Urban forests typically are not valued for food production in U.S. cities (McLain et al., 2012), but food trees can simultaneously provide nutrients that are absent from many American diets and

enhance important ecosystem services such as providing shade, reducing runoff, and stabilizing soils (Lafontaine-Messier et al., 2016; Clark & Nicholas, 2013). In the last two decades, there has been an increase in urban agroforestry projects both in North America and Europe (Hübner et al., 2018).

2.3 EGI Benefits

EGI can improve the multifunctionality of urban and peri-urban landscapes by performing both ecological and cultural functions (Russo et al., 2017; Lovell, 2010). Cultural benefits include providing greater opportunity for community-building, social gathering, relaxation, and recreation (Belmeziti et al., 2018). Community-building involves any practice or activity that connects individuals or social groups leading to the formation of constructive relationships. This improves the capacity of communities to solve problems collectively (Weil, 1996). The congregation of people in these multifunctional spaces also has the potential to increase food literacy and promote the spread of important local environmental knowledge (McLain et al., 2012). EGI can help preserve cultural heritage through the growth of culturally significant crops (Haaland et al., 2015). The aesthetic improvement resulting from EGI implementation is another cultural benefit (Lovell, 2010).

When stakeholders such as community members, non-profits and community-based organizations, and local governments take part in collaborative planning, EGI can be used as a tool to address social injustices (Bukowski & Munsell, 2018). Urban green space, which improves local air and water quality, is disproportionately distributed in U.S. neighborhoods defined by lower household incomes and predominance of people of color. They typically have limited access to green space, which has negative implications for physical health (Belmeziti et

al., 2018; Haaland et al., 2015). Urban green space also is especially critical for the physical health and psychological development of children (Haaland et al., 2015).

EGI can improve public health not only by increasing green space but also by reducing food insecurity (Zezza & Tasciotti, 2010). The condition of food security is "when all people, at all, times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2008). Food insecure people are likely to become diabetic, obese, and develop cardiovascular disease, reducing life expectancy (Smith, 2012). According to the FAO (2008), urban agriculture has reduced food insecurity both through the food produced by these systems and the income generated from selling produce. Thus, by making public green spaces multifunctional (i.e., food-producing and health-enhancing), EGI can help alleviate multiple public health concerns (Altieri, 2002).

There are potential economic opportunities associated with EGI (Lafontaine-Messier et al., 2016). Poverty may decrease by improving access to healthy produce and creating jobs to maintain these spaces (Russo et al., 2017). EGI also can help supplement incomes and lower grocery bills (Clark & Nicholas, 2013). For example, the Mayor's Office in San Francisco, California paid youth almost double the minimum wage for work after school at St. Mary's Youth Farm, which focuses on environmental education and habitat restoration through food production. The resulting produce was then sold at discounted rates to residents of an adjacent housing project (Ferris et al. 2001).

Another benefit of EGI is that it can improve environmental sustainability by increasing wildlife habitat and enhancing supporting and regulating ecosystem services such as pollination, nutrient cycling, improved microclimate, and air and water purification (McLain et al., 2012;

Lovell, 2010). Also, EGI increases aquifer recharge zones and may be used in comprehensive storm water management plans (McLain et al., 2012). Increasing local, sustainable food production has the potential to decrease a city's carbon footprint, as the production, packaging, and transportation of food to consumers in urban and peri-urban areas involves high fossil fuel expenditures (Russo et al., 2017). In addition, by serving as places of recreation, relaxation, and social gathering, EGI may decrease the need for people 'to escape' from the city and help reduce heavy traffic and fuel consumption (Haaland, 2015).

2.4 EGI Barriers

There are health-related concerns with growing food in urban and suburban spaces. Local governments may be hesitant to plant food trees because of liability concerns related to fallen fruits and nuts in public spaces (Bukowski & Munsell, 2018). Moreover, soil pollutants, found in higher concentrations in former industrial sites, can affect the safety of food production (Hunter et al., 2019). Planting varieties that do not accumulate these toxins or using raised beds are ways to eliminate risk (Lovell, 2010), but apprehension is common given the propensity to reclaim abandoned sites for EGI. Concern also has been raised over the use of pesticides, herbicides, and fertilizers in urban and suburban areas (Russo et al., 2017).

Another common barrier to EGI implementation is competition over limited space in urban environments. Finding sufficient space is a struggle faced by many municipalities (Belmeziti et al., 2018; Haaland et al. 2015). EGI may be in direct competition with other land uses like sports fields and nature parks/trails (Lovell, 2010). A lack of land tenure also threatens the implementation and maintenance of EGI (Horst et al., 2017; Heynen et al., 2006; Konijnendijk & Gauthier, 2006). Urban agricultural activities in the U.S. often are viewed as a 'placeholder' if they are not protected in zoning codes, by land trusts, or through other policy

measures to ensure continued use (Horst et al., 2017; Hou et al. 2009). Moreover, secure land tenure is a necessity for woody perennial-based systems (Raintree, 1986).

EGI policy requires long-term planning, and some municipalities may be hesitant to allow projects without assurance that they will be properly maintained (Haaland et al., 2015). Some food trees require frequent watering, pruning, and fertilizing, which may not be possible for resource-poor cities or towns (Russo et al., 2017). Overcoming this barrier involves the assessment of where EGI can be implemented, what types of EGI are allowed, and how EGI will be managed and harvested. These decision-making processes may demand a considerable investment in time and human capital (Bukowski & Munsell, 2018).

2.5 EGI and Land Use Policy

Policies regulate and incentivize human behavior, thus changing how people interact with surrounding ecosystems (Orach & Schlüter, 2016). Policies also can help specify the best sites for EGI, what types of EGI should be grown, and how projects should be managed. For example, policies can require that EGI is located a minimum distance from roads to prevent pollution of crops from vehicle emissions (Russo et al., 2017). Despite the fact that the American Planning Association (APA) values comprehensive planning for food systems at community and regional levels, the fact of the matter is that edible landscapes are rarely protected through land use codes (Bukowski & Munsell, 2018; Lovell, 2010). EGI policies are needed in the U.S. if population centers are to play an integral role in scaling agroecological food production and realizing associated benefits (Nordahl, 2009).

Several city planning approaches may be compatible with EGI implementation. For example, Smart Growth promotes greater multifunctionality of green space and access to fresh food for residents. Including more fruit and/or nut trees and vegetables and herbs along streets

and other common areas are simple changes that can aid in accomplishing this objective (Lovell, 2010). Also compatible with EGI is New Urbanism, which is a movement and planning approach that formed as a reaction to the widespread adoption of Euclidean zoning after the Progressive Era reforms in the early 20th century (Smith, 2012). Euclidean zoning codes designate only one use to land parcels (Ohm & Sitowski, 2003).

Since the late 1970's, U.S. municipalities of all sizes have developed ordinances based on the tenets of New Urbanism, encouraging form-based codes that promote mixed land uses (Smith, 2012). This planning approach emphasizes the preservation of public green space to encourage multiple uses such as social gathering, recreation, and community-building (Ohm & Sitowski, 2003). If a city's land use codes are Euclidean in nature, zoning EGI as the principal use can prevent competition with other uses (Smith, 2012).

2.6 Conceptual Framework: Punctuated Equilibrium Theory and Behavioral Science Theories

Punctuated Equilibrium Theory (PET) offers a framework for studying EGI policy processes. Adapting theory from evolutionary biology (Prindle, 2012), PET posits that there are several ways in which issues get the attention of policymakers. It is useful for understanding how, when, and why political actors set agendas and make policy (Baumgartner & Jones, 1993). Though typically applied at larger scales such as national and international levels (Rychert & Wilkins, 2018; Walgrave & Varone, 2008), PET also is valuable for study policy-making at the local level (Kwon et al., 2013; Robinson, 2004; Jordan, 2003).

The PET view of the policy process is that political institutions generally operate in a period of stasis, during which policy changes are made incrementally (Baumgartner & Jones, 1993). Incremental changes are negative feedbacks, reinforcing the current policy monopoly—"a set of powerful ideas or images carrying empirical information about the issue and its

solutions" (Orach & Schlüter, 2016, p. 17). Incrementalism also promotes dynamic equilibrium within policy subsystems—stakeholder groups (e.g., government officials, interest groups, researchers) bound to a particular issue and geographic context (Weible, 2005).

Occasionally, disturbances to political stability occur (Baumgartner & Jones, 1993). Exogenous shocks, drivers coming from outside the policy-making arena, are positive feedbacks that initiate large-scale policy shifts (Howlett & Cashore, 2009). A punctuated policy shift can result from several, small shocks or a singular disruption to political stability. In either situation, friction—the resistance of policymakers to change because they cannot attend to all policy issues simultaneously—must be overcome (True et al., 2007).

Issue definition is the driving force behind political stability and instability (Baumgartner & Jones, 1993). When a policy issue is redefined, actors are motivated to change policies so that they coincide with a new policy image (i.e., a new understanding and discourse regarding the issue supported using a combination of emotionl appeals and empirical information) (Baumgartner & Jones, 1993). Though exogenous actors play a key role in initiating change (Howlett & Cashore, 2009), endogenous actors (e.g., elected officials and city staffers) can accelerate the rate at which the shift occurs. After policymakers prioritize an issue that leads to a punctuated shift in policy, they incrementally develop policies and budgets that reinforce stability for that issue (True et al., 2007). These policies are expressions of the dominant policy image (Baumgartner & Jones, 1993).

Behavioral science theories provide constructs for understanding human decision-making processes. The Theory of Planned Behavior (TPB) has been prominent in behavioral science for over three decades. TPB states that an individual's attitudes toward a behavior, subjective norms around that behavior, and perceived behavioral controls influence their intention to perform the

behavior (Ajzen, 1991). Schifter & Ajzen (1990) explain that intention also is influenced by actual behavioral controls— 'realistic constraints' that are outside the control of the individual.

Modeling Human Behavior (MoHuB) (Schlüter et al., 2017) is a synthesis of common elements derived from several decision-making theories (e.g., Rational Choice Theory, Bounded Rationality, Theory of Planned Behavior, Habitual/Reinforcement Learning, Descriptive Norm, and Prospect Theory). MoHuB was designed for social-ecological systems research applications and the framework breaks down the decision-making process into three components: "what comes in (perception), what goes out (behavior), and what happens in between (i.e., rules and representations that lead to the selection and execution of a behavior)" (Schlüter et al., 2017, p. 23). These components are influenced by factors like social and biophysical contexts, and the state of the individual (e.g., his or her needs, assets, and values).

2.7 Summary

Urbanization and human population growth are increasing, which can have negative consequences for ecosystem services. EGI is one land use strategy in areas where humans concentrate that can help feed our growing population while promoting ecological and social health. Despite the benefits of EGI, land use codes in most U.S. municipalities that relate to EGI, in name or concept, either do not exist or are not conducive to implementation. EGI policies are needed to clarify pathways for community use and to mitigate potential barriers. PET and behavioral science theories relate to the EGI policy process through constructs that define key decision-making factors and pivot points.

Chapter 3: Edible Green Infrastructure Policy in U.S. Cities: Drivers, Approaches, and Impacts

Abstract

Today, most of the world's population lives in cities. Urbanization can compromise the ability of ecosystems to provide services essential for human well-being. Edible green infrastructure (EGI) is a strategy for enhancing these services including food production in urban and peri-urban areas. To understand how and why EGI policies develop, we interviewed 12 key policy actors in six U.S. cities that have passed EGI ordinances. The interview process was guided by Grounded Theory (Glaser &Strauss, 1967) and data were analyzed using open and axial coding (Strauss & Cobin, 1990) and Punctuated Equilibrium Theory (Baumgartner and Jones, 1993). Our results indicate that the main drivers of EGI policy are improving public health, securing land tenure, managing vacant lands, accommodating population growth, and the influence of the local food movement. Though policymaking approaches differed among the six cities in this sample, the following are common stages: 1) issues were redefined by local communities; 2) governments collaborated with communities; 3) land use ordinances were passed, signifying an abrupt policy change; and 4) additional policies affecting land use policy and EGI were developed incrementally. This study provides insights into EGI policy processes at the local level, as well as the impacts, challenges, and recommended strategies for policy adoption.

3.1 Introduction

Urbanization is a major cause of global habitat and biodiversity loss, which can negatively affect ecosystem resiliency and services (McDonald et al., 2013; Grimm et al., 2000; McNeill, 2000, Daily, 1995). The Millennium Ecosystem Assessment (2005) categorizes ecosystem services as: "1) provisioning services such as food, water, timber, and fiber; 2) regulating services that affect climate, floods, disease, wastes, and water quality; 3) cultural services that provide recreational, aesthetic, and spiritual benefits; and 4) supporting services such as soil formation, photosynthesis, and nutrient cycling." Ecosystems provide valuable environmental and cultural services, and deliver products upon which humans depend.

In the coming decades, the negative impacts of urbanization on ecosystem health are likely to increase unless preventative measures are taken. Van der Voorn & Popov (2013) predict that the percentage of the of the world's population living in cities will shift from 50% in 2010 to 70% by 2050. In the U.S., more than 80% of the population presently resides in urban areas (Bukowski & Munsell, 2018), and U.S. cities struggle to provide adequate green space for residents, especially for lower-income neighborhoods and communities of color (Haaland et al., 2015). As the number of Americans living in cities grows, strategies to enhance ecosystem services in the built environment are increasingly needed.

Edible green infrastructure (EGI) is a strategy that cities can use to improve ecosystem services. EGI combines urban infrastructure and sustainable food production with the primary objective being to increase provisioning services. This excludes larger scale food production (e.g., commercial farming and animal husbandry) (Russo et al., 2017). Examples of EGI include urban food forestry initiatives, such as community food forests and edible forest gardens, as well as rooftop gardens, edible hedges, and community gardens. Many cities are retrofitting or

‘agrifitting’ existing grey and green infrastructure to include food production, which can help improve multifunctionality in the limited spaces of urban environments (Clark & Nicholas, 2013; Lovell, 2010; House, 2009).

EGI is multifunctional, delivering a number of cultural, economic, and ecological benefits. Aside from promoting cultural functions of education, community-building, social gathering, relaxation, and recreation (Belmeziti et al., 2018), EGI can also provide economic opportunities. For example, cities can provide jobs to maintain these spaces, and residents can supplement their income by selling produce (Russo et al., 2017; Clark & Nicholas, 2013; Ferris et al., 2001). EGI also increases access to green space and healthy food, which have positive implications for public health (Clark & Nicholas, 2013; Smith, 2012; FAO, 2008; Altieri, 2002).

By providing regulating and supporting ecosystem services, EGI can improve the health of humans and ecosystems more broadly (Belmeziti et al., 2018). For example, EGI can benefit nutrient cycling, improve microclimates (reducing urban heat island effect), and increase air and water quality (McLain et al., 2012; Lovell, 2010). It can also increase biodiversity both directly through use of polycultures and indirectly by providing habitat for pollinators and wildlife. EGI can increase aquifer recharge zones and reduce stormwater runoff (McLain et al., 2012). Not only does EGI have the potential to improve local urban ecosystems, it also can provide important global benefits. For example, growing food in cities can reduce greenhouse gas emissions associated with the production and transportation of food (Russo et al., 2017). Moreover, providing spaces for recreation and social gathering in city centers, EGI can decrease vehicle emissions by reducing the need for people ‘to escape’ from the city (Haaland, 2015).

Despite the potential benefits of EGI, there are several barriers to adoption. Cities may be concerned with the liability and safety of growing food in potentially contaminated

environments, the use of pesticides, herbicides, and fertilizers, and the hazards of fallen fruits and nuts (Bukowski & Munsell, 2018; Russo et al., 2017; Lovell, 2010). Policies can help alleviate concerns by specifying where and what types of EGI can be grown and practices (e.g., organic) for ensuring safety (Russo et al., 2017). Competition over limited space is another barrier to EGI adoption (Belmeziti et al., 2018; Haaland et al. 2015; Lovell, 2010). Underutilized spaces (e.g., vacant lots) may be suitable sites for EGI (Bukowski & Munsell, 2018), but if there is concern over competition with cultural or environmental uses, stressing EGI multifunctionality may increase adoption.

Another challenge in terms of EGI adoption is a lack of secure land tenure (Horst et al., 2017; Lovell, 2010; Heynen et al., 2006). Activities associated with urban food production typically are seen as 'placeholders' until other more profitable uses are proposed for the site (Horst et al., 2017; Hou et al., 2009). Land tenure is especially important when woody perennials are included in food systems (Raintree, 1986). Thus, perhaps the greatest barrier to EGI implementation is that it requires long-term planning (Haaland et al., 2015). For example, cities may be hesitant to plant edible perennials because of the requirements (e.g., watering, pruning, fertilizing) of certain food-producing trees and shrubs (Russo et al., 2017).

Policies can help cities overcome these barriers and balance the ecological and social benefits of food production (Fernandez et al., 2013; Altieri, 2009). By regulating and incentivizing people's behaviors, policies can alter human interactions with their environments (Orach & Schlüter, 2016). Increasing sustainable urban food production is a priority of organizations such as the APA, yet land use codes that support EGI are lacking in most municipalities (Bukowski & Munsell, 2018; Lovell, 2010). Effective EGI policies are therefore

needed to encourage provisioning of associated social and environmental services (Lafontaine-Messier et al., 2016; Haaland et al. 2015).

EGI is a strategy that cities can use to provide multiple ecosystem services in urban environments, and previous research outlines several potential drivers of EGI policy and associated challenges. Policies can help proliferate EGI in the built environment, and knowledge of the EGI policy process can inform cities interested in adoption. To study the relevance of these factors in EGI policy formation, we used Punctuated Equilibrium Theory (PET) to conceptualize developmental processes in U.S. cities where formal EGI policies exist. PET explains how and why issues get the attention of policymakers (i.e., agenda-setting) at local, national, and international scales, and characterizes processes as either punctuated or incremental (Rychert & Wilkins, 2018; Kwon et al., 2013; Walgrave & Varone, 2008; Robinson, 2004; Jordan, 2003).

PET is adapted from evolutionary biology theory and views policymaking as abrupt policy shifts that occur after long periods of stasis (Prindle, 2012; Baumgartner & Jones, 1993). Political institutions are usually stable, during which policies develop incrementally. These incremental changes are negative feedbacks, which reinforce stability (Baumgartner & Jones, 1993). During periods of stability, there is a dominant policy image—how the issue is widely understood and supported using both empirical information and emotional appeals (Baumgartner & Jones, 1993).

Occasionally, dynamic equilibrium is interrupted by punctuated policy shifts (Baumgartner & Jones, 1993). Shifts are caused by exogenous shocks, drivers coming from outside the current policy subsystem (Howlett & Cashore, 2009). These shocks are positive feedbacks, which amplify the attention given to the issue by policymakers (Baumgartner &

Jones, 1993). For a shift to occur, actors must overcome friction—when policymakers delay significant policy change until adequate attention has been drawn to the issue because they have a limited capacity to respond to all issues simultaneously (Walgrave & Varone, 2008; True et al., 2007). This shift can result from multiple small drivers, or one large driver (True et al., 2007).

During periods of disturbance, issues are defined in a way that creates a new policy image (Baumgartner & Jones, 1993). Although exogenous actors are fundamental for issue redefinition (Howlett & Cashore, 2009), the level of attention that endogenous actors (i.e., elected officials and city staffers) give to that issue can influence how quickly that change will occur. Prioritization by policymakers is reflected in the passing of new policies and budgets (True et al., 2007). During a new policy paradigm, policies are passed incrementally until another abrupt shift occurs (Baumgartner & Jones, 1993).

The purpose of this study was to understand the approaches and drivers of EGI policy in U.S. cities. To do this, we studied the policy process of cities that have passed EGI ordinances. Research questions were: 1) How do EGI policies develop and what are the primary drivers? and; 2) What are the challenges and opportunities of EGI policies? We hypothesized that EGI policy processes in U.S. cities initiate with civic organization and action and that collaboration between exogenous and endogenous actors culminates in a punctuated shift in land use policy. We also hypothesized that drivers of EGI policy would include improving public health, the environment, and economic opportunities for residents.

3.2 Methods

Case Studies

We used the following keywords using the search engine, Google: *edible landscape, community garden, perennial, polyculture, fruit trees, nut trees, rooftop gardens, urban*

agroforestry, food forest, urban agriculture and *policy* or *ordinance* to identify U.S. cities that have passed ordinances that support EGI in public spaces. From this search, we purposively selected six cities (Seattle, Washington; San Francisco, California; Austin, Texas; Baltimore, Maryland; Cleveland, Ohio; and Madison, Wisconsin) to ensure geographic and cultural diversity.

We determined that these cities were sufficiently diverse using 2018 U.S. Census Bureau data. They span several geographic regions, from the West Coast, the South, the Midwest, and the East Coast. The geographic area of cities ranged from around 47 square miles to nearly 300 square miles. Cities also had different racial and ethnic makeups. For example, African-American residents comprised 50% or greater of the population in some cities, while others had only 5%. Also, the percentage of homes speaking a language other than English ranged from 10% to nearly 45%. These cities also varied economically. The median household income ranged from less than $30,000 to over $100,000, and the poverty rate varied from 10% to 34%. Lastly, the population sizes of cities were between 250,000 and 900,000, and the percent change in population from 2010 to 2018 ranged from -3% to over 20% (U.S. Census Bureau, 2018).

We searched city hall minutes and agendas to identify EGI policy actors for each city. From these publicly available secondary data, we contacted key actors involved in developing the ordinances. If actors were not found when searching minutes and agendas, we called or emailed government offices (e.g., planning departments or offices of sustainability) and asked who was involved in the EGI policy process and if we could contact them. In all instances, contact information was provided. We additionally used a "snowball" technique (i.e., a chain-referral, non-probability sampling method) (Babbie, 2007) if interview participants were able to refer us to other relevant EGI policy actors in their cities.

Interview participants fit at least one of the following criteria: 1) they were directly involved in the advocacy or drafting of the ordinance; or 2) they worked with the city on the operationalization (i.e., standardizing protocols) of the ordinance. The first included researching and networking within the community to address public concern, holding public hearings, drafting language for the ordinance, serving as a liaison between city departments like utilities and community members, or approving the ordinance before being sent to city council. The second included creating and implementing strategies for how to enforce or raise awareness of the ordinance, standardizing protocols, serving as a liaison between city departments like utilities and community members, and making suggestions for future policies impacting EGI.

Interview Protocol

Fifteen actors were invited to participate, and 12 accepted. Five participants were identified from city hall minutes or agendas, three participants were referred by government offices, and four were identified using chain-referral. We used semi-structured interviews (after Walgrave & Varone, 2008) and participants ranged from city staffers (e.g., planners, food policy directors), to NGO employees and members of city council-appointed boards. At the start of all interviews, participants were informed of the purpose and scope of the research, as well as their rights. Verbal consent was required to participate in the interview, and data were recorded at the discretion of the participant. The IRB protocol #19-379 was approved by Virginia Tech on May 14, 2019.

Participants were asked a set of open-ended questions (Table 3.1), and interviews lasted between 30 and 45 minutes. The interview process was designed according to Grounded Theory (Glaser & Strauss, 1967), an inductive reasoning method involving the categorizing of qualitative data based on emerging themes. This approach is appropriate when interested in

discovering naturally occurring themes as opposed to asking pointed questions that could influence participant responses.

Table 3.1. Interview topics and open-ended questions pertaining to primary drivers and policymaking approaches for six U.S. cities. Themes emerged using open coding followed by axial coding.

Interview Topics and Questions
1) Policy Drivers
Who, other than yourself, was involved in the policy process, and what role did each of you play?
What were the primary reasons for passing the ordinance?
2) Policymaking Approach
Could you walk me through the timeline of how the ordinance was developed?
Did you look to examples from other cities when you were drafting the ordinance?
3) Impact
Could you describe the impact this policy change has had on your community?
4) Challenges and Strategies to Overcome them
If you knew that another city was trying to draft a policy like yours, are there any strategies you would recommend or pitfalls to avoid?

We formulated interview questions based on PET. Question 1 addressed important actors and policy drivers, and steps leading to the passing of EGI ordinances. Question 2 focused on the mode (i.e., abrupt or incremental) and speed (i.e., rapid or slow) of policy change and the policymaking approach more broadly. Question 3 honed in on whether policy drivers (e.g., improving public health, managing vacant lands) were actual impacts of the ordinances. Question 4 was intended to understand how cities can overcome barriers during the policy process. Responses were obtained by asking these questions over the phone, taking field notes, and recording and transcribing interviews.

Data Analysis

Data were open-coded based on our observations of interview responses. This involved taking participant words and assigning labels based on a concept that they represent (Glaser & Strauss, 1967). After open coding all interviews, we used axial coding (Strauss & Corbin, 1990), which is the process of finding relationships between open codes and categorizing them based on similarities. We used axial coding to aggregate open codes into overarching themes related to EGI policy drivers, approaches, impacts, challenges, and strategies. We analyzed these data using PET concepts to characterize the EGI policy process. For example, we considered the role of exogenous actors in issue definition (e.g., framing EGI as a strategy to improve public health) and studied whether working within the government structure to overcome friction resulted in a punctuated shift in land use policy.

3.3 Results

Policy Drivers

EGI ordinances were developed because of endogenous and exogenous actors who were motivated by common policy drivers (Table 3.2). Initiatives began with non-profit directors and employees, university professors and students, and community members that farmed or gardened and sought to implement and/or protect various forms of EGI in their communities. These exogenous actors spurred the government to act since, in the words of one participant, “we [city government] usually don’t come up with things to do.”

Table 3.2. Major EGI policy drivers, impacts, strategies, and challenges in six U.S. cities: Seattle, San Francisco, Austin, Baltimore, Cleveland, and Madison.

Drivers	Strategies
Improving Public Health Improving Land Tenure Managing Vacant Lands Planning for Population Growth The Local Food Movement	Dedicate Time to Research Create Staff Positions Streamline Protocols Work with the Public
Impact	**Challenges**
Educational Opportunities Secure Land Tenure Community-Building Environmental Benefits	Bureaucratic Slowness Raising Awareness of the Policy Achieving Desired Impacts

The endogenous actors (i.e., coming from within city government) responded to concerns from communities facing barriers to implementing EGI or protecting extant EGI in the city. Elected officials prioritized EGI ordinances within their political agendas because exogenous actors effectively demonstrated that this mattered to constituents. The attention of local policymakers was shifted, signifying the overcoming of friction. Participants agreed that acquiring the support of mayors and councilmembers early on also increases the speed at which shifts occur.

Together with elected officials, city employees can play a critical role in the development of EGI policies. For example, one city planner was caught in a dispute between a councilmember and the mayor, where one was in favor of changing the land use code while the other opposed. The city planner, who worked in a department under the mayor's administration, chose to continue drafting the legislation because it was important to her and residents of the city. She was fully supported by the councilmember and his staff, and this support grew within city government until the ordinance was passed. The importance of city staffers who care personally

about these polices was a key factor, especially in the midst of feuding political agendas between elected officials.

Improving public health was a primary driver of EGI policy development. In response to evidence that local food production can improve nutrition and food security, cities passed ordinances hoping to increase access to healthy food. For example, one mayor issued a directive on food security, and EGI was a specified strategy to take action. In this instance, the mayor and councilmembers worked closely with city departments to update the land use code to include EGI.

Tied to the desire to improve public health was the influence of the local food movement in the U.S. One participant reflected that at the time the ordinance was passed, "the local food movement was…beginning to gain broader acceptance…there was a greater awareness about local food as a strategy to improve health and wellness and community health and wellness." Another participant described how local food access was important to residents in her city, demonstrated by results from a parks and recreation "community survey [that] had a very high number of respondents who prioritized community gardens." Some participants observed that there might have been a correlation between increasing public interest in local food access and the Great Recession (2007-2009). One explained, "They don't get into how to grow food until a recession hits. But 10 years into the expansion and they forget it. When a recession hits again, there will be a renewed interest." Another aspect of local food movement, a driver of EGI policy in U.S. cities, was the perception that eating locally improves the sustainability of one's lifestyle.

Part of the changing culture regarding sustainability is demonstrated by the fact that cities are planning for current and future population growth, which also is influencing the development of EGI policy: "What we do know as a city is that the world population is increasing, and what

we want to do as a city is prepare areas to be repopulated, so maybe every single parcel won't become a housing development site," remarked one participant from a city that had lost population in recent decades. Other cities are already experiencing population growth but recognize the need to do it sustainably: "Now the council prioritizes sustainability because of our huge growth," explained another. Regardless of current population trends, cities are taking action to protect EGI both for current and future residents.

Another driver of policy creation was the need to improve land tenure to protect EGI. In some cases, communities already stewarded EGI but were unsure if they would be allowed to continue: "The primary reason for adopting the policy was to provide land security for community leaders who have been caring for land in their neighborhood for a long time…and to secure those spaces for the community." Without the policy, there would be "no security at all. And people come to think of the land as their communities, and they put so much effort and love into it, but from the city's point of view, it's not theirs at all," explained one participant.

Lastly, vacant land management was cited as a primary driver. In two cities, decreasing population led to excess vacant lots, which were visually unappealing, decreased real estate values, and even attracted criminal activity. Participants explained that cities typically form land banks to maintain these properties until a promising investment is proposed, but land banks do not guarantee the protection of the land for EGI or other open-space uses. Creating use districts and developing land trusts are two solutions presented by participants that prevent properties from being sold and allow the land to continue to be stewarded by communities. Participants also explained that if a city were to sell the land to communities who were already caring for it, this would be ethically questionable and attract negative press, so land trusts and/or zoning solutions provide an attractive opportunity for both city governments and community members. These

cities chose to invest in land in a different way—by protecting community spaces in neighborhoods for EGI.

While the combination of primary policy drivers was unique for each city, all cities chose to pass ordinances because, unlike resolutions, they have the force of law: "There are different legislative processes we can use, and by in large, we pass mostly resolutions. They're good to have in that they have some oomph behind them, but they're not law…But if we want to do something and actually have that be law, then we establish an ordinance." Ordinances require a higher level of policy adherence, which is why they are critical for cities hoping to encourage more sustainable human interactions in the built environment. Moreover, these policies can streamline the process for people wanting to use, develop, and steward EGI.

Policy Approaches

The cities in this sample took different EGI policymaking approaches but shared some common steps (Figure 3.1). The following were approaches used by the cities in our sample: 1) passing ordinances to transfer open-space parcels to a land trust; 2) changing land use codes to incorporate multiple uses including EGI; 3) changing land use codes to create use districts for EGI; or 4) developing city-supported programs for EGI plantings on public lands. Each approach comes with distinct advantages and disadvantages.

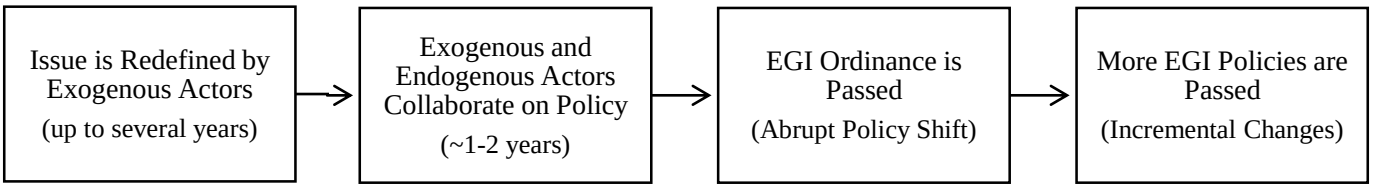

Figure 3.1. EGI policy process in six U.S. cities: Seattle, San Francisco, Austin, Baltimore, Cleveland, and Madison.

Zoning for EGI improves land tenure because zoning variances are required to change the designation. One participant explained, “Zoning changes in most cities across the country, most cities if not all, require more of a public process than a simple council action…it requires notices being mailed to adjacent and nearby property owners…and a public hearing before the city planning commission and city council.” The fact that a zoning variance entails more than a “simple vote of council that wouldn’t have notices sent to neighbors and wouldn’t have as many processes involved” protects EGI as a long-term use of the site.

For the cities in our study, zoning changes took two main forms. One way was to add EGI as a use category for most or all existing zoning districts in the city. This does not strictly prevent other uses, but it makes growing food a possibility almost everywhere. Another strategy was to create a use district specifically for EGI, which prevented other uses in parcels that were zoned in that district. While certain structures such as sheds, tables, and benches were allowed, all other forms of development were banned. While use districts secure land tenure for EGI, they might also limit opportunities if a food forest, garden, or orchard is no longer being used. One participant believed that “a vacant community garden is as bad as any other vacant lot. And if the neighborhood really moves on, we have to be able to move on, so I didn’t think the zoning solution [is] good for that.”

An alternative policy model was to pass an ordinance developing a process for transferring city land to land trusts. If a city had a land bank beforehand, the purpose was “to try to find developers to build housing or other things…but the idea was that the city was a more responsible steward of this land and to find developers who had the best interest of the community than a spectator might.” Because EGI “had become well-established and been there for years and really had become neighborhood assets in many people’s minds, then there was this

issue that the city can always [develop the land] at the drop of a hat," so a more permanent solution had to be found. The role of urban land trusts that preserve green space includes preventing development of other uses and providing technical expertise for management of their sites. They may also provide liability coverage for those working the land. Land trusts protect EGI, along with the community's interest and vision for the site.

The last EGI policy model we observed in our study was developing city-supported programs to plant edible perennial species on public land. An example is to allow fruit and nut trees to be planted on city land through a permit process, involving a partnership with city departments (e.g., parks, engineering, water, stormwater) who provide technical expertise and guidance. An application process "takes the guess work out of it on public land," so that the city can "make sure you have a planting plan, a harvest plan, something like a maintenance plan, and they can go about their lives doing it." For example, ensuring that edible products are not grown on a location that was once a landfill is necessary to protect the health and well-being of those growing and consuming them. An approval process to use city land for EGI also guarantees communication with the relevant departments in city government. Without this communication, the land owned by parks and recreation or engineering departments may accidentally cut or mow down saplings.

Before drafting ordinances, the cities assessed the social, political, and environmental factors that were most important to the city to increase the likelihood of acceptance by the community. For example, one participant mentioned that making EGI a permissible use within an existing district would have created pushback from one of the city's strongest lobbies. The person who wrote the ordinance had the forethought to make EGI a permissible use in all zoning

districts except that one. Consideration for the specific socio-environmental context was a key aspect of the policymaking approach for each city.

Another common theme was that each city researched other cities—typically those with similar demographics—as potential examples to follow. In the words of one participant, "We can always try to look at other places when we do these things because why recreate the wheel?" Some cities found that understanding policy models used by other cities, especially those similar to their own, bolstered the argument for better codes that included more protections of EGI. By producing white papers (i.e., research reports), they had better-informed policy suggestions for their cities. However, most participants believed there were no exemplary cities after which to model their policies. One described her city as being "on the front edge" and that they were unable to find another city that had done what they had planned. The belief that they were early in the nationwide movement was a sentiment echoed throughout the interviews.

While the level of community involvement in the policymaking process differed for each city, interest was always initiated by individuals or organizations outside the city government. Policy initiatives usually began with a community group making a list of asks—things they hoped to see the city address. In one city, the initiative began with two concerned citizens who wanted to EGI to be a permitted use. They worked directly with city staffers in the planning department, and other entities such as utilities and water boards to shape the ordinance. Other cities responded to the community-driven interest by having public hearings and aggregating community responses. The way in which the exogenous actors (e.g., community leaders, NGOs) defined the issue of EGI and land use policy were then used to inform ordinance language.

A collaboration between city staffers (endogenous actors) and the communities was another shared approach. One participant remarked, "They helped us understand the policy

process and how to frame things, and helped to sponsor a lot of the things we submitted." Another described how city planners worked directly with neighborhoods who wanted extra protection for their activities to decide if they should change zoning. If, for example, the space in question was located in an area with a strong real estate market, being zoned within the EGI district would ensure greater protection for continued use. Deciding which parcels were under the greatest threat to competing interests involved cooperation between city planners and community members.

Many of the cities formed stakeholder groups, boards, or committees dedicated to tackling sustainable food systems and policy. Members of these groups were typically diverse, comprising concerned citizens, non-profit workers, researchers, mayor's offices, city planners, and other city employees, each bringing different and necessary expertise to the table: "[The board members] provide technical expertise and work because the city council can't be an expert on everything," one participant commented. Some of these boards have drafted multiple ordinances tackling food systems issues in their respective cities over the last decade. The interviews revealed that volunteer-based boards require dedicated individuals willing to sacrifice their personal time, so the use of government funds for staff positions dedicated to this may be a more reliable approach in the long-term.

Collaborations within city government were vital in both speeding up the process of passing EGI ordinances, as well as creating fewer potential issues with EGI implementation. One city formed a working group that met frequently and worked to keep several people, "including the comptroller, the Mayor, and the Council President," engaged in the process. The participant explained that there was "a pretty important meeting between [their] parks department, watershed protection, and real estate, and kind of bringing together these kinds of city

departments that had never really gathered to talk about food production on city land." The working group also identified available public lands and how they could be used.

Working closely with councilmembers and their staffers has several advantages. Firstly, many of the participants mentioned that having a councilmember sponsor the ordinance was required for their city. Even if it were not required, it is helpful to have councilmembers as early proponents because of their political experience and networks. One participant described how a councilmember and his staffer helped her to understand the local policy process, as well as how to frame the ordinance following the legislative norms of that city. In another instance, a councilmember not only sponsored several of the submitted documents needing approval by various departments but also championed for a paid position at city hall for an NGO executive who was drafting the ordinance. As a result, she developed a policy that was consistent with the city's vision for land use policy and that did not conflict with existing policies or procedures. It was also to the city's advantage to partner with a non-profit to manage EGI.

Other key partnerships formed outside the scope of the city, although these were not described in as much detail by interview participants. Examples included working with state or federal employees who shared important horticultural and/or forestry knowledge. In one city, an expert from a state department was invited to work with a city planner to develop a policy informed by best practices. Participants suggested that other cities in the process of developing policies to promote EGI should consider available state and federal resources.

Regardless of the kinds of partnerships that formed to pass EGI ordinances, a shared approach was to work within the existing structure of the government: "The way that our policy works is that we're not using some policy that's foreign to the infrastructure of the city. We're using the policy that was created with them, and therefore follows some of their normal

protocol." Another described the policymaking process as working "within the government structure to make sure this is paid attention to and some resources go towards it."

The interviews also demonstrated the importance of community engagement throughout the policy process. Some cities chose to have smaller, more informal gatherings within neighborhoods, while others had larger public hearings as ordinances were being introduced to the planning commissions and other relevant boards or departments. Participants agreed that giving the public opportunities to voice their input was necessary so that concerns could be addressed before passing the ordinance: "If you want to create a policy, you need to consider the community's input…as policymakers, you can't just do things in a vacuum," stressed one participant.

Aside from decreasing possible contention, understanding the perspectives of the people whose lives are being impacted by these ordinances results in better policy—no government has the answer to all their constituents' problems. One participant remarked, "City government, by its nature, takes a top-down view, and that's not how life is necessarily." Working with the community on issues that impact land use and growing food can become quite personal. It was shared by a participant that "[she] was just unbelievably surprised at how personal food was for everybody, if we're talking about growing things, and so it was a different kind of policy conversation that happened." Cities seeking to develop policy related to food production will likely evoke strong emotions from community members, but participants suggested that creating opportunities to better understand their needs and concerns will lead to better policy outcomes.

Most EGI ordinances were developed and passed between one and two years, although some had slightly shorter or longer timelines. All EGI ordinances in this study were passed between 2007 and 2013. One participant described, "It was not a protracted process. It took

longer to identify where these particular parcels should be rezoned, and generally it tended to be where there was some threat of development of something other than [green space for food production].” Another participant believed that one of the delays in getting the ordinance passed was, perhaps ironically, the formation of a food policy board. A community group had already begun the process, but they wanted to use the board—experts appointed by city council—because they believed they would have a greater chance at getting the ordinance passed. Ordinances that were passed quickly within the legislative timeline still involved several meetings with city agencies and stakeholders, hearings, council action, and the mayor’s signature.

Regardless of the speed at which EGI ordinances were passed, they marked the beginning of a new land use policy paradigm supporting EGI in these cities. Since passing these ordinances, many of the cities have passed policies incrementally to reinforce the policy image that is supportive of food production in public spaces. For example, some cities developed fiscal policies such as levies to support EGI initiatives directly or tax breaks to people using the land for agricultural purposes. Others passed ordinances allowing for other urban food production, such as animal husbandry and beekeeping, or they modified land use codes to change EGI from accessory to principal uses. One participant described how an important offshoot of a land use code change was the creation of a city-supported program dedicated to the creation of urban orchards in city parks. Several cities have since partnered with non-profits to plant, maintain, and harvest edible perennials, and others have created grant programs dedicated to supporting these initiatives.

No policy is all-encompassing, and regardless of how many resources a city puts into developing policies, realizations will occur after-the-fact. One participant noted, “You’re going

to realize that when you were developing the process, there was some little piece you forgot"; another stated, "There will always be a department that does some piece of the work, that the people you're working with wouldn't have thought about." Several other similar statements were made during the interviews. Even if every possible issue could be addressed in a policy, the needs of cities also evolve over time, which is why policies must change to address them: "The biggest advice that I would give is to make sure that everyone understands that it's a living document that's going to grow and change as your city grows and changes."

Impact

While potential educational opportunities were likely known by policymakers beforehand, these were some of the greatest impacts observed by the cities (Table 3.2). Participants discussed that these spaces have helped communities to develop a stronger sense of pride because they promote self-sufficiency. The interviews also revealed that raising awareness about food and health consciousness through the policymaking process has led to the creation of other policies. One participant described these spaces as "endless laborator[ies] of wonderful things."

The primary driver of improving land tenure to support long-lasting edible landscapes was one of the greatest observed impacts. One participant explained that land that would "otherwise probably be sitting there as just kind of neighborhood nuisances that are now neighborhood assets that not only produce food but...more importantly, or just as importantly, neighbors are coming together to maintain and assist in a project to maintain and operate these [spaces]." Another described that residents in her city now have "an environment where you have more land security knowing that you can continue to do this work." One participant

explained that, as a result of the ordinance, "[The city] simply [has] more land preserved for neighborhoods that they know they can count on."

One of the most important benefits of EGI in urban environments has been increased community-building activities. Adding "security for people who want to invest their time and their energy and participate in that activity" has led to "more community connection...a lot of interaction and cooperation, and people working together." One participant explained how communities have grown stronger because they "see things growing and things changing [so] they are more willing to make a closer connection with neighbors or folks who are managing that operation." In a couple cities in this study, these spaces have increased interaction between people of different social groups: "You have people interacting that would never interact normally because of the circle they're around, and they're coming together."

An improved urban environment was an observed impact mentioned by most participants. By preserving land for uses other than housing or business development, cities preserved green spaces that supported local flora and fauna. Among increasing plant diversity and providing wildlife habitat, they turned spaces that may have been underutilized eyesores into beautiful places regularly enjoyed by communities. The ability to connect with nature—even in the middle of a city—is viewed as a fundamental component of wellness.

Challenges

Bureaucratic slowness was seen as the greatest barrier to passing EGI ordinances (Table 3.2). One participant described it as "the time it takes to pass everything through each of the departments it has to go through to get signed off on…it will get caught up in one because it doesn't have priority or it's not in someone's job description that it will fit." Another explained, "There are so many layers it has to go through, community members having time to collect their

responses, aggregate them, and then have it in the form that you want to give it out to councilmembers…it's time consuming." The interviews demonstrated that ways to avoid this might include creating a staff position dedicated only to these issues.

Another time-consuming aspect of bureaucracy relates to how meetings are structured. In some states, open meeting laws mandate that city employees or boards do not reply to public commentary during the meeting. These laws require that nothing beyond what is posted on the agenda is discussed, and agendas have to be posted a pre-specified amount of time before the meetings. Ultimately, the inability to have conversations during meetings can prolong the policymaking process. One participant explained, "You can't take what they're saying and put that on a future agenda item…you don't debate things. You basically make presentations and make decisions at the board meetings, but between the board meetings, there are working groups." These ad hoc working groups are informal, not widely publicized, and there is no limit to how many can occur.

There were also barriers experienced during the implementation of EGI uses permitted by the ordinances. Raising awareness about the policy, not only within the communities but also within the various departments of city government, is another challenge. "I would say that as great as it is to have a policy change on the books or an ordinance change on the books, equally important is to make sure that people know about it," remarked one participant. Developing an outreach plan, involving media communications and visits with neighborhood associations or organizations that are interested in planting in community spaces was a suggested strategy "because they're the ones who are going to be carrying that water for you later, especially if you don't want to be constantly promoting the process."

While EGI ordinances significantly decreased barriers associated with EGI on public land, they have not achieved some of the intended impacts. For example, most participants were unsure whether the ordinance improved food security directly, nor did they feel that they created significant new economic opportunities**.** One participant believed that in her city, the policy did not change whether people could support themselves by growing and selling food but that the produce harvested from these sites was still useful as donations to food banks. Another participant explained that what resulted from the policy passed in her city was "more about community and more about people who are just kind of interested in growing food or the process of it than [about] reclaiming this space." Often, policies were perceived as culturally important but were not being used as tools to reduce inequality: "I don't necessarily know that there's a ton of overarching equity or educational consideration in terms of underserved or folks that maybe can harvest this and lower their monthly grocery bill. I think people really see this as a cool thing rather than a societal tool to use to address issues."

Participants felt that EGI is most prominent in the affluent parts of their cities because the people who live nearby are property owners, and most people who want these spaces for their neighborhoods are not struggling with food insecurity. According to one participant, policies should be developed with target populations in mind: "So if you're going to do this like an equality thing…you're going to get the same results every time. But [you could] do this with an equity lens, and say what we're trying to do is mitigate those gaps and disparities deliberately [rather than opening] the land to whoever who can have access to it'…but people have a hard time with that because they just want everything to be equal." In summary, EGI policies reduced barriers to healthy food access but may not have increased food security to the extent that policy actors had intended.

Suggested Strategies

Participants were asked to make suggestions for other cities interested in developing similar land use ordinances, and common themes emerged (Table 3.2). They agreed that research is a critical component for not only making a good case for why a policy should be passed but also how effective the policy will be afterwards. When researching other cities, it is important to study cities that are comparable in terms of geography and other demographics. A white paper strategy was used in some cities to make the case for policy. Lastly, it is important to research who, specifically, is going to benefit. Without doing so, "We create something that is cool, healthy, and great but always seems to miss our populations." Health impact assessments were suggested as a tool to predict how well policies achieve their intended goals.

The most common recommendation was to have an established staff to draft and review policies, implement programs or handle applications, coordinate anything on-site or provide city resources. In the words of one participant, "you can't hand it off as a second body of work" to staff or departments who are consumed with other priorities. Having government jobs that focus solely on food systems and land use issues is a key asset: "If you don't have anyone who is paid to do that in the public sector, then you definitely don't get as many things to happen…that's our experience for sure," remarked another.

Developing ordinances with streamlined, easy-to-follow protocols was another suggested strategy. For example, if the policy requires approving and tracking permits, participants stressed the importance of "mak[ing] that process as simple as possible." Some community members have felt more scrutinized for their land use activities after the ordinances were passed since they may have been unnoticed before. One participant explained that "it was really a sticky balance between providing protection for making things formal, but also it become more work for them

because of the permitting process." Participants suggested involving the community to find the right balance.

While all of the cities in the sample effectively did this, working with the public throughout the policymaking process was another proposed strategy. "I think that finding more ways for the community to shape what they're doing makes it more powerful. It's important that you have a vested partner in the community," described on participant. Demonstrating that residents are in favor of the policy also increases the likelihood of it being passed: "If you show a policymaker that their constituents actually want this, that makes this much more of a piece of cake." Moreover, by shaping the resulting policies and programs with the community, their needs are more likely to be met.

Since all communities are different, there is no 'one-size fits all' approach for how to develop EGI policies. Participants suggested building a partnership with the community rather than telling them what to do: "[When] developing policies…you really have to engage the public and stakeholders. A lot of times I think there are things that a small group are interested in, [and] they want to be able to garner resources to move their agenda forward, but it may only serve a very small population of people…[The] smart thing to do is to make sure that as a policy is being shaped, there is evidence that there can be a benefit for everyone."

3.4 Discussion

Interview data largely supported our hypothesis that EGI policy processes in U.S. cities begins with civic organization and action and that collaboration between exogenous and endogenous actors culminates in a punctuated shift in land use policy. In each city, community leaders (e.g., NGO employees, neighbors, gardeners, farmers, professors, students, or other concerned citizens) brought EGI to the attention of their governments and collaborated to find

policy solutions. Our results also demonstrate that key actors within policy venues drive policy change (Walgrave & Varone, 2008), as there were government employees (e.g., urban planners, other city staffers, or elected officials) in each city committed to adapting the city's policies in response to the needs of constituents. Thus, EGI policies resulted from the collaboration of endogenous and exogenous actors.

Collaboration between local governments and communities involved the knowledge and expertise of NGOs and local governments, supporting Russo et al. (2017)'s assertion that diverse experts are needed to implement and promote EGI in the built environment. According to participants, involving communities in the policy process is an essential part of good policymaking, as this builds social capital, "trust, networks, and norms of reciprocity that enable people to effectively work together," (Butterfoss & Kegler, 2018, p. 314). Some cities used food policy councils/boards to improve collaborative efforts, which also is strategy promoted by the APA (2007) to develop policy, programming, and partnerships to improve the resilience of cities.

All six cities had punctuated policy shifts in land use policy. Before policies were passed, either cities prohibited EGI as uses on public land or they were not protected as a permanent land use. Because of subsequently passed ordinances, EGI became a strategy used by cities for improving community health and wellness, which created a new policy image. Participants described several motivating factors (policy drivers) for passing EGI ordinances, and a few also indicated that the Great Recession may have served as an additional shock spurring communities to take action. This finding coincides with that of Hübner et al. (2018) showing the rise in urban agroforestry projects in the U.S. circa 2005 to 2015, during which all cities in this study passed EGI ordinances.

Policy drivers were positive feedbacks that disrupted the political stability on land use policy. The passing of EGI ordinances signified an abrupt change, while successive policies (e.g., levies, tax abatements, and other land use code changes that further support EGI) were made incrementally during the new land use paradigm. For these drastic shifts to occur, communities overcame friction. Their definition of the issue—that EGI policies are needed to address problems within the city—resulted in a new policy image (Baumgartner & Jones, 1993). Although dedicated government employees catalyzed the passing of EGI ordinances, the fact that the initial interest and demonstrated need for EGI policies originated within communities outside the municipal government coincides with McNew-Birren's (2015) findings that environmental policy change is initiated by local communities.

While the cities in this study were geographically and culturally diverse, two overarching narratives emerged related to EGI policy development. Two cities experienced significant population decline in the last few decades, resulting in excess vacant properties. Communities began stewarding these neighborhood spaces but needed secure land tenure for guaranteed continued use, requiring a land use policy change. Four cities experienced pressures related to population growth and citizens urged their governments to change land use policies either to allow for or to remove barriers to urban food production on public land. Results are that these cities were able to take community-driven steps toward one strategy for addressing challenges related to urban population growth, climate change, and urban environmental management. They might also increase food security for residents during economic recessions (Clark & Nicholas, 2013). Even if interest in EGI declines within a city, already having policies to handle renewed interest demonstrates a proactive approach to policymaking.

A variety of approaches, from creating zoning districts, adding use categories, developing land trusts, and developing city-sponsored programs to create edible landscapes, were taken. Adding EGI as a permissible use may be less effective than zoning districts in preventing competition with other, perhaps more profitable uses. Secure land tenure is especially critical for communities stewarding woody perennial-based systems (Raintree, 1986), and land trusts emerged as a mechanism to guarantee land tenure for the growth of perennials while allowing for flexible open-space uses.

Requiring a permit to plant on city-owned land could present a barrier for some; however, there are advantages to using this model. Developing a proposal that is approved by knowledgeable city staffers ensures that the site is suitable for food production, that best practices will be used, and that there is a plan for how sites will be maintained. Therefore, this approach may help overcome other potential barriers (e.g., liability of the city for health and safety of public EGI) that we identified in our literature review. Effective NGO-government partnerships might be a solution for other cities looking to adopt EGI policy but who have concerns over long-term maintenance. We suggest that cities looking to pass EGI policies research the specific needs of their communities and other cities with similar demographics before choosing an approach.

Participants observed that some of the greatest impacts of EGI ordinances were increased educational opportunities for residents, more secure land tenure for the growth of edible landscapes, and an improved urban environment both visually and through enhanced ecosystem services such as pollination, water filtration, and greater biodiversity. EGI also created opportunities for community-building, the growing connection between individuals or groups that improves the ability of communities to work together and solve problems (Weil, 1996). For

example, in a couple cities, EGI policies resulted in more affluent or privileged groups working with more marginalized groups, which reduced previous biases about those in the other group. Aside from improving land tenure, the greatest policy impacts were different from the primary drivers as defined by participants.

Despite the fact that improving public health via increased food security was a primary driver, participants were doubtful that food security had been improved as a result of these policies directly. Participants did mention that community organizations and NGOs harvested a significant quantity of fruits, nuts, and vegetables from public landscapes and donated them to food banks, which may be an underestimated economic and health benefit for poorer residents (Lafontaine-Messier et al., 2016). Improved food literacy resulting from more EGI projects might also indirectly improve food security. Still, a more deliberate integration of vulnerable communities whose voices may have been neglected may more effectively address food security and poverty (McClintock, 2018; Konijnendijk & Gauthier, 2006). By being more intentional about who these policies will benefit, cities may be more likely to achieve intended impacts.

The speed (e.g., slow/rapid) of policy change varied slightly among cities, and even though most participants felt that EGI ordinances were passed quickly compared with other policies, the greatest challenge during EGI policy development was bureaucratic slowness (i.e., the time it took to introduce the legislation, refer it to the appropriate departments, and get it passed by council). A strategy to overcome this barrier is to dedicate a staff position to handle all EGI-related matters within city government. Regardless of whether there is an official staff position, cities looking to develop EGI policies might consider available state or federal resources. Working with experts (e.g., extension specialists and agents) and state departments to understand best land use practices may be useful so that they can be incorporated into the policy.

Participants suggested the following for cities interested in developing similar EGI policies, which are also key for overcoming the aforementioned challenges: 1) dedicate time to research; 2) create staff positions; 3) streamline protocols; and 4) work with the public. In other words, they suggested that stakeholders; 1) understand models used by other cities as well as specific socio-environmental context in which they are working; 2) have personnel who can prioritize EGI above all else; 3) develop operating procedures that are simple and easily understood; and 4) communicate and share ideas with the public so that potential concerns are addressed. For cities that are in the process of a land use policy shift, using these strategies improves the likelihood that the EGI policies will be passed quickly and that they will achieve desired impacts.

3.5 Conclusion

Although the EGI policy process differed among the cities in this sample due to diverse geographic, political, and cultural contexts, common themes were observed in terms of policy drivers, approaches, and impacts. Improving public health and land tenure, managing vacant lands, planning for population growth, and the influence of the local food movement are salient reasons why cities in this study passed EGI ordinances. While it is impossible to capture every aspect of the policy development process (Orach & Schlüter, 2016), the cities in our study shared these steps: 1) issue definition by exogenous actors; 2) collaboration between endogenous and exogenous actors involving shared expertise and knowledge; 3) passing ordinances that significantly altered the city's land use policy image; and 4) incrementally developing new policies to further existing ordinances. The advantages and disadvantages of the different approaches taken, as well as suggested strategies by policy actors, may be used to guide cities that are considering similar policies.

We recommend that more empirical and longitudinal studies be completed to understand how cities use EGI to respond to the challenge of providing ecosystem services as urbanization and global climate change progress. Future research might include case studies of other U.S. cities, including those lacking formalized EGI policies. A comparison of those with and without EGI policies might provide further insights regarding key policy drivers. Considering that the cities in this study developed ordinances during or shortly after Great Recession, it might also be useful to study if there will be a 'second wave' of U.S. municipalities adopting EGI policy in response to other potential disturbances to stability in land use policy (e.g., the Covid-19 pandemic and related economic shutdown). In summary, future research might explore the variation in early, middle, or late adopters of EGI policies.

Chapter 4: Edible Green Infrastructure Opportunities and Challenges in Small Towns

Abstract

EGI is a land use strategy that could provide significant cultural, environmental, and health-related benefits in small towns. Yet, to our knowledge, the practices and policies surrounding food production on public lands in smaller towns is scarcely studied. To better understand the challenges and opportunities of EGI in small towns, we surveyed mayors of Virginia municipalities with populations less than 25,000. One-hundred and seventy-six mayors received a paper survey through the mail and 68 (39%) responded. One-third of small towns in Virginia have not established EGI on public land and less than one-fifth use woody perennials. The greatest perceived barrier to EGI was long-term maintenance. Most towns (78%) do not have land use codes pertaining to EGI, yet almost all respondents were unaware of extant legal constraints regarding implementation. Respondents also were asked to characterize their town in terms of available space, support for public green space, and attitudes regarding the implementation of food-producing trees and shrubs. These data were used in a K-means cluster analysis to group towns into four categories: 1) *Ambivalent and Resource-Poor*; 2) *Optimistic and Capable*; 3) *Doubtful and Unsupported*; and 4) *Unsure with Potential*. Though towns face different social and physical limitations, EGI is a multifunctional land use strategy for public land and mayoral opinions and perceptions suggest that stressing cultural and educational values are most compelling.

4.1 Introduction

Half of the world's population lives in towns or villages, and residents in these built environments depend upon the ecosystems within or adjacent to them (Forman, 2019). The variation in the quantity and quality of recreation/open space, tree cover, and other "green" areas within towns influences the extent to which they support biodiversity, purify air and water, and conserve soils (i.e., the delivery of ecosystem services). According to the Millennium Ecosystem Assessment (2005), ecosystem services fall into the following categories: 1) provisioning (e.g., producing timber, fuel, and food); 2) regulating (e.g., influencing climate, water, and air quality); 3) cultural (e.g., providing spiritual and recreational benefits); and 4) supporting (e.g., facilitating nutrient cycling, photosynthesis, pollination).

The influence of local land management affects all residents, yet the study of 'town ecology' has gained scholarly attention only recently (Forman, 2019). As more people move to urban areas in the coming decades (Van der Voorn & Popov, 2013), resource-user interactions within town landscapes also will change. Thus, understanding the opportunities and challenges regarding land use practices in towns is increasingly important in terms of shaping the future management of these ecosystems (Forman, 2019).

Edible green infrastructure (EGI) is the integration of food production in built environments (Russo et al., 2017) and a land use strategy that towns can use to improve ecosystem services and local resilience. For example, U.S. residents, whether in Maine or Arizona, depend largely on produce from California, which supplies more than one-third of the nation's vegetables and two-thirds of its fruits and nuts (CDFA, 2019). Producing more food in and around built infrastructure would shift some of the locus and ownership of production to residents who increasingly are interested in healthy and dependable supply (Clark & Nicholas,

2013). Types of EGI vary, but include among others edible forest gardens/community food forests, allotment gardens/community gardens, edible green roofs, and edible green walls/facades (Russo et al., 2017).

EGI adoption increases the production of seeds, fruits, nuts, vegetables, and other edible goods (Russo et al., 2017) and can serve many other cultural and environmental functions such as education, social gathering and community-building, and recreation and sports. Practices that build community increase social connectivity between individuals or organizations and improve collective problem-solving capacity (Weil, 1996). EGI also can beautify public spaces and neighborhoods, which strengthens community connection to these places (Belmeziti et al., 2018; Lovell, 2010). Other benefits include improving public health by purifying air and water and increasing access to healthy foods (Haaland et al., 2015; Lovell, 2010; Altieri, 2002).

EGI can enhance economic opportunities while also strengthening local environmental resilience. For example, municipalities could provide jobs for people to steward sites, and residents might lower their grocery bill by reducing the frequency with which they buy produce at the store. Using agroecological practices (e.g., polycultures that remove the need for pesticides/herbicides and include nitrogen-fixing species to improve the productivity of other plants) can also reduce costs, and improve the profitability and performance of EGI (Lafontaine-Messier et al., 2016). At the same time, EGI can provide wildlife and pollinator habitat, mitigate flooding events (thus reducing costs related to stormwater management), and deliver countless other environmental services that otherwise would be expensive for municipalities (McLain et al., 2012; Lovell, 2010; Costanza et al., 1997).

Despite the benefits of EGI, there are challenges that must be overcome for it to be a feasible strategy for management of public lands. For instance, local governments may be

concerned about resident safety of food consumption (Lovell, 2010). Downed fruits and nuts might be viewed both as unsightly and a liability if they fall onto streets or other frequently traversed places (Bukowski & Munsell, 2018). The use of synthetic chemicals (e.g., pesticides, herbicides, etc.) in public spaces also could pose health risks to residents, but there are ways to reduce or eliminate their use when establishing and managing EGI (e.g., organic practices) (Russo et al., 2017).

Other barriers to EGI in towns might be related to spatial and temporal requirements. For example, many municipalities have limited public space for EGI, and competition for these spaces may be high (Lovell, 2010). Tenure is another challenge that municipalities must overcome (Konijnendijk & Gauthier, 2006; Horst et al., 2017), which is especially pertinent in terms of growing and managing woody perennials (Raintree, 1986). Perhaps the most significant barrier is the allocation of resources for long-term maintenance (Russo et al., 2017). Ensuring proper and consistent management of EGI not only requires a detailed plan but also continued investments in financial, human, and built capital (Bukowski & Munsell, 2018).

Municipal policies specific to EGI are one mechanism for improving likelihood and ease of adoption. Political change is fundamental for ecological change (Fernandez, 2013; Altieri, 2009) because policies regulate and/or incentivize human behaviors, thus influencing human-environment interactions (Orach & Schlüter, 2016). Yet most municipalities do not have land use codes that promote the use of EGI (Bukowski & Munsell, 2018; Lovell, 2010). If residents of smaller towns seek to implement EGI in their municipalities, then understanding the legal and social constraints, especially with respect to food-producing trees and shrubs, is a necessary step.

Mayors and other government officials play a key role in local policy. In the U.S., there are two main forms of local government: mayor-council (strong mayor systems) and council-

manager (weak mayor systems). In a strong mayor system, the mayor has administrative duties, and in a weak system, the administrative authority lies with a city or town manager who has technical management expertise. Weak system mayors serve on a council and are elected by other members rather than residents (Carr, 2015), and this system has grown steadily over the last century because it is viewed as a more efficient, professional alternative to the mayor-council form (Carr, 2015; Feiock et al., 2003). Regardless of the system of local government, the work of U.S. mayors requires a firm understanding of the social, economic, and political issues in their towns and cities, and mayors provide a standardized population for collecting data about the perspectives of municipal leaders regarding EGI and the opportunities and limitations of its use.

The focus of this study is on forms of EGI that include edible, woody perennials species (i.e., food forestry initiatives) because they offer nutritional and environmental benefits that differ from production systems comprised only of annual species. Perennials can improve food security by providing nutrients from fruits, nuts, or seeds that are missing from many American diets (Clark & Nicholas, 2013). Moreover, they are especially important for soil and water conservation and providing shade (Raintree, 1986). The intentional use of food-producing perennials in U.S. municipalities has gained ground in the last decade (Hübner et al., 2018), but the majority of food forestry initiatives and research are concentrated in urban areas (Bukowski & Munsell, 2018; Lafontaine-Messier et al., 2016; Clark & Nicholas, 2013). To our knowledge, little is known about EGI in smaller municipalities.

We studied mayoral perspectives on EGI by surveying mayors of municipalities with less than 25,000 people in Virginia, U.S. Behavioral science theory informed study design and hypotheses. We used constructs in the Theory of Planned Behavior (TPB), in which attitudes,

subjective norms, and perceived behavioral controls influence intentions to perform a certain behavior (Ajzen, 1991; Ajzen, 1992). We also used Modeling Human Behavior (MoHuB), a framework applied specifically to social-ecological systems research to understand decision-making processes (Schlüter et al., 2017).

This research sought to understand the challenges and opportunities that exist for EGI adoption in smaller towns. Based on the literature and anecdotal evidence, we hypothesized that opportunities identified by mayors would relate to environmental, social, economic, and health-related benefits, and challenges would involve lack of physical space and concerns over long-term maintenance and liability. Results improve our understanding of how smaller towns view food production in their public green space and what leaders see as the associated challenges and opportunities. From this, we discuss how municipalities can overcome barriers if EGI is a priority.

4.2 Methods

Study Area

Virginia has the 12th largest state population in the U.S. with over 8.4 million people. In Virginia, the designation of town or city is independent of population size. An incorporated municipality is considered a town if it is seated within a county, whereas cities are independent from counties. The majority (88%) of municipalities in Virginia have populations under 25,000 (U.S. Census Bureau, 2019). These smaller municipalities are referred to as ‘towns’ even if they are technically cities to make the distinction between them and larger, urban areas. All municipalities in Virginia except the capital city, Richmond, have council-manager governments.

Survey Instrument

Mayors in Virginia, U.S., serving in municipalities with less than 25,000 people were surveyed about their perspectives regarding public green space, implementation of food-

producing perennials in their municipalities, and preferred approaches to policymaking. They also were asked how long they have been the mayor of their town and demographic questions such as sex, age, education, and political views. Respondent opinions about EGI were measured, as well as perceptions about the potential for EGI in their town.

A pilot survey was developed based on the literature review and interview responses described in Chapter 3. The instrument was tested and modified using input from other researchers, as well as two mayors in Virginia who were not included the sample. Mailings were sent using physical addresses posted on official government websites. If they were not posted, town hall offices were called to confirm an address.

Following Dillman's Tailored Design Method (2009), four mailings were used to complete the survey. The first mailing was a solicitation letter including survey details and an invitation to participate via mail or phone. Ten days later, a cover letter was mailed, along with the paper survey, a response card to fill out if the mayor preferred to take the survey over the phone, and a pre-addressed, stamped envelope. Two weeks later a postcard serving both as a reminder to those who had not taken the survey and a thank you to those who did was sent to all participants. A final mailing occurred two weeks afterward and included a cover letter, paper survey, response card, and a pre-addressed, stamped envelope to mayors who had not yet responded.

We used the 'wave' method (after Rogelberg & Stanton, 2007) to address non-response. This method treats late respondents as proxies for non-respondents. T-tests were used to determine if demographics and select summated dependent variables differ significantly between late respondents and early respondents. We also used a t-test to determine if town population differs significantly between respondents and non-respondents. Test results were not significant.

The survey asked mayors to select all possible benefits they believe are associated with public green space and all potential barriers associated with food-producing trees and shrubs in public spaces. Mayors also were asked to specify all types of EGI that exist in their town, that are included in the town's zoning codes, or that are impacted by other legal restrictions in their municipality (Table 4.1).

Table 4.1. Possible survey responses to benefits of public green spaces, barriers to planting food-producing trees and shrubs in public spaces, and types of EGI that exist, are in zoning codes, or are impacted by legal restrictions. Possible types of EGI were the same for each question that referenced EGI.

Benefits of Public Green Spaces	Barriers to Planting Food-producing Trees and Shrubs in Public Spaces	Types of EGI
Social Gathering or Community-Building	Long-term Maintenance	Community Gardens
Beautifying the Environment	Lack of Space	Public Orchards
Providing Places for Recreation/Sports	Hazards Related to Fallen Fruits/Nuts	Fruit and Nut Trees
Connecting People to Nature	Competing Land Use Interests	Edible Plants in Rights-of-Way
Improving Public Health	Food Safety Concerns	Rooftop Gardens
Educational Opportunities	Changing the Aesthetic of the Town	Community Food Forests
Benefitting Pollinators and Wildlife	Reduced Visibility Hazards	Other
Improving Stormwater Management	Nothing	
Providing Spaces for Food Production		
Providing Jobs		
Other		

Mayors indicated how much they agree with statements about public green space generally, as well as food-producing trees and shrubs in their municipality's public spaces. Responses were provided on a unipolar scale ranging from 1 to 5, where 1=not at all, 2=a little bit, 3=somewhat, 4=mostly, and 5=completely. Also measured were preferred policymaking approaches. In response to what were the best/most effective policies and how policies had developed in their municipality, mayors chose between slow, incremental changes/policy modifications, rapid abrupt changes/new policy development, or a combination thereof. Open-ended questions included what kinds of public green space should be protected, whether they believe zoning is the best way to encourage edible perennials on public land in their municipalities (yes/no), and why they held that opinion.

Data Analysis

To decrease the number of variables used for statistical analyses while sufficiently accounting for data variance, exploratory factor analysis (EFA) was conducted using principal component analysis and varimax rotation. Eigenvalues indicate the magnitude of variance explained by each factor, which consist of survey item groupings that meaningfully explain a portion of overall variance. Acceptable factor groupings have an eigenvalue score greater than one (Spector, 1992). Weak (i.e., loading <0.60) or crossloaded survey items in each factor grouping were eliminated. A total of 14 survey items with factor loadings ≥0.60 were used to identify 5 underlying factors with mean scores (i.e., summated constructs) calculated from survey items sufficiently loaded in the factor grouping. Using summated constructs creates a more accurate, parametric mean score for latent constructs (DeVellis, 2003).

A K-means cluster analysis was performed using mayors' assessments as a proxy for characterizing towns. Four unique clusters reflected differences in mayoral perspectives on three factors: 1) available space for food-producing trees and shrubs in their towns; 2) how strongly the public supports existing green space in their towns; and 3) public attitudes about the implementation of food-producing perennials in public green space. The K-means cluster procedure was used to create groups that maximize response differences between clusters and minimize differences within clusters (Ding & He, 2004).

One-way ANOVA using Tukey's HSD post-hoc analysis was used to determine how clusters differ according to grouping factors (α=0.05). Clusters were named according to views on implementation, the degree to which public green space is supported, and available physical space in the town. One-way ANOVA and Tukey's HSD were used to evaluate whether clusters

varied in their intention to plant edible perennials and the capacity of the government to support these species (α=0.05).

Descriptive statistics and frequency distributions for other survey variables were compiled. Descriptive statistics for each cluster also were collected for comparison between clusters. Open-ended responses were coded and grouped into common themes, which were studied to contextualize whether and why respondents think zoning is the best way to encourage food-producing perennials on public land and what kinds of public green space, if any, should be protected. Results provide a deeper understanding of mayoral responses, particularly in terms of policy constraints and opportunities to protect public green space and food-production systems.

4.3 Results

One-hundred and seventy-seven paper surveys were mailed to mayors of municipalities in Virginia with populations under 25,000. Sixty-eight responded for an adjusted rate of 39% (Table 4.2). Two mayors (3%) opted to take the survey over the phone. Around 30% of respondents were female, and more than 60% of mayors had a bachelor's degree or higher. More than one-third of mayors were from municipalities with populations between 1,000-4,999 and one-third had populations of 5,000 or greater. Two-fifths chose "slightly conservative" or "conservative," as their political orientation, and only one-fifth marked themselves as "slightly liberal," "liberal," or "very liberal." One-third of mayors viewed their orientation as "moderate". Almost two-thirds of mayors believed the primary political preference of their municipality was "slightly conservative," "conservative," or "very conservative". Around one-third had been the mayor of their town between 2 and 5 years, and another third between 6 and 10 years.

Table 4.2. Demographics based on survey responses of mayors of municipalities with populations less than 25,000 in Virginia, U.S.A. (n=68).

Demographics	Categories	Percent (n)
Sex	Male	70.3 (45)
	Female	29.7 (19)
Education	High School	9.2 (6)
	Some College	27.7 (18)
	Bachelor's	36.9 (24)
	Graduate	26.2 (17)
Age	<50	16.1 (10)
	50-59	27.4 (17)
	60-69	33.9 (21)
	70-79	12.9 (8)
	≥80	9.7 (6)
Population	<500	16.9 (11)
	500-999	16.9 (11)
	1,000-4,999	35.4 (23)
	5,000-9,999	16.9 (11)
	10,000-24,999	13.9 (9)
Years as Mayor	<2	17.9 (12)
	2 to 5	34.3 (23)
	6 to 10	32.8 (22)
	>10	14.9 (10)
Political Orientation	Very Liberal	1.8 (1)
	Liberal	9.1 (5)
	Slightly Liberal	10.9 (6)
	Moderate	32.7 (18)
	Slightly Conservative	9.1 (5)
	Conservative	30.9 (17)
	Very Conservative	5.5 (3)
Town's Political Orientation	Very Liberal	0.0 (0)
	Liberal	8.9 (5)
	Slightly Liberal	8.9 (5)
	Moderate	23.2 (13)
	Slightly Conservative	17.9 (10)
	Conservative	35.7 (20)
	Very Conservative	5.4 (3)

More than 80% of mayors believed that promoting social gathering or community-building, beautifying the environment, and providing places for recreation or sports were benefits of public green space (Table 4.3). Less than half believed that food production was a benefit, and less than a quarter thought providing jobs was a benefit. Nearly four out of five respondents

indicated that long-term maintenance is a significant barrier to planting food-producing perennials in public space. Other barriers were lack of space (44%) and concern over fallen fruits and nuts (39%).

The most prevalent form of existing EGI was community gardens (45%), and one-third reported having none (Table 4.3). Almost 80% wrote that food production systems were not included in the zoning codes for their municipalities. When they did, the most common food production system was community gardens (14%). Almost three-fourths indicated that there were no legal constraints affecting food-producing trees and shrubs in public green space, while nearly a quarter were unsure if any constraints exist.

Table 4.3. Mayors' perspectives on benefits of public green spaces and barriers to planting edible perennial species, as well as what types of EGI, food production systems included in zoning codes, and food production systems impacted by legal constraints are in their municipalities.

Benefits of Public Green Spaces	Percent (n)
Promoting Social Gathering or Community-Building	87.9 (58)
Beautifying the Environment	87.9 (58)
Providing Places for Recreation/Sports	84.8 (56)
Connecting People to Nature	78.8 (52)
Improving Public Health	74.2 (49)
Providing Spaces for Educational Opportunities	72.7 (48)
Benefitting Pollinators and Wildlife	69.7 (46)
Improving Stormwater Management	62.1 (41)
Providing Spaces for Food Production	42.4 (28)
Providing Jobs	24.2 (16)
Barriers to Planting Edible Perennials in Public Spaces	
Long-term Maintenance	78.8 (52)
Lack of Space	43.9 (29)
Hazards Related to Fallen Fruits/Nuts	39.4 (26)
Competing Land Use Interests	24.2 (16)
Food Safety Concerns	18.2 (12)
Changing the Aesthetic of the Town	13.6 (9)
Nothing	9.1 (6)
Reduced Visibility Hazards	7.6 (5)
Existing Types of EGI in Public Space	
Community Gardens	45.1 (23)
There are None	33.3 (17)
Public Orchards/Fruit and Nut Trees	19.6 (10)
Edible Plants in Rights-of-Way	5.9 (3)
Rooftop Gardens/Gardening Along Buildings	3.9 (2)
Community Food Forests	2.0 (1)

Food Production Systems included in the Zoning Codes	
None	77.8 (49)
Community Gardens	14.3 (9)
Fruit and Nut Trees	3.2 (2)
Edible Plants in Medians or Rights-of-Way	3.2 (2)
Rooftop Gardening/Gardening Along Buildings	1.6 (1)
Public Orchards	1.6 (1)
Community Food Forests	0.0 (0)
Food Systems Impacted by Legal Constraints	
None	72.7 (48)
Not sure	24.2 (16)
Public Orchards/Fruit and Nut Trees	1.5 (1)
Community Food Forests	1.5 (1)
Edible Plants in Medians or Rights-of-Way	1.5 (1)
Community Gardens	0.0 (0)
Rooftop Gardens/Gardening Along Buildings	0.0 (0)

Fourteen survey variables were grouped into five factors with eigenvalues over 1 in the rotated matrix and explained 65.5% of the overall variance (Table 4.4). Five items measuring the extent to which the mayors believed public green space was supported by their towns were labeled *public green space support*. Two items measuring the degree to which mayors felt their municipalities intended to plant edible perennials in public space were labeled *intention to plant*. *Implementation attitudes* consisted of three items that measured mayoral perspectives pertaining to the use of edible perennial species in public green space. Two items measuring how confident mayors were that their municipalities could provide government support for food-producing trees and shrubs in public space were labeled *government support*. *Space available* included two items that measured the extent to which respondents believed there was adequate public green space to plant edible perennials.

Table 4.4. Rotated component matrix with factor loadings in an EFA of variable survey item responses among mayor respondents in Virginia, U.S.A. (n=68). Fourteen variables grouped into five factors. Item variable means reported.

Variable	Item $\bar{x}$	Public Green Space Support	Government Support	Space Available	Implementation Attitudes	Intention to Plant
Public Green Space to Produce Food	2.94	0.01	0.04	**0.85**	0.34	0.06
Ample Public Green Space	3.16	0.37	0.05	**0.80**	-0.18	0.08
Public Green Space Visited Often	3.68	**0.71**	0.09	-0.13	0.04	-0.05
Conducive Codes for Public Green Space	3.17	**0.74**	0.26	0.14	0.07	-0.24
Budget for Public Green Space	2.97	**0.76**	0.29	0.25	0.11	0.21
Physical Resources for Public Green Space	2.98	**0.71**	0.19	0.20	0.08	0.38
Community Allies for Public Green Space	3.06	**0.68**	0.03	0.30	0.18	0.23
Policy to Support Edible Perennials	2.68	0.16	**0.88**	0.04	-0.01	0.09
Budget to Support Edible Perennials	2.55	0.40	**0.69**	0.03	0.21	0.24
Priority of Planting Edible Perennials	2.61	0.02	0.05	0.17	0.34	**0.71**
Current Effort to Increase Edible Perennials	1.38	0.16	0.19	0.02	-0.03	**0.78**
Ease of Implementation	2.75	0.06	0.44	0.11	**0.60**	-0.17
Pertinence of Implementation	3.35	0.39	-0.26	-0.18	**0.61**	0.06
Cost of Implementation	3.52	0.07	0.13	0.24	**0.78**	0.25
Factor $\bar{x}$ (scale)		3.14 (1-5)	2.6 (1-5)	3.05 (1-5)	3.19 (1-5)	2 (1-4.5)
Minimum/maximum		2/5	1/5	1/5	1/5	1/5
Total Variance Explained						65.5%

Space available, *public green space support*, and *implementation attitudes* differed significantly across clusters: *Ambivalent and Resource-Poor*, *Optimistic and Capable*, *Doubtful and Unsupported*, and *Unsure with Potential* (Table 4.5). Respondents in *Optimistic and Capable* and *Unsure with Potential* clusters more strongly believe that their municipalities have the space available to support food-producing trees and shrubs when compared to other groups. *Optimistic and Capable* respondents feel most confidently that public green space is supported in their municipality, and those in *Doubtful and Unsupported* are significantly least confident. Respondents in *Ambivalent and Resource Poor* and *Unsure with Potential* are less confident than *Optimistic and Capable* and more confident than *Doubtful and Unsupported*. Respondents in *Optimistic and Capable* have significantly more favorable attitudes regarding the implementation of edible perennials in their municipalities compared to other clusters.

Table 4.5. Means ANOVA test results for significant differences among space available for edible perennials, support for public green space, and implementation attitudes among respondent types for mayors in Virginia, U.S.A. Scale: 1=not at all, 2=a little bit, 3=somewhat, 4=mostly, 5=completely. Mean scores in columns with the same letter do not differ significantly using Tukey's HSD post hoc test (α=0.05).

Respondent Type (n)	Space Available $\bar{x}$	SE	Public Green Space Support $\bar{x}$	SE	Implementation Attitudes $\bar{x}$	SE
Ambivalent and Resource- Poor (18)	2.25^{a}	0.12	3.48^{a}	0.13	3.35^{a}	0.14
Optimistic and Capable (14)	4.03^{b}	0.17	4.33^{b}	0.14	4.06^{b}	0.16
Doubtful and Unsupported (18)	1.97^{a}	0.15	1.95^{c}	0.14	2.70^{a}	0.17
Unsure with Potential (16)	4.19^{b}	0.15	3.05^{a}	0.19	2.92^{a}	0.16
F	62.56		41.25		13.22	
P	0.00		0.00		0.00	

Ambivalent and Resource-Poor had less conservative and younger mayors than other groups, and around half had between 1,000-9,999 residents (Table 4.6). *Ambivalent and Resource-Poor* had the highest percentage of liberal mayors (over 28% reported themselves as "liberal" or "slightly liberal") and less than 6% were over the age of 70. *Optimistic and Capable* generally had mayors who were less conservative and older than other groups. This group had the highest percentage of senior mayors (more than 40% were 70 years or older) and largest population sizes (50% were over 5,000 and nearly 25% were over 10,000). In contrast, respondents in *Doubtful and Unsupported* had the smallest populations of all clusters, with over 40% having less than 500 residents. This group was more conservative than *Optimistic and Capable* and *Ambivalent and Resource-Poor*, as nearly 70% reported themselves as "conservative" or "slightly conservative." Lastly, *Unsure with Potential* consisted primarily of conservative and middle-aged mayors from mid-sized towns (three out of five were between 1,000 and 9,999 residents). This group had the highest percentage of respondents who reported their political orientation as "very conservative."

Table 4.6. Demographics by cluster based on survey responses of mayors of towns with populations less than 25,000 in Virginia, U.S.A.

Demographics	Categories	Percent (n)			
		Ambivalent and Resource- Poor (n=18)	Optimistic and Capable (n=16)	Doubtful and Unsupported (n=18)	Unsure with Potential (n=14)
Sex	Male	77.8 (14)	61.5 (8)	62.5 (8)	81.3 (13)
	Female	22.2 (4)	38.5 (5)	37.5 (5)	18.7 (3)
Education	High School	5.9 (1)	21.4 (3)	5.9 (1)	6.2 (1)
	Some College	29.4 (5)	21.4 (3)	35.3 (6)	25.0 (4)
	Bachelor's	35.3 (6)	7.1 (1)	41.2 (7)	56.3 (9)
	Graduate	29.4 (5)	50.0 (7)	17.6 (3)	12.5 (2)
Age	<50	11.8 (2)	14.3 (2)	21.4 (3)	18.8 (3)
	50-59	35.3 (6)	21.4 (3)	28.6 (4)	25.0 (4)
	60-69	47.0 (8)	21.4 (3)	21.4 (3)	37.5 (6)
	70-79	5.9 (1)	21.4 (3)	14.3 (2)	12.5 (2)
	≥80	0.0 (0)	21.4 (3)	14.3 (2)	6.3 (1)
Population	<500	5.9 (1)	7.7 (1)	41.2 (7)	12.5 (2)
	500-999	29.4 (5)	0.0 (0)	17.6 (3)	18.8 (3)
	1,000-4,999	35.3 (6)	38.5 (5)	29.4 (5)	43.7 (7)
	5,000-9,999	17.6 (3)	30.8 (4)	5.9 (1)	18.8 (3)
	10,000-24,999	11.8 (2)	23.1 (3)	5.9 (1)	6.2 (1)
Years as Mayor	<2	27.8 (5)	0.0 (0)	22.2 (4)	18.8 (3)
	2 to 5	33.3 (6)	28.6 (4)	27.8 (5)	50.0 (8)
	6 to 10	16.7 (3)	64.3 (9)	33.3 (6)	18.8 (3)
	>10	22.2 (4)	7.1 (1)	16.7 (3)	12.5 (2)
Mayor's Political Orientation	Very Liberal	0.0 (0)	8.3 (1)	0.0 (0)	0.0 (0)
	Liberal	21.4 (3)	0.0 (0)	7.7 (1)	6.7 (1)
	Slightly Liberal	7.1 (1)	16.7 (2)	0.0 (0)	13.3 (2)
	Moderate	35.7 (5)	41.7 (5)	23.1 (3)	33.3 (5)
	Slightly Conservative	7.1 (1)	0.0 (0)	23.1 (3)	6.7 (1)
	Conservative	28.6 (4)	25.0 (3)	46.1 (6)	26.7 (4)
	Very Conservative	0.0 (0)	8.3 (1)	0.0 (0)	13.3 (2)
Town's Political Orientation	Very Liberal	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
	Liberal	7.1 (1)	8.3 (1)	15.4 (2)	6.3 (1)
	Slightly Liberal	0.0 (0)	8.3 (1)	7.7 (1)	12.5 (2)
	Moderate	21.4 (3)	25.0 (3)	15.4 (2)	31.3 (5)
	Slightly Conservative	21.4 (3)	25.0 (3)	15.4 (2)	12.5 (2)
	Conservative	42.9 (6)	25.0 (3)	38.4 (5)	37.5 (6)
	Very Conservative	7.1 (1)	8.3 (1)	7.7 (1)	0.0 (0)

ANOVA post-hoc analysis using Tukey's HSD showed that the means for *intention to plant* and *government support* were significantly higher (α=0.05) for *Optimistic and Capable* compared to *Doubtful and Unsupported* (Table 4.7). *Ambivalent and Resource-Poor* and *Unsure with Potential* were not significantly different from any clusters.

Table 4.7. Means ANOVA test results for significant differences between mayor respondent types regarding their municipality's intention to plant food-producing perennials in public spaces and ability for the government to support food producing perennials. Scale: 1=not at all, 2=a little bit, 3=somewhat, 4=mostly, 5=completely. Mean scores in columns with the same letters do not differ significantly (α=0.05). (Tukey's HSD post hoc test).

Respondent Type (n)	Intention to Plant $\bar{x}$	SE	Government Support $\bar{x}$	SE
Ambivalent and Resource-Poor (18)	2.25^{ab}	0.21	2.78^{ab}	0.22
Optimistic and Capable (14)	2.36^{a}	0.26	3.14^{a}	0.30
Doubtful and Unsupported (18)	1.53^{b}	0.15	2.00^{b}	0.18
Unsure with Potential (16)	1.93^{ab}	0.19	2.60^{ab}	0.25
F	4.25		3.29	
P	0.03		0.01	

Open-ended comments regarding the types of public green space that should be protected from 40 mayors were coded and grouped into 13 categories (Table 4.8). The most common responses were: 1) parks (58%); 2) trails (15%); and 3) forests or woodlands (15%). Only 8% specifically mentioned EGI, for which they all wrote "community gardens". There were also five (13%) mayors who felt that all green spaces should be protected, supported by statements such as, "Any and all green space should be protected"; "Any and all. We are an old town and somewhat landlocked, so all opportunities are important"; "All green space should be protected"; and "Any town-owned parcels."

Open-ended responses explaining mayors' stances on whether zoning was the best way to facilitate EGI implementation were coded and grouped based on common themes. Of the 36 mayors who did not think zoning was best, 25 (72%) explained their reasoning, compared to 13 (62%) of 21 pro-zoning mayors. Mayors were against zoning because: 1) EGI is not a priority for the public; 2) there is a lack of public space and available resources to support EGI; 3)

education/awareness are better first steps; and, 4) they were opposed to a regulatory approach (Table 4.8). Reasons for zoning included: 1) government support provides guidance on implementation; 2) it creates opportunities for education and raising awareness; and 3) if there is public interest.

According to some mayors against zoning, food production on public land was not a priority in their town from lack of interest or need: “They want parks and open space—not food producing on the limited space we have”; “Food production is already happening on private property, so there is no need”; "We are a farming town and county—no interest”. Mayors were supportive of zoning if there is public interest, or, “If this is what you want in your town.” Some even thought that being an agricultural town was a plus, because there is already an interest in food production: “We are fortunate to have an abundance of agriculture in our region and gardening is fairly common among residents," explained one pro-zoning mayor.

Other mayors against zoning cited a lack of physical and fiscal resources: “We just don't have the space to do it"; "The zoning codes are likely not the major impediment to this use—funding/lack of open space is likely the primary impediment here,” and similar statements were common responses. Yet, there were also pro-zoning mayors who thought supportive policy was an important aspect of facilitating EGI, even if space is lacking. One wrote, "If people see it is supported [in zoning codes], it is more likely to happen”; and another, “"[Zoning] would assist with lack of physical space question to be able to point to by right areas."

Education and awareness were cited both as reasons for and against zoning. There were mayors who believed that education and awareness were needed before making changes to the zoning codes: “Education and awareness would be more appropriate"; and “encourage the use through community volunteer efforts first, and if it catches on, then look at the codes for future

protections." Yet some pro-zoning mayors thought that educational opportunities could arise from zoning for EGI. They referenced the learning that might take place from the process of policy change: "By looking at zoning, the public has a chance to discuss food production with council and mayor"; "Including food production systems in zoning codes would raise awareness and start the conversation." Another wrote; "I believe it might help people understand the importance of food/green space and teach children and adults about their food."

There were discrepancies in mayoral opinions about the role of the government in encouraging EGI. Some mayors against zoning disagreed with a regulatory approach: "Public support would [need to] come first; we do not lead through forced change"; "I would prefer a non-regulatory approach." Others thought that government support could provide guidance on implementation and long-term protection of EGI uses. One mayor wrote, "We don't specify what types of plants or trees are required in our zoning codes so food producing trees and shrubs are allowed but not commonly planted. I think council should set policy to encourage those types of plantings." Another explained, "[EGI] must be in the code and comprehensive plan. If it's not in the code, when current council or mayor leaves, the next generation would not know what to do. These codes and plans ensure that they will be allowed for a long period of time (unless the people want to re-zone)."

Table 4.8. Open response frequencies based on mayors' views on the protection of public greens space and food-producing, woody perennials.

Public Green Space that Should be Protected by Codes (n=40)	Frequency
Parks	23
Trails	6
Forests/woodlands	6
Wetlands/places along the Water	6
All green spaces	5
Recreation areas	4
Flower gardens	3
Community gardens	3
Spaces for farmer's markets	3
Greenbelts/greenways	2
Historical sites	2
Conservation lands	2
Department of Transportation Land	1
Reasons Against Zoning for Food-producing Trees and Shrubs (n=25)	
Not a priority for the public	9
Lack of public space and/or resources available	7
Education/awareness needed first	5
Do not agree with regulatory approach/forcing the issue	4
Reasons for Zoning for Food-producing Trees and Shrubs (n=13)	
Government support provides needed guidance	5
Raises awareness and provides educational opportunities	4
If there is public interest	4

4.4 Discussion

Sixty-eight mayors in Virginia participated in our study of the opportunities and limitations related to EGI adoption in small towns. We hypothesized that opportunities will include environmental, social, economic, and health-related benefits, and challenges will be limited space and long-term maintenance and liability. Findings generally supported this supposition. However, economic benefits were not identified as an opportunity, and long-term maintenance was by far the greatest challenge, followed by lack of space and liability related to downed fruits and nuts.

Our findings indicate that mayors of small towns value preservation of public green spaces. Nearly 60% provided open-ended comments explaining the types of green space that they believed should be protected by land use codes. They primarily value green space for benefits other than job creation and food production, and key reported benefits were largely along the lines of cultural and community services, such recreation and aesthetics. These results support what is known about longstanding views of public green space among municipal leaders, in that they largely are recognized for civic functions, and communities often prioritize these services over food production (Clark & Nicholas, 2013; Lovell, 2010). Emphasizing civic and cultural benefits therefore potentially is a more salient strategy for residents to make an argument in favor of EGI in public spaces, wherein particular EGI design can fold in other functions such as food production and supporting or regulating services.

EGI can provide commonly recognized civic benefits, in addition to other multifunctional outcomes that are not offered by other types of public green space. For example, communities may choose to grow culturally or regionally significant crops that honor their heritage (Haaland et al., 2015) in and around walking paths and exercise equipment. The educational value of EGI in public space also differs from other forms of green space, such as functioning as an outdoor classroom for topics like growing food, nutrition, and cooking, and nearly three-quarters of mayors indicated that they support such forms of outdoor education. Thus, there is a potentially important role for education in advancing EGI given that U.S. municipalities spend the most on education and the least on environmental services (Delisle & United States, 2010). Framing EGI as a place for education rather than a food-producing hub could prove to be a compelling pathway for increasing public EGI and shaping complementary land use policies.

EGI is multifunctional and positioned to achieve common public green space goals such as recreation, while also incorporating additional benefits like food production and environmental conservation. Extant public green space supported by communities in small towns can be easily transformed to add food production to the list of other cultural, regulating, and supporting ecosystem services. For example, edible shrubs and trees can be implemented along existing greenways that are in towns (Bentrup et al., 2001). Additionally, current forest patches can be transformed into edible landscapes by planting food-producing understory species (McLain et al., 2012). Towns also can make use of unusual or underutilized areas (e.g., rooftops, medians, or streets), especially if competition for public land use is high (Lovell, 2010). With creativity and planning, food production can be integrated into town landscapes without increasing pressure on classic green space about which most mayors are quite protective. This integration is an asset and some larger U.S. municipalities have started to retrofit, or 'agrifit', extant grey and green infrastructure along these lines (Clark & Nicholas, 2013; House, 2009).

According to mayors, the greatest barrier to EGI is maintenance. Confounding this challenge is that municipal policies explicit to EGI policy are rare according to mayors, thus the permissible structure, function, and locus of EGI are largely undefined. Establishing comprehensive plans and land use codes may alleviate concerns related to long-term maintenance by specifying design relative to placement and scale. It also would ensure that when political turnover occurs, EGI processes and practices carryforward. In terms of zoning, mayors in favor of formal EGI mechanisms argued that policies are necessary for guiding municipalities if other assets (e.g., physical or fiscal) are lacking, whereas those that were opposed felt that awareness and education were best practices. Either way, community-wide dialogue may be needed as a precursor to policy change to better understand public interest and preferences, and

to weigh associated costs and benefits. In open-ended comments, mayors pointed out that educational opportunities for residents and town councils could arise from such discussions.

Dubbeling & Mertzhal (2006) argue that a concerted effort to include diverse community stakeholders is required to maximize the benefits of dialogue pertaining to EGI. Involving communities in decisions over public land use builds crucial social capital, or the "trust, networks, and norms of reciprocity that enable people to effectively work together" (Butterfoss & Kegler, 2018, p. 314). For towns in this study, some residents are likely interested in EGI, but a lack of policy, government support, and other resources may deter them from taking action. It also is possible that council-manager led local governments, which are increasing, may not be able to respond to small constituencies as well as towns that are mayor-council led (Clingermayer & Feiock, 2001).

One-third of municipalities in this study do not have EGI on public land, and almost none have EGI policies. Mayors explained that one basic impediment to policy change is a general lack of public space, but that most also believed there is widespread lack of interest in the public sphere because people already manage EGI on private property. In larger urban areas, many residents do not have private land suitable for EGI, especially forms that include woody perennials (Heynen et al., 2006). This may explain why food production on public land, as well as the creation of supportive policies, has been more popular in cities than in small towns.

Where food production exists on public land in towns, mayors reported that essentially all were community gardens, not multistoried systems including woody perennial food-producing species for public access. The intentional use of food trees and shrubs essentially is absent, yet around three-quarters of mayors indicated that there are no legal constraints to their implementation. Perhaps the lack of EGI could be viewed as counter-intuitive where nothing is

specifically prohibited; it is likely more reasonable to suggest that an uptick in use is contingent on policies that define possibilities and outline implementation (Fernandez, 2013; Orach & Schlüter, 2016).

Some mayors mentioned municipal governments "can push people in the right direction" using policy mechanisms, but others opposed "forcing an issue" through a regulatory approach, especially if there appears to be no public interest. If policy formation proceeded in earnest, it would be important to consider how the structure and function of EGI will complement other more common uses and visions of public green space (Smith, 2012). In other words, focusing on tangible benefits rather than abstract concepts likely would generate more favorable public interest (Busch & McCormick, 2014). For example, language like 'ecosystem services' may seem obscure to residents of small towns, but emphasizing educational and recreational opportunities would be more likely to resonate with the public, with ecosystem services and other collective aims.

Governments or community members who are interested in advancing EGI would do well to consider the 'type' of municipality wherein their efforts will occur. Mayor assessments resulted in four types of towns in Virginia that differ in levels of support, attitudes, and available space for EGI: 1) *Ambivalent and Resource-Poor*; 2) *Optimistic and Capable*; 3) *Doubtful and Unsupported*; and 4) *Unsure with Potential.*

Optimistic and Capable, with the highest means in each category, had significantly greater government support for and intention to plant perennial forms of EGI than *Doubtful and Unsupported*, with the lowest means in each category. This suggests that the likelihood of EGI adoption may be influenced by the amount of space available, support for existing public green spaces, and town attitudes on EGI implementation. Still, *Optimistic and Capable* contained the

greatest number of towns with large population sizes (>10,000), and *Unsure with Potential* had the most towns with smaller populations (<500); therefore, larger towns might be more likely to adopt EGI as a strategy to manage public lands. This coincides with what we have observed about greater use of public land for EGI in cities, where populations are denser (Wu, 2014), and access to large private parcels is rare (Heynen et al., 2011) compared to small towns. Moreover, larger towns likely have greater resources (e.g., social, fiscal, physical) to support EGI on town-owned land.

Regardless of the factors that drive differences among municipality types, assessing a town's attitudes, assets, and interest in EGI would be useful. For example, *Optimistic and Capable* towns, which have the most area available and greatest support for public green space, as well as the most favorable EGI attitudes, might consider larger initiatives like community food forests or public orchards. *Unsure with Potential* towns may have ample space, but a better understanding of how they could support EGI in the long-term would be needed before taking steps like changing land use codes. *Ambivalent and Resource-Poor* towns may be space-limited, but they could try agrifitting or making use of underutilized spaces. *Doubtful and Unsupported* towns lack physical space and support needed for implementation, and therefore may decide that EGI is not the best land use strategy for what little public space they have. Ultimately, the needs and limitations of U.S. towns are unique, so EGI implementation also will differ.

4.5 Conclusion

EGI offers many potential benefits for towns, which can be prioritized in various ways to achieve unique municipal goals and meet the needs of residents. Municipal governments and residents would benefit from assessing the possible opportunities and challenges together. By doing so, and when EGI gains traction in the public sphere, they might find an approach that

optimizes the ecological, educational and public health benefits that are collectively valued. The use of multiple stakeholder processes, including government officials, community members, scientific or technical experts, is a strategy that towns could take to make these decisions (Dubbeling & Mertzthal, 2006).

Small towns are changing worldwide, and this has implications for managing green space in built environments (Forman, 2019). Ecosystems likely will be strained in coming decades as human population growth continues, thus heightening the need to strengthen local resilience. Access to private land could increase for some and decrease for others, which may influence the extent to which communities prioritize the use of public land for food production. If this study is an indicator, then the majority of small towns in the U.S. and likely the world over have not developed policies to promote food production in public spaces. Planning to do so on public lands would demonstrate progressive policymaking on behalf of local governments.

Chapter 5: Conclusion

5.1 Summary

In this research, we sought to understand local decision-making processes pertaining to the development of EGI policy and its use in public spaces. The benefits of EGI are well-known by scientists and practitioners of sustainable urban agriculture and agroforestry, yet adoption remains low in most U.S. municipalities. The perspectives of those in the policymaking arena ground our theoretical understanding of EGI policy processes and potential routes to adoption.

The first research objective was to understand how and why EGI policies develop in U.S. cities. We interviewed twelve individuals who were involved in EGI policy processes in six U.S. cities. A semi-structured format was used, where interviewees were asked a set of questions that allowed us to analyze responses using PET. For this exploratory study, we took a Grounded Theory approach in developing interview protocol and in analyzing responses through the use of axial coding. We used these methods because our intent was to allow themes to form organically regarding EGI policy drivers, approaches, and impacts. We applied PET because it helped us frame key elements of EGI policy processes.

We found that EGI policy processes were initiated by exogenous actors but that dedicated community leaders and government employees worked together to pass and implement EGI ordinances. Though policymaking approaches differed among the six cities in this sample, the following were common stages: 1) issues were defined by communities; 2) city governments collaborated with communities; 3) ordinances were passed, marking an abrupt shift in the land use policy paradigm; and 4) more policies affecting land use policy and EGI were developed incrementally. Primary policy drivers included improving public health, securing land tenure, managing vacant lands, the local food movement, and planning for population growth. The

greatest challenges related to EGI policy adoption were bureaucratic slowness, raising awareness of the policy, and achieving intented impacts. Dedicating time to research, hiring staff to work on EGI in the city, streamlining protocols, and working with the public can minimize these obstacles.

The second research objective was to understand the opportunities and challenges for EGI policy adoption in small towns. We surveyed mayors of towns in Virginia with less than 25,000 residents. Survey items measured environment and assets constructs from MoHuB, and intention, subjective norms, perceived/actual behavioral controls, and attitudes from TPB. We found that EGI often is absent in public spaces in small towns, and of the existing forms, most did not contain woody perennials. According to mayors, concern for how these species will be maintained over time is the greatest challenge to adoption. Open-ended comments suggested that the general availability of private land for residents of small towns may explain why they have not prioritized the use of public land for food production.

Most (~60%) mayors believed public green spaces should be protected in zoning codes for their towns, and they valued these spaces primarily for cultural ecosystem services. We used EFA to create five summated variables from 14 survey items, resulting in 5 factors related to towns' assets, environment, intention, and attitudes (constructs from TPB and MoHuB). Three of these variables (mayors' perceptions of the amount of available space, support for public green space, and attitudes regarding the implementation of food-producing trees and shrubs in their towns) were used in a K-means cluster procedure to segment towns into types based on mayoral assessments. The analysis resulted in four clusters and differences in the three variables used to generate descriptive titles—*Ambivalent and Resource-Poor*, *Optimistic and Capable*, *Doubtful and Unsupported*, and *Unsure with Potential.* Using ANOVA and Tukey's HSD, we found that

the *Optimistic and Capable* cluster were significantly more likely to intend to plant food-producing perennials and government support for food-producing perennials when compared to the *Doubtful and Unsupported* cluster (α=0.05). This signifies that existing support for green space, attitudes about EGI implementation, and physical space are important factors for EGI adoption in small towns.

5.2 Conclusion

The need to understand EGI policy in municipalities has been previously articulated (Lafontaine-Messier et al., 2016; Haaland et al. 2015), but there is little in the way of research focusing on how EGI policies evolve, and whether and why small municipalities use EGI. Our results suggest that in places where EGI policies exist, exogenous actors pushed city governments to create land use policies that are supportive of EGI. As cities adapted to new challenges, they have passed policies incrementally to reinforce land use paradigms that support the growth of EGI. Our findings demonstrate the major steps involved in passing EGI policies for six diverse U.S. cities, including the challenges they faced and suggested strategies. This knowledge may be beneficial for localities planning to pass EGI policies in terms of defining considerations regarding opportunities and challenges leading to desired outcomes.

We also studied challenges and opportunities pertaining to EGI policy and implementation in small towns. Based on mayoral opinions and perceptions of their towns, the greatest values of EGI are civic and educational benefits. Stressing these benefits may be an effective strategy if towns seek to pass EGI policies. Our findings show that towns with greater physical resources, more favorable attitudes, and greater levels of support for existing green spaces have greater intentions to implement EGI and greater capacity to pass policies and budgets in support of EGI. As such, EGI may be more feasible for *Optimistic and Capable*

municipalities. Most small towns in Virginia do not have perennial forms of EGI, nor do they have complimentary legal frameworks. Thus, it may be useful to raise awareness of the potential benefits of supportive policies among Virginia's municipal government leaders, as well as local residents, who can push their governments to act if they hope to increase EGI in their public landscapes.

Population density may influence the prioritization of EGI by U.S. municipalities. In Chapter 3, we see examples of cities where most residents have limited access to private land appropriate for food production and have passed ordinances pertaining to EGI on public land. In Chapter 4, the lack of public land and relative abundance of private land was cited by mayors as a reason against changing zoning codes pertaining to EGI. We also observe that in towns where EGI may be most feasible, population sizes are greater. Therefore, it may be useful for small towns to consider whether there are benefits that could ensue from the use of EGI in public spaces, even if the majority of residents currently have access to private land suitable for EGI.

Creating staff positions to plan and manage EGI on public lands; researching policies and programs in municipalities of comparable size, geography, and demographic characteristics; and assessing how likely a proposed policy is to achieving desired outcomes are pertinent strategies for municipalities of any size. Similarly, community conversations on appropriate types of and locations for EGI, building and maintaining public support, and the role that policy and other forms of government support should play in facilitating the growth of EGI would be wise for all cities and towns where EGI is being proposed. In larger municipalities where there may greater income inequality and cultural diversity than in small towns, including the voices of traditionally marginalized groups may be a more effective way to improve food security. Smaller towns might do well to focus on ways that EGI can enhance recreational and educational functions of existing

open space. They might also consider partnering with community organizations, schools, or places of worship to address long-term maintenance concerns, especially if the fiscal and human capital of local governments are stressed.

We intend to create a step-by-step guide outlining these strategies to be used by municipalities of varying sizes, while also specifying areas which cities and towns might benefit from focusing. Disseminating this information with local government offices may improve the likelihood of EGI adoption in U.S. municipalities, and at the very least, expose government leaders to a land use issue to which they might not have devoted significant attention. Sharing our research findings might even act as an exogenous shock contributing to local land use policy change.

5.3 Recommendations for Future Research

EGI is an understudied policy area and new patterns of policy development may emerge over time. We recommend that longitudinal studies be completed to understand how land use policies pertaining to EGI continue to evolve, especially as more cities adapt to anticipated population growth and climate change. Interview participants believed that their cities were among the first to pass EGI policies, and there may be differences in approaches of cities that adopt EGI policy in the future. It also may be helpful to study EGI policy processes using different frameworks, such as Advocacy Coalition (Sabatier, 1987), Institutional Analysis & Development (Kiser & Ostrom, 1982), Multiple Streams (Cohen et al., 1972), and Policy Networks (Rhodes, 1986). These theories highlight different aspects of policy change (Orach & Schlüter, 2016), and the use of multiple conceptual frameworks will increase the breadth and depth of our knowledge of EGI policy processes.

Our study of mayoral perspectives on EGI and land use policy is, to our knowledge, the first of its kind. Since the scope is contained to small towns in Virginia, we suggest that similar studies be completed in other states to account for regional and cross-cultural differences. Case studies of small towns where EGI policies have been formalized may be particularly valuable for other small towns seeking to enact similar policies. In the U.S., over half of municipal governments are council-manager form (National League of Cities, n.d.); therefore, we also recommend that future research incorporate the perspectives of town managers. Managers handle the administrative tasks of local government (e.g., enforcing policies and budgets; Carr, 2015; Feiock et al., 2003), and they may have different perspectives when compared to mayors on the opportunities and challenges of EGI in small towns. As we used mayors as a proxy for their towns, it would be beneficial to measure the perspectives of town residents to be compared with mayors' perceptions of their towns. Using a Co-Orientation Model (Grunig & Hunt, 1984) may be an appropriate avenue for this kind of study.

Another area of future investigation is whether adoption perspectives are influenced by the availability of private versus public land. Mayors indicated that their residents did not prioritize EGI on public land because they were already using private land. Cities, which typically do not contain ample private land for residents to implement EGI, may have taken lead on policy development outlining possibilities on public land out of necessity. Calculating ratios of municipalities' private and public land and comparing these with public attitudes on EGI, finding the median amount of public and private space per capita, and exploring the extent to which residents use private land for EGI could have implications for EGI adoption.

There are a number of appropriate journals for publishing this research, such as *Land Use Policy*, *Urban Forestry & Urban Greening*, and *Agroecology and Sustainable Food Systems*.

Also, there is an exciting opportunity to publish in *Urban Agriculture & Regional Food Systems*, which is currently calling for papers for a special issue on urban agroforestry. Partnering with the USDA National Agroforestry Center, which has recently placed a greater emphasis on increasing information to support adoption of urban agricultural practices involving the use of perennials, may be a germane approach for future studies. The Center for Agroforestry at the University of Missouri also may be able to provide guidance and support for next steps with this research.

EGI scholarship draws from several fields, including agroecology, agroforestry, urban agriculture, urban greening, and urban forestry. By exploring the role of policy in EGI adoption, we have added another lens through which to study EGI and contributed to the aforementioned fields. Moreover, we have highlighted potential pathways for EGI adoption in small towns, which have largely been unstudied. Ultimately, we hope findings from this research can be applied by municipalities across the U.S. and beyond.

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Appendix

Appendix A. Reflexivity Statement

Sustainable urban food production is an important topic to me personally, and this has influenced my research interests and master's thesis. During my undergraduate studies in environmental science at Stetson University, I developed an understanding that many of the world's most complex socio-environmental problems are linked to how we produce food—from the use of large-scale monoculture systems, dependence on synthetic fertilizers and pesticides, and exploitation of human labor. I also observed that industrialized, centralized food production can not only directly harm ecosystems and human well-being, but it often removes opportunities for communities to bond and learn together by growing food.

My experiences in Central America (Costa Rica and Guatemala) exposed me to ways of producing food in or around grey infrastructure that I had not yet observed in the U.S. For example, there are towns that I visited in Guatemala where just twenty feet of space between buildings were used for growing maize or other crops and even grazing cattle. I admired the resourcefulness of these communities, and I became fascinated by this visible harmony between food production, the built environment, and 'nature'. There are communities in the U.S. making deliberate efforts to improve the multifunctionality of open spaces, and this is why I have chosen to study their approaches and motivations.

Before undertaking this research, I assumed that EGI would be a panacea for several problems faced by U.S. municipalities (e.g., violent crime, poverty, homelessness, obesity, and heart disease). I thought that it would seriously reduce hunger among the nation's most impoverished communities just by existing. I now understand that EGI certainly can be a tool to

address a variety of social and environmental issues, but simply starting a community garden or planting fruit and nut trees in a park is not enough. Community ownership and investment from local residents and organizations of EGI is essential. Of course, support from municipal governments is also necessary, but a top-down approach may fail to build the social capital needed to ensure long-term success.

Appendix B. Coding Table

<table>
<tr><th>Process</th><th>Drivers</th></tr>
<tr><td>Initiated by the community in some form:

Community-driven, grassroots-idea comes from the people; Community group making a list of asks.

Community responses and needs aggregated.

Push from small urban farmers to make these permitted uses.

These groups inform boards, city staffers, etc.</td><td rowspan="3">Both internal and external actors:

Internal:

Push from councilmembers—any legislation requires city council action, so this is key.

Really dedicated employees-

Problem with the mayor and council president…legislative vs. executive. Staffers caught in the middle of political agendas but chose to stick with it because it was important to her. Just kept going and gathered enough momentum so that it couldn’t be stopped.

The mayor directed a number of departments to update land use code and worked with the community.

External:

University professors and students.

Community driven (see process).</td></tr>
<tr><td>General Process of Passing an Ordinance:

Legislation had to be written by Department of Planning and Development—advocacy from the community to councilmembers and this department.

Proposal for an ordinance has to go through the planning commission to provide a recommendation to the board of supervisors.

Ordinances related to zoning had to go through the city planning commission; “the city staff is often responsible for initiating zoning changes and, somewhat, zoning advocacy.”</td></tr>
<tr><td>Zoning:

“Well, zoning changes in most cities across the country, most cities if not all, require more of a public process than a simple council action, so in other words, it requires notices being mailed to adjacent and nearby property owners, and requires a hearing, a public hearing before the city planning commission and city council, as opposed to a simpler voce of council that wouldn’t have notices sent to neighbors and wouldn’t have as many processes involved.” Having these areas zoned for is an added protection because of the process required for a zoning variance, and the community saw this land as more of an asset than a house. “As time went on, and it became clear that some of these…had really become a community asset, and they had become not only the value of bringing fresh food into a neighborhood, but actually bringing neighbors together to work together to create and maintain these urban gardens, and it was worth actually protecting these in zoning rather than just as an interim use.”

Process for rezoning: “First, it gets introduced to the city council, and then it gets referred to the city planning commission, which holds the public hearing, and then it goes back to city council for a public hearing before a city council committee, and then it becomes law.”</td></tr>
<tr><td>A stakeholder group/committee was formed
Stakeholders were diverse—concerned citizens, non-profits, researchers, mayor’s offices, planning officials, public utilities
Several food policy boards or sustainable food boards formed in these cities to tackle several issues.</td><td>Public health: Increasing food access, healthy food access, local food/healthier diets, improving health and wellness and community health and wellness

The Dept. of Public Health motivated the mayor to issue a directive on food security. Executive director worked with them to rethink the urban culture and ordinances.</td></tr>
<tr><td></td><td>Address land security/land tenure issues (this is critical to promote the growth of perennials):</td></tr>
</table>

"Engagement process with stakeholders to vet whether this is something that is good, and then something is drafted. There needs to be a legislator involved in the process usually because, in order for it to be adopted, there has to be some kind of councilperson sponsoring it so there may be 1,2,3, or more council people who are involved in that."	Protect areas where they already had green space and didn't want land to be developed. "The primary reason for adopting the policy was to provide land security for community leaders who have been caring for land in their neighborhood for a long time, so to protect the greenspaces in neighborhoods, and to secure those spaces for the community." "The city at that time had an adopt-a-lot program, which it still has, but it's only from year to year and can be cancelled from time to time. So, basically, it provides no security at all. And people come to think of the land as their communities, and they put so much effort and love into it, but from the city's point of view, it's not theirs at all, except they know that the neighborhood could mobilize the press, and it would be pretty ugly if they try and sell it."
Process is unique/specific to the locality: No other cities to look at for this really, so creative process. Understand what issues are important to your city and think of those in advance (ex: one city the protection of industrial zones was important, so they were sure that the ordinance would not upset the industrial land lobby). Food policy gets personal and emotional, and it's a different conversation. Working on a parcel-by-parcel basis for rezoning. Involved early on in the wave to do this kind of thing, so not many examples. On "the front edge" although worked with the state to do some things in a partnership, couldn't necessarily look to other cities. Some did look to cities of similar sized and realized that they were lacking these spaces. "custom-tailored to the needs of the city"	**Vacant Land:** City needs a better way to deal with the problem of vacant lots. Decreasing population—increase in vacant lots (thousands of them) Once had manufacturing jobs but the vacant land within neighborhoods meant that they had available land for these kinds of activities. So many vacant properties, and not having them zoned for means the city can do what it wants. You don't want to charge communities with the spaces they are taking care of.
Collaboration between the community and the city: Many community members involved in gardening/farming. City planners working with the neighborhoods who wanted extra protection if they thought there was a strong market for rea estate and they wanted to keep their garden area. If areas had weaker real estate markets, they didn't feel the need to rezone because there were not really threats to the community spaces. Working closely with councilmember and staff people: "I do know that there were a couple of councilmembers who were champions of it."	**Proactive policymaking and preparing for future population growth:** "What we do know as a city is that the world population is increasing, and what we want to do as a city is prepare areas to be repopulated, so maybe every single parcel won't become a housing development site; however, we have to be strategic and look at the

"_____ kind of helped us understand the policy process and how to frame things, and helping to sponsor a lot of the things we submitted." Another councilperson helped them get the staff position. "There was a big public information process, so once they get the legislation, it's an enormous book, it's an enormous map. And City Council holds all power in legislation…and decide what's what."	infrastructure developments that have taken place overtime." Facing a lot of growth and the need to do it sustainably. The future is unpredictable, and having a tool to deal with it ahead of time is good: "We have a process set up to take care of that where we're not having to deal with a surge in public interest." Encouraging sustainable agriculture in the city In the face of population growth, trying to grow sustainably: "Now the council prioritizes sustainability because of our huge growth."
Policies are never perfect and always evolving: Re-writing land use code rather than utility policy, but allowing the city to tackle huge land use issues. Can't do it all. "the process is still convoluted, even one staff person isn't enough, so now we're asking for another one…" "You're going to realize that when you were developing the process, there was some little piece you forgot. So in doing the work for example of transferring land, what we learned is that one of the things we need to get the city to do before they transfer the land is to look at the past, to make sure the water bills prior to this go down, and that's something we discovered while transferring the land and then getting billed, and then having the city correct it after the fact that we need to amend the policy to have it be a product of the community." "There will always be a department that does some piece of the work, that the people you're working with wouldn't have thought about." "The biggest advice that I would give is to make sure that everyone understands that it's a living document that's gonna grow and change as your city grows and changes."	**Streamlining the Process:** The process for using land for agricultural purposes was very convoluted and required navigating the bureaucracy, which mean that people wanted to streamline the process. "We needed a single point of contact between the citizens and my position, we were basically having to call different city departments and navigate this really complicated bureaucracy to get a community garden on city land.
Timeline: **Sometimes quick:** 1-2 years, pretty quick…didn't take very long and not too controversial. Adding ordinances about animal husbandry is usually trickier. In one case, the completely new legislation went right over people's heads. "Using them as growing areas for fruits and vegetables, basically…really there wasn't any opposition to doing that. It was not a protracted process. It took longer to identify where these particular parcels should be rezoned, and generally it tended to be where there was	**Making policy to fit the public agenda and changing culture/local food movement:** Taking action on parts of strategic city plans or other agendas, like declaring "A Year of Urban Agriculture". "the local food movement was sort of beginning to gain broader acceptance

some threat of development of something other than [green space for food production]." 3 years: ordinance passed in 2011 but written in 2008. "I think actually part of the delay was that we kind of had to change tactics a little bit. Originally we were going to send a letter to the City Council, but then with the Food Policy Board in formation, it ended up making more sense to wait until that got formed a little more since that was kind of their purpose. So you know, it was a great thing that it got formed, but at that point, it did actually cause a delay in that process, so that was part of it…maybe the turnover between my predecessor and me."—possibly staff turnover or groups forming, wanting to take the most logical approach. A board was already forming, so wanted to use them. 6-8 months from the time the group approached the city…a typical legislative timeline with many meetings with the city agencies and the stakeholders…introductions, hearings, back to board of supervisors and the mayor signing it. "I would say it was more than a year process, but I do think it went pretty quick because there was some urgency around the land use code…I would say two years." Less than a year. **Regarding PET:** the momentum started in the communities probably a long time ago, but it's harder to track when the initial interest was sparked. Also, several policy offshoots from these policies. They represent a broader movement and policy agenda within the city. Hard to pin point one specific policy in some cases. Also, there are several cases where the policies keep building off each other, representing incremental change. Many of these cities are implementing a combination the allocation of financial resources by city government to fruit and nut tree planting initiatives, tax breaks and reduced water costs for urban ag land, allowing land bank parcels to become land trusts, allowing land bank parcels to be rezoned as districts for urban gardens, or passing ordinances to allow plantings on city-owned land. It makes sense, when a city has a policy agenda/path they're on, and in many cases these are written out in strategic plans.	or there was a greater awareness about local food as a strategy to improve health and wellness and community health and wellness." Working to take action on comprehensive plans for cities. Possible correlation between this and the recession, since many of these happened 2008-2009ish. "They don't get into how to grow food until a recession hits. But 10 years into the expansion and they forget it. When a recession hits again, there will be a renewed interest." –and the policy will be in place to deal with it. A commission on sustainability was forming in the city, and they wanted to make a sustainability plan, and the person was asked to be on one of the committees. Public opinion: "Parks and Rec just did a real big community survey and had a very high number of respondents who prioritized community gardens, and I think more than most people expected"
Research: "We did an in-depth research study into all the land trust models, you know, other land trust models in other cities that are similar to Baltimore and some that are not, and that is how we made the case for having a land trust here and having the model." Had whitepapers produced, which informed their policy suggestion. "We can always try to look at other places when we do these things because why recreate the wheel?"	**Staff:** "We really wanted to have someone who was employed by the city to work across departments to work on food systems issues." Staff members forming to deal with these after ordinances passed and boards formed to be either coordinators or food policy directors. "If you don't have anyone who is paid to do that in the public sector, then you definitely don't get as many

	things to happen…that's our experience for sure." **Having a staff position already created to handle these kinds of issues (dedicating resources beforehand):** "I think probably the functions of that job formed this project and that kind of policy approach." City attorney is involved in the legality of establishing fruit and nut trees on public land. The attorney drafts the language, keeping in mind the zoning code and safety restrictions/building inspections. *Having staff before and after to dedicate resources to these issues.*
Land banks (a starting point): May have started out with a land bank, which takes in the vacant land that may not be taken care of or had a demolished structure…through aging out of foreclosure…if the owners don't want to deal with taxes or other costs then it goes to the city's land bank. Got federal funding to stabilize neighborhoods. The land bank's purpose "was to try to find developers to build housing or other things…but the idea was that the city was a more responsible steward of this land and to find developers who had the best interest of the community than a spectator might." City then decided to lease the land to the neighborhoods instead so that they can be gardens and farms, but even this had security issues. "Where the zoning came into play is when some of these urban gardens had become well-established and been there for years and really had become neighborhood assets in many people's minds, then there was this issue, well of course, the city can always at the drop of a hat" develop the land. Land bank was always considered an interim thing rather than permanent solution for plots. "if you're a farm, it's a risky business, so it should totally be protected while you're doing it, but if the resources aren't there to make a permanent promise, you can just hand it to a land trust that can promise to permanently preserve it as long as you are taking care of it."	**Wanting the force of law—pass an ordinance:** "There are a couple of ways to get business done. There are different legislative processes we can use, and by in large, we pass mostly resolutions. They're good to have in that they have some oomph behind them, but they're not like law. You should strongly adhere to them, but they're not necessarily a law. So we could form a resolution if we wanted to join a society, or the city wanted to have membership in some kind of membership-based organization, and to allow this, we would pass some sort of resolution to be able to accept grant funds and disperse grand funds. But if we want to do something and actually have that be law, then we establish an ordinance." "An ordinance adds a higher level of adherence to it [the policy]."
Involving the community: Community meetings—announced meetings in a neighborhood vs. public hearings—as ordinance is introduced before city planning commission and city council. Working with the public by having hearings made everybody happy…a real feel good moment.	

Need public hearings and meetings to engage stakeholders. Have people voice their input… "If you want to create a policy, you need to consider the community's input." Be transparent. "As policymakers, you can't just do things in a vacuum." Health impact assessment methodology to help to develop a policy to engage the community. "I was shocked at how emotional talking about food was and people got…it was very personal. And I was just unbelievably surprised at how personal food was for everybody, if we're talking about growing things, and so it was a different kind of policy conversation that happened because it was so personal…it's the only word I can come up with." Compromising with the community when necessary (like a land swap, and like preserving industrial lands so not allowing activities on areas zoned for that use). City doesn't have all the answers—listen to the people of the neighborhoods. "City government, by its nature, takes a top-down view, and that's not how life is necessarily, and I think there came to be an understanding of like, we're not going to be a city of nearly a million. And if people are building assets, then we should be happy."	
Key Partnerships: Cities can use state resources and departments to inform policymaking. Strengths of farming techniques, forestry knowledge, etc. in combination with knowledge about zoning and the policymaking process. Cities may also want to partner with non-profits to manage and maintain the spaces. Small group of people forming a non-profit and then working with the city. "I was paid as a consultant to go sit at a desk in city government once a week and work with staff and work with that agency and other agencies to create a policy that would be the city's own policy for transferring land to a land trust." **Collaboration between departments within the city:** "There was a working group and we were having a bunch of meetings…we did an awful lot of going around to keep people, including the comptroller, the mayor, and the council president [engaged in the process]." Identifying what public lands were available and how they could be used, and I remember having a pretty important meeting between our parks department, and watershed protection, and real estate, and kind of bringing together basically these kinds of city departments that have never really gathered to talk about foo production on city land." **There is a referral process:** "it had to go through a lot of committees like Public Works and Parks and Recreation….so it had to wind its way through that meeting schedule."	
In some cases, Food Policy Board/Councils form to tackle issues (then they form policies from within the government or quasi-government): There had been an attempt to have one before but failed. The board is still relatively new. "There are a series of board and commissions who	

are technical experts and provide technical expertise and work because the city council can't be an expert on everything." "The city is a city-manager model, and so our mayor is not the mayor that controls everything. The mayor is part of our city council, and they direct the city manager through resolutions and ordinances, and then the city manager directs staff. SO the way that they do it here is they have a series of boards and commissions…and they use their boards and commissions to advise them on different policies and policy development and implementation, and some boards and commissions are more powerful than others…like the planning commission, for example." The board members are appointed by the city council. Since they were also a city-county board, they were appointed by county reps as well. A citizens' advisory board is made of volunteers who are not paid but were still appointed by the city council and have a lot of input. They are valued by representatives because they are experts.	
Working within the existing structure of the government: "One thing that works really really well for how we do what we do is that the policy was developed with city government. So, as it was being designed, it was designed with the understand of how they operate and their own structures, right and so, the way that our policy works is that we're not using some policy that's foreign to the infrastructure of the city. We're using the policy that was created with them, and therefore follows some of their normal protocol. So, we have to draft a memo on behalf of the director of parks, for example, which wouldn't be a normal non-profit style of doing things. And so, the director signs off on the memo, so we have forms that are very similar and based in their forms and their officials will then sign off." "I felt that a lot of the things we have done here is maybe different than other cities, that we had a real active group of people who wanted to make sure that food was on the table and food systems were on the on the table in terms of policymaking, but it wasn't a super grassroots-y kind of a thing. It kind of came from a 'let's work within the government structure' to make sure that this is paid attention to and some resources go towards it." (Although a list of policy concerns were still compiled by the community).	
Operationalization/formalization of the ordinance (addressing long-term maintenance concerns): Mission and outreach, developing "a unifying process that could we could use to handle the applications. So every application that comes in, we want to make sure that everyone knows how to handle it. Safey: Have a system in place to make sure that it's safe. You wouldn't want to grow edible products in a location that was once a landfill, for example. Having a permit system "takes the guess work out of it on public land," so that the city can "make sure you have a planting plan, a harvest plan, something like a maintenance plan, and they can go about their lives	

doing it. They don't have to pay for it, but we have a formalized process so that we know what's going on in the park or engineering land so that staff don't come through and mow it down or cut it down." *Communication between the city and the people—this makes sure that everyone is working together and is on the same page.* Just passing the ordinance isn't enough, and developing standard operating procedures for staff is important. Implementation can take several years.	

Appendix C. Survey Cover Letter

VIRGINIA TECH

Forest Resources and Environmental Conservation
310 West Campus Drive
Blacksburg, Virginia 24061
P: (540) 231-5483
frec@vt.edu

October 1, 2019

Dear [Name],

My name is Sarah Coffey, and I am a student in the Department of Forest Resources and Environmental Conservation at Virginia Tech. I am writing to ask for your help with a student project to understand the perspectives of Virginia Mayors on planting community places with trees and shrubs that provide food. Places where this "edible green infrastructure" might make sense include public green spaces such as parks, community gardens, green corridors such as "rails-to-trails" pathways, and street ways. The study is titled "Edible Green Infrastructure in the United States: Policy Approaches and Drivers at the Municipal Level," and I work with John Munsell, Associate Professor at Virginia Tech.

We hope to better understand the challenges and opportunities associated with passing ordinances or taking other steps that promote these kinds of edible green space projects. Your responses to questions in this short survey (no more than 10 minutes) will inform other municipalities in the United States and beyond about the opportunities and challenges associated with intentionally planting food-producing trees and shrubs in public spaces. Please know that we are interested in hearing from you no matter what you think about the topic (i.e., good or bad idea – we want to know!). We will also send you a summary of the results of this study so that you know what the Virginia mayoral community thinks.

In the next week, we will send you a questionnaire along with a pre-paid self-addressed and stamped envelope to complete and send back to us. You will also have the option to complete the questionnaire over the phone. If you would like to take the survey over the phone, you can indicate this on a response card that will be sent along with the questionnaire and mail it back. We will reach out to schedule a call if we receive a card from you. Please understand that the survey is voluntary, and your responses will remain confidential, but the general results may be published. *We understand the importance of your public service and will take every measure to ensure your confidentiality*. For questions about your rights, email the Virginia Tech Institutional Review Board at irb@vt.edu or call (540) 231-3732.

If you have any questions, please contact me at (860) 449-3830 or secoffey@vt.edu. We hope you will enjoy sharing your thoughts and opinions when completing the questionnaire. We look forward to hearing from you.

Respectfully,

Sarah Coffey
Graduate Student, Virginia Tech
secoffey@vt.edu

John Munsell, PhD
Associate Professor, Virginia Tech
jfmunsel@vt.edu

Appendix D. Survey Instrument

Public Land and Food Forestry: *What do you think?*

A Short Survey for Virginia Mayors

By
Virginia Polytechnic Institute and State University
Department of Forest Resources and Environmental Conservation
Blacksburg, VA 24060

Instructions

We want to understand your views as Mayor regarding the planting of food-producing trees and shrubs in public places in your town. Places where this "edible green infrastructure" (i.e., food forests) might make sense include, but are not limited to, public green spaces such as parks, community gardens, green corridors such as "rails-to-trails" pathways, and street ways. Your responses to this short survey will help inform other municipalities in the United States and beyond about the opportunities and challenges associated with intentionally planting food-producing perennial woody species in Virginia's public spaces. The survey should take no more than 10 minutes, and, by law, your responses will be confidential. *We understand the importance of your public service and will take every measure to ensure your confidentiality*. Before taking the survey, please be sure you have read the consent for participation below. Thank you very much for participating. We will send you a general summary of the results so you can learn about the perspectives of other Virginia Mayors.

Consent for Participation

You will be participating in a study called, "Edible Green Infrastructure in the United States: Policy Approaches and Drivers at the Municipal Level." The investigators are myself, Sarah Coffey, a master's student in the Forest Resources and Environmental Conservation Department at Virginia Tech, and my advisor and Associate Professor in the department, John Munsell. The purpose of this research is to learn how and why policies on edible green infrastructure have come into place and what barriers exist to adopting them. We hope our findings will be used by cities and towns who are interested in enacting this kind of legislation or developing programs to promote EGI in public spaces.

You are one of 177 Mayors in the Commonwealth of Virginia whom I am asking to participate. During the 10-minute survey, you will be expected to answer my questions to the best of your ability and to be honest in your responses. Your responses will be kept anonymous in any data that is shared, meaning that your name and your town will not be shared with anyone. Any information identifying yourself will be protected and confidential. Your participation in this survey is completely voluntary, and you can stop the survey at any time. This research involves no known risk to you, and there are no tangible benefits to you for participating in this research. It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research. Your participation in this survey indicates that you have given your consent.

I, Sarah Coffey, can be contacted at secoffey@vt.edu or at (860) 449-3830. John Munsell can be contacted at jfmunsel@vt.edu. If you should have any questions about the protection of human research participants regarding this study, you may contact the Virginia Tech Institutional Review Board at irb@vt.edu or (540) 231-3732.

Section 1 – Public Green Space in Your City/Town

1) **To the best of your ability, please estimate your level of agreement with the following statements (Circle only ONE number for each).**

Green space is space intended for public use that contains primarily vegetation (grass, trees, shrubs) but may also be in combination with trails, benches, tables and other infrastructure to enhance the recreation, social gathering, or other uses of the site.

Statements	How much do you agree with the statement? →				
	not at all	a little bit	somewhat	mostly	completely
We have ample public green space in my town	1	2	3	4	5
Preserving public green space is a top priority in my town	1	2	3	4	5
Public green spaces are rarely visited in my town	1	2	3	4	5
Increasing public green space is a key objective in my town	1	2	3	4	5
Codes in my town are conducive to public green space	1	2	3	4	5
Producing food in public green space is popular in my town	1	2	3	4	5

2) **In your opinion, what kind(s) of public green space, if any, should be protected in the zoning codes for towns your size? Examples include…**

_____

_____

3) **Which of the following do you feel are benefits of public green space? (Check ALL that apply).**

- ☐ improving public health
- ☐ providing spaces for education
- ☐ providing places for recreation/sports
- ☐ improving stormwater management
- ☐ providing jobs
- ☐ promoting social gathering or community building
- ☐ connecting people to nature
- ☐ benefiting pollinators and wildlife
- ☐ beautifying the environment
- ☐ providing spaces for food production
- ☐ other (*please describe*)_____

4) **As Mayor, please rate the extent to which you feel your city/town has the following resources to manage public green space.**

Budgets (i.e., financial line items, in-kind public staff time)

Budgetary capacity/means increase from left to right →

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

Physical Resources (i.e., equipment, skilled technicians, waste management infrastructure)

Physical capacity/means increase from left to right →

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

Community Allies (i.e., stakeholder buy-in, green space advocacy groups, community volunteers)

Social capacity/means increase from left to right →

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

5) Is food production in public green space explicitly referenced in any of the zoning codes in your town?

☐ yes ☐ no → *If No, skip to question 6.*

Please describe.

_____

_____

_____

6) Are there any existing ordinances, resolutions, or other legal constraints that interfere with food production in public green space in your town?

☐ yes ☐ no → *If No, skip to question 7.*

Please describe.

_____

_____

_____

Section 2 – Mayoral Approaches to Policymaking

For questions 7-10, please circle the option you agree with most.

7) **What is your preferred approach to policymaking?**
   a. modifying current policies
   b. developing new policies
   c. a combination of both *a* and *b*

8) **How do you think the most effective policies are developed?**
   a. slow, incremental changes
   b. rapid, abrupt changes

9) **Land use policy in my town has evolved…**
   a. rapidly in the last few years
   b. slowly over time

10) **When a problem arises in your city/town, which do you think is best?**
   a. passing new legislation to address the problem
   b. modifying current legislation to address the problem
   c. a combination of both *a* and *b*

Section 3 – Food Production in Public Green Spaces

11) **In my town, we have…**

☐ community gardens ☐ community food forests ☐ public orchards
☐ fruit and nut trees ☐ edible plants in medians or right-of-ways ☐ rooftop gardens
☐ other (please describe) _____

12) **To your knowledge as Mayor, have municipal funds been explicitly directed in recent years to support the planting of food-producing trees and shrubs in public green space in your city/town?**
☐yes ☐no

13) **As Mayor, please rate the extent to which the planting of food-producing tree and shrub species in public green space has been or could be supported in your city/town.**

Policy (i.e., zoning codes, park management planning, repurposing abandoned lots)

Policy capacity/means increase from left to right

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

Budgets (i.e., financial line items, in-kind public staff time)

Budgetary capacity/means increase from left to right

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

Physical Resources (i.e., equipment, skilled technicians, waste management infrastructure)

Physical capacity/means increase from left to right

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

Community Allies (i.e., stakeholder buy-in, green space advocacy groups, community volunteers)

Social capacity/means increase from left to right

No capacity/means		Some capacity/means		Sufficient capacity/means
1	2	3	4	5

You are halfway done already. Thanks for your time!

14) **To the best of your ability, please estimate your level of agreement with the following statements (Circle only ONE number for each).**

Statements	How much do you agree with the statement?				
	not at all	a little bit	somewhat	mostly	completely
Planting food-producing trees and shrubs in public green space is a low-priority issue in my town	1	2	3	4	5
I think it would be easy in my town to increase government support for food-producing trees and shrubs in public green space	1	2	3	4	5
My town has a substantial amount of public green space where planting food-producing trees and shrubs can be grown	1	2	3	4	5
My town is actively exploring how to increase the use of food-producing trees and shrubs in its public green space	1	2	3	4	5
The costs of planting food-producing trees and shrubs in public green space outweigh the benefits in my town	1	2	3	4	5

15) **Check ALL of the following that you feel would slow down your city/town from planting food-producing trees and shrubs in public green spaces. *(If nothing, check nothing would slow us down).***

- ☐ lack of physical space
- ☐ hazards related to reduced visibility
- ☐ changing the aesthetic of my town
- ☐ food safety concerns
- ☐ nothing would slow us down
- ☐ long term maintenance and care
- ☐ hazards related to fallen fruit or nuts
- ☐ competing land use interests
- ☐ other (*please explain*)_____

16) **Check ALL of the following public green space food production systems included in the zoning codes for my town. (*If nothing, check we do not include any food systems*).**

- ☐ community gardens
- ☐ community food forests
- ☐ public orchards
- ☐ fruit and nut trees
- ☐ rooftop gardening
- ☐ edible plants in medians or right-of ways
- ☐ other (*please list*) _____
- ☐ we do not include any food systems

17) **As Mayor, do you think that including these food production systems in zoning codes is the best way to encourage these uses in your city/town? *(Please explain why).***

☐ yes ☐ no

Why?

_____

_____

18) **Are there any existing ordinances, resolutions, or other legal constraints that interfere with the protection of the following in your city/town? Please check all that apply.**

- ☐ community gardens
- ☐ community food forests
- ☐ public orchards
- ☐ fruit and nut trees
- ☐ rooftop gardening
- ☐ edible plants in medians or right-of ways
- ☐ I don't know
- ☐ there are none

19) **Are there any other constraints that were not covered in this survey that impact the food production systems in green spaces in your city/town?**

☐ yes ☐ no → *If No, skip to question 20.*

Please describe.

_____

_____

Section 4 - General Information

20) **Are you?** ☐ Male ☐ Female

21) **What year were you born?** __ __ __ __

22) **What is the highest level of school that you have completed?**

- ☐ Some high school
- ☐ High school graduate or GED
- ☐ Some college
- ☐ Associate/technical degree
- ☐ Bachelor's degree
- ☐ Graduate degree

23) **How long have you been the Mayor of your city/town?** _____ year(s)

24) **What is your political preference?** ***(Check only ONE please).***

☐Very liberal ☐Liberal ☐Slightly liberal ☐Moderate
☐Slightly conservative ☐Conservative ☐Very Conservative

25) **What is the primary political preference in your city/town?** ***(Check only ONE please).***

☐Very liberal ☐Liberal ☐Slightly liberal ☐Moderate
☐Slightly conservative ☐Conservative ☐Very Conservative

26) **Would you be interested in participating in a *short* *(no more than 15 minutes)* follow-up phone call to discuss your views on food production in public green space in detail?**

These conversations are very helpful for understanding context, but they are voluntary. The phone call will not be recorded, and more information regarding giving consent will be given before participation. If you would like to participate, please provide a preferred phone number, and good times and days to call. Otherwise, leave below blank.

Phone:_____
Good times to call:_____
Good days to call:_____

27) **Is there anything else you would like us to know? If so, please use the space below to tell us.**

You are finished. Thank you for your time and participation!

Appendix E. Institutional Review Board Permission Letter

VIRGINIA TECH

Division of Scholarly Integrity and Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE:	May 14, 2019
TO:	John F Munsell, Sarah E Coffey
FROM:	Virginia Tech Institutional Review Board (FWA00000572, expires January 29, 2021)
PROTOCOL TITLE:	Edible Green Infrastructure at the Municipal Level: Policy Approaches and Drivers
IRB NUMBER:	**19-379**

Effective May 14, 2019, the Virginia Tech Human Research Protection Program (HRPP) and Institutional Review Board (IRB) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category(ies) 2(i),2(ii).

Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit a new request to the IRB for a determination.

This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Determined As:	**Exempt, under 45 CFR 46.104(d) category(ies) 2(i),2(ii)**
Protocol Determination Date:	**May 14, 2019**

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.