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The integration of 18th and 19th century subsistence farming practices into the planning and x-zoning laws of the city and county of Baltimore

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The Integration of 18th and 19th Century Subsistence Farming Practices into the Planning and Zoning Laws of the City and County of Baltimore

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List of Abbreviations

Agencies

FAO...United Nations' Food and Agriculture Organization

MDP...Maryland Department of Planning

NASS...National Agricultural Statistics Service

NOAA...National Oceanic and Atmospheric Administration

USDA...United States Department of Agriculture

USGS...United States Geological Service

Measurements

Brl...Barrel

Bsh...Bushel

Cal...Kilocalorie

Cwt...British Hundredth Weight

G...Gram

GDU...Growing Degree Units

Ha...Hectares

Ib...Pound

In...Inches

Kcal...Kilocalorie

kJ...Kilojoules

Mm...Millimeter

RDA...Recommended Daily Allowance/Amount

Tbls...Tablespoon

Zoning

B.L. .... Business Light Zone

B.M. .... Business Major Zone

B.R. .... Business Roadside Zone

B-1 .... Neighborhood Business Zone

B-2 .... Community Business Zone

B-3 .... Community Commercial Zone

B-4 .... Central Business Zone

B-5 .... Central Commercial Zone

D.R. .... Density Residential Zone

E.A.R. .... Elevator, Apartment Residential Zone

FAR .... Floor to Area Ratio

M.H. .... Manufacturing Heavy Zone

M.L. .... Manufacturing Light Zone

M.L.R. .... Manufacturing Light Restricted Zone

M.R. .... Manufacturing Restricted Zone

M-1 .... Industrial Zone

M-2 .... Industrial Zone

M-3 .... Industrial Zone

MLC .... Maximum Lot Coverage

O.3 .... Office Zone

O.R.1 .... Residential Office Zone

O.R.2 .... Residential Office Zone

Zoning

O.T. .... Office Technology Zone

PUD..Planned Unit Development

R.C. .... Resource Conservation Zone

R.C.C... Resource Conservation Commercial Zone

Other

BFPI .... Baltimore Food Policy Initiative

BMP ....Best Management Practices

CSA...Community Supported Agriculture

GIS .... Geographic Information Systems/Science

Abstract

The Industrial Revolution divorced the majority of urban dwellers from the land in the United States. Today, people rely upon industrial food products from global food systems. These systems cause environmental pollution, land degradation, and loss of biodiversity. Additionally, there is unequal food distribution in these systems with poor farmers growing for production and not consumption. The rigid distribution system through grocery stores often leaves poor economic areas without access to fresh, healthy food.

The solution to these problems is a return to local food systems, where people can grow or have access to fresh, local food. However, local food systems are not always legal in the planning and zoning codes for municipalities. The purpose of this study is to integrate 18th and 19th century subsistence farming practices into the planning and zoning codes, legalizing the expansion of the local food system. In addition, the study calculates the amount of land available for the food system and the best crops types for the study areas. The study areas are the City and County of Baltimore, MD.

The results for subsistence farming practices originated from a literature review. All other generated results were from mathematical models using data from the USDA, USGS, NOAA, and nutritional almanacs. The study found six subsistence farming practices applicable for integration into the study areas' planning and zoning laws. In the study areas, 108,700 acres are available for cultivation. This represents 40% of the 306,000 acres required to feed the populations. The climate and soil conditions allow a wide variety of crops for cultivation. The results do not represent the total cultivatable land within the study areas due to lack of data regarding open space available for all

zoning types. The integration of the subsistence farming practices requires minor amendments to the zoning laws. However, a noncompeting local food system between the study areas requires new regional planning legislation. Through this research, the City and County of Baltimore have the basis for such legislation. Thus, combating the existing food deserts and gaining additional food security for the region.

I. Introduction

With the Industrial Revolution, people living in urban areas became divorced from the land. We created industries that drastically alter the natural environment through raw material extraction, transportation, production, consumption, and waste generation. One such industry in the United States (U.S.) is industrialized agriculture, which uses heavy machinery along with synthetic inputs to produce crops (U.S. Census Bureau, 2012). This industry characteristically has long supply chains, commodification of crops, large corporate farms, and disintegration of local farmers in America. Currently within the United States, less than 1% of its 308 million population claim farming as an occupation (U.S. Environmental Protection Agency, 2012). Less than 1% of the U.S. population holds the knowledge and land to feed the entire nation.

It is the view of this paper that the current practices of industrialized agriculture, with the majority of the population divorced from the land, are unique in human history (Lui, Duan, & Yu, 2011). We have come to expect agricultural products to be available year round without thought of how or where the crops grew, conditions of harvest, and the energy required to transport, house, and sell (Lyson & Guptill, 2004). These expectations were not always prevalent; there was a time, not so long ago when populations fed themselves through subsistence farming (Ellis & Wang, 1996). Another trend within America's poor urban (rust belt cities) regions is the unavailability of fresh, healthy food due to a lack of supermarkets. The aim of the dissertation is to analyze if 18th and 19th century subsistence farming practices can be integrated into modern day urban and suburban landscapes through planning and zoning within the City and County of Baltimore.

The subsequent sentences detail the paper in its entirety. The Literature Review discusses background information regarding local food systems, industrial agriculture, land use planning, and U.S. farming since the 1860s. In addition, this section presents the 18th and 19th century subsistence farming practices and urban agricultural systems. Lastly, the section details the study area locations of Baltimore City and Baltimore County. These are acceptable study areas because I live in the Baltimore area, existence of food deserts, presence of urban, suburban, and rural landscapes, and displayed willingness for local food system legislation.

The Methodology section describes the processes utilized for selecting the subsistence farming practices and ultimately the amount of land available for the local food system. In addition, this section details the processes for calculating the amount of land available that includes acres needed to feed the study areas, total kilocalories needed to nourish the populations, and Calories per acre for cultivation. Lastly, the section details the method for crop selection within the cultivatable land and techniques used for GIS visualization.

The Results section presents the findings for the paper including subsistence farming practices, acreage needed to feed study areas, acreage available for a local food system, and crop selection. The Discussion section explains whether the subsistence farming practices can function within the current planning and zoning laws and the changes that need to take place if not allowed. In addition, this section examines crop placement within the study areas along with the benefits of the crop selection. Lastly, the section examines the full extent of cultivation within the study areas and implementing changes to allow for a unified local food system between the study areas. The paper ends with a conclusion about the main findings.

II. Literature Review

The literature review details the historical context of the decline of local food systems and farmers in America. In addition to the historical context, this section reviews the concepts of industrial agriculture, land use planning, and subsistence farming practices of the 18th and 19th centuries. The evaluation of these practices helps determine the feasibility for integration into the study areas' planning and zoning regulations for the development of a local food system. A discussion of how urban agriculture is a vehicle for implementation of the subsistence farming practices into the urban environments of the City and County of Baltimore. The discussion of energy value and nutrient content of foods provide the basis for the selection of crops suitable for the soil and climate conditions of the study areas.

The literature review proceeds in the following subsections local food systems, 18th and 19th century subsistence farming practices, agriculture and land use planning, and current urban agriculture occurring in U.S. cities. Following these subsections are the energy values and nutrient content of crops, the political threats to local food systems, and a discussion on the study areas of Baltimore City and Baltimore County. The discussion of the study areas includes soil types, climate patterns, demographics, planning and zoning regulations (regarding agriculture), growth trends, and the current state of the local food system.

Local Food Systems

Global food corporations currently dominate food systems in America. These trends have occurred post WWII with the onset of the "Green Revolution." However, many in America do not prefer these global food systems, specifically some residents in the City and County of Baltimore (Baltimore Office of Sustainability, 2010). Over the past 10 years, these localities have developed local food systems to combat inadequate distribution, environmental degradation, and biodiversity destruction cause by industrial global food systems.

A local food system is a collaborative effort to build a locally based food economy (Goodman & Goodman, 2009). Currently, there is not a legal or universally accepted definition of a local food system (Martinez, et al., 2010). The geographic distance meant by "local" has different adaptations between 100 miles to within the same state (Jarosz, 2008). Regardless of actual distance, local implies a short supply chain between grower and consumer. For the purposes of this study, the local food system is within the City and County of Baltimore.

A second characteristic of a local food system is the small farm size and scale of operations, often less than 50 acres (Jarosz, 2008). In addition, operations are normally of an organic or holistic manner, not relying upon synthetic inputs or genetically modified seeds (Jarosz, 2008). The third characteristic is the existence of alternative food purchasing venues. The venues include food cooperatives, farmer's markets, community supported agriculture (CSA), and food-to-school partnerships (Jarosz, 2008). The final characteristic of the local food system is the "commitment to the social, economic, and environmental dimensions of sustainable food production, distribution, and consumption" (Jarosz, 2008).

Recently, local food systems have developed within metropolitan regions in the United States. Detroit, Michigan and Milwaukee, Wisconsin have extensively developed local food systems. In both cities, the system started by combating food deserts within the cities. Food deserts are "places where people do not have easy access to healthy, fresh foods, particularly if they are poor and have limited mobility" (Corrigan, 2011). Detroit created an extensive network of school gardens to provide food, gardening education, and revitalization of vacate lots (Detroit Food Policy Council, 2012). Will Allen developed Milwaukee's local food system in 1993, in response to a food desert at a local housing project (Growing Power, 2013). He founded Growing Power, Inc. a non-for-profit organization providing food and education at their local farms in Milwaukee and Madison, Wisconsin and Chicago, Illinois. (Growing Power, 2013).

18th and 19th Century Subsistence Farming Practices

The integration of subsistence farming practices is necessary within the study areas' planning and zoning regulations to create a local food system. The goal of integration is to provide guidance and direction for updating the planning and zoning laws, allowing for a local food system. Subsistence farming participation dates back to the agricultural revolution. Subsistence farming is a "farming or a system of farming that provides all or almost all the goods required by the farm family usually without any significant surplus for sale" (Merriam-Webster, 2013). However, since the Industrial Revolution, most urban dwellers do not cultivate their own food. The following paragraphs discuss subsistence farming practices of the 18th and 19th centuries.

The choice to use 18th and 19th century subsistence farming practices is because these periods mixed pre-industrial and industrial societies. Agrarian societies dominated the 18th century throughout the world, while the 19th century saw an explosion of industry and migration to cities in the West. The agrarian society fits more closely to the rural character of Baltimore County, and the industrial society fits the urban areas of the City and County of Baltimore. The 18th century practices persisted into the 19th century in the rural regions. However, the 19th century introduced land and time shortages within urban environments for agricultural practices.

Research revealed that 18th century subsistence farming practices were similar throughout the world with the exception of crops species, typed of livestock, and land ownership. A practice of subsistence farming was to cultivate crops for consumption by the grower and family. The goal was to grow enough food to feed them throughout the year. Another practice was raising livestock for meat, dairy products, manure, and materials for clothing (wool and leather) and insulation (down feathers). Other important practices included recycling green wastes back into soil for continued fertility, preserving foods for consumption in the non-growing season, resource sharing between farmers (animal labor, food sharing, and processing equipment), intercropping (agroforestry), multiple cropping, and seed collection for the next planting season (Barrows, 2012) (Waters, 2007).

In addition, farmers recognized the importance of cultivating crops that were adapted to the climate and soil conditions. For example, rice grew extensively in Asia, maize in the Americas, wheat in Southern Europe, and Rye in Northern Europe. Bartering was another important practice in subsistence farming, as monetary currency was generally not available to subsistence farmers and inconsistent throughout the 18th century (Waters, 2007). Lastly, subsistence farmers did not always own the land they lived off. It was a common practice in Europe and Asia for peasants to farm a property owner's land in exchange for a portion of the crops (Schutkowski & Herrmann, 1996).

The 19th century saw a continuation of these practices, except for families that moved into cities within the industrializing countries and the homesteaders of the United States. Although these families could no longer practice subsistence farming, due to a lack of open space, they could supplement their food requirements through urban farming (see urban farming subsection for details). During the latter half of the 19th century and early 20th century, the United States enacted homesteading acts that gave an applicant ownership of federally regulated land. The Homestead Act of 1862, which came into power on January 1 1862, granted land ownership to persons previously denied, such as freed slaves and women (37th Congress, 1862). The tracts of land granted were a quarter section or 160 acres (64.7 hectares) (National Park Service, 2013).

Agriculture and Land Use Planning

The following subsections detail the practices of industrial farming and land use planning as well as a brief history of U.S. agriculture from 1860. While the described reductions of agriculture are on a macro-scale for the U.S., the pattern holds true for the micro-scale within the City and County of Baltimore. Recently however, local farming and farmland protection has seen resurgence in the study areas and the United States. Additionally, this subsection details the current planning and zoning trends concerning agriculture taking root within the United States. This subsection details how agricultural employment and land use have declined in the U.S. These declines led to the consolidation into large corporate farms that utilize industrial agricultural practices. However, recent demands in local food led many municipalities to implement urban farming or farm protection policies (Allen, FitzSimmons, Goodman, & Warner, 2003) (Jarosz, 2008).

Industrial Agriculture.

Industrial agriculture is a consequence of the Industrial Revolution. The two main contributors are the increase in farm technology (synthetic inputs and machinery) and the exploding world population. Although life is not necessarily easier in an industrial world versus an agrarian one, medical breakthroughs occurred due to better science and technology allowed individuals to live longer. During the transitional developing period, death rates decreased while birth rates remained high. This pattern attributed to the skyrocketing world population since the 19th century. As the population boomed, food production systems and farm technologies evolved to keep pace.

Industrial agriculture characteristically has large monocultures farms utilizing synthetic inputs (fertilizers and pesticides) to increase production. Multinational corporations buy from or contract these farms with little ties to the local population. The corporations transport the yields from the cultivation site (using freezing or chemical preservation) for processing then consumption. On average food travels 1,020 miles within America from production to consumption (Weber & Matthews, 2008). Often, only these highly processed industrial foods are available within urban blighted areas through fast food restaurants and convenience stories, creating food deserts. While industrial agricultural dramatically increased food production, it caused delayed negative feedbacks to the food system that often take years for the effects to surface and reverse. These feedbacks developed out of the “Green Revolution” practices that made increased food production possible, such as synthetic inputs, monocultures, farm machinery, and more recently genetically modified organisms.

These “Green Revolution” practices caused environmental and soil degradation, water stress, and loss of biodiversity through pollution runoff, chemical residues, and cultivation of invasive plant species. People can see the consequences of industrial farming and its harmful practices in the eutrophication in the Gulf of Mexico from synthetic input runoff from farming on the Mississippi River basin, and soil loss and water stress from monocultures in the Midwest. More consequences include the loss of native pollinators due to chemical residues from synthetic inputs, loss of habitats, highly resistant pest species, and loss of local plant varieties to highly competitive hybrid species.

Land Use Planning.

Land use planning is a system for developing localities through future land use patterns (Berke, Godschalk, Kaiser, & Rodriguez, 2006). These normally take the form of Comprehensive Master Plans that create overarching guidelines for growth. The plans include sections for economic growth, residential development, transportation networks, environmental protection, and more. However, each section will have different goals and agendas, depending on the municipality. These plans are long-term, normally lasting 20 years. At which time they undergo reviews and updates, reflecting the current needs of the community. The plans ratify through voting from the local population or governing bodies.

A vital component to a comprehensive plan is grouping all land within the municipality into zones, such as residential, commercial, industrial, institutional, transportation, recreation, natural, agriculture, water, etc. It is the arrangement and activities allowed within each zone that implement the developmental goals in the master plan. Further subdivision within zoning types accommodates multiple land uses of a similar nature, such as low, medium, and high density residential, commercial, or industrial. Zoning laws are in place to direct growth, protect property values for parcels within each zone, and to determine tax rates, the revenue for cities generated by property taxes.

The zoning laws dictate the land uses allowed on a parcel within each zone. Normal land uses include permitted, accessory, and conditional uses. Permitted uses are primary activities allowed by law within the parcel, such as a single-family home in a low-density residential zone, or food processing plant in a light industrial zone. Accessory uses are secondary activities allowed by law, but may require a permit from the planning authority for use authorization. Examples of accessory uses are animal facilities in a low-density residential zone or temporary storage of building materials in a business commercial zone.

Conditional uses are primary activities allowed by law within a parcel, but which require approval by a zoning authority or public ordinance. Examples of conditional uses include community correction centers in office commercial zones or a hospital in a single-family residential zone. Individual parcels rezoning within a zone is possible with the zoning authority’s approval. However, the authority considers the general welfare of the surrounding parcels before rezoning.

A Brief History of Agriculture within the United States.

Since the 1860s, agriculture has shrunk as a percentage of the U.S. economy (Alston, Anderson, James, & Pardey, 2010). In 1869, the gross domestic product (GDP) accounted for by farm value-added products was 37.5% while in 2006 it was 0.8% (see Figure 1) (Alston, Anderson, James, & Pardey, 2010). These value-added products are farm products that have not gone through the industrial systems such as breads, jams, cheese, etc. The agricultural sector did not contract; rather the U.S. economy grew dramatically the due to mechanized agricultural technologies allowing more workers to enter industrial sectors. United States farm value-added products grew from $17 billion in 1929 to $98 billion in 2006; while GDP grew from $866 billion to $11.3 trillion (see Figure 2 on page 12) (Alston, Anderson, James, & Pardey, 2010). Thus, Americans developed a greater dependence on industrially produced food.

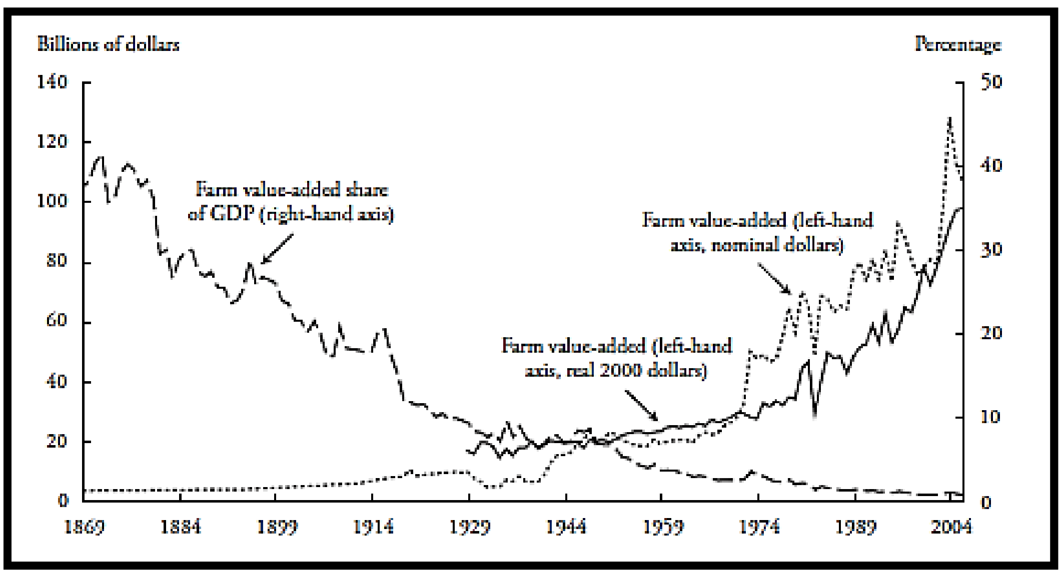

Figure 1: Farm value-added products and share of GDP, 1869 – 2006 (Alston, Anderson, James, & Pardey, 2010)

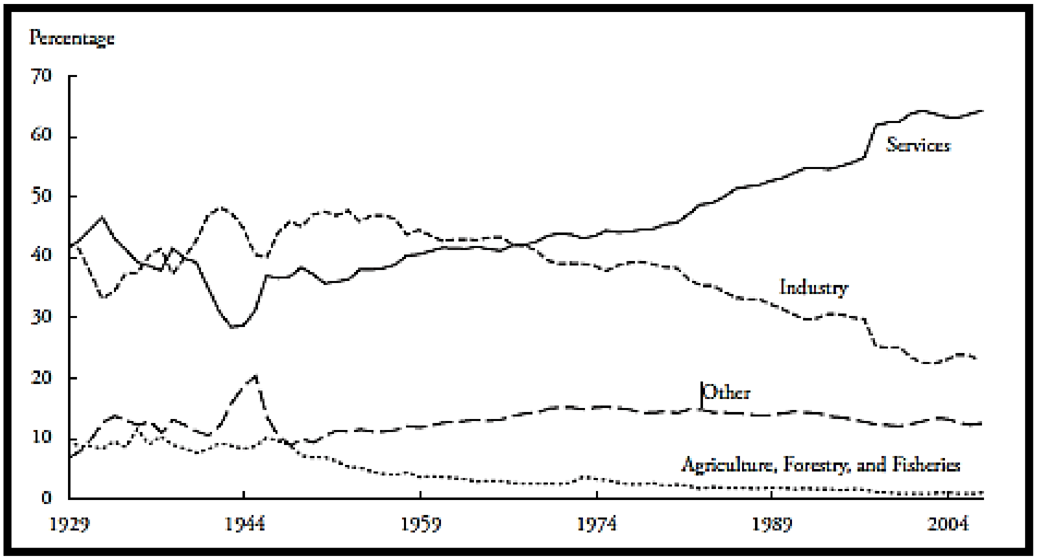

Figure 2: National income share by sector, 1929 – 2007 (Alston, Anderson, James, & Pardey, 2010)

Agricultural production within the United States has seen shifts in output trends, farm size, and geographical location. Within the 20th century, agricultural outputs have increased significantly over inputs. The agricultural inputs include seeds, fertilizers, pesticides, water, labor, energy, etc.; while, agricultural outputs are the meats, grains, fruits, vegetables, and dairy products (Alston, Anderson, James, & Pardey, 2010). Between 1912 and 2002, the quantity of U.S. agricultural outputs increased by an annual rate of 1.73% while agricultural inputs increased by 0.14% per year (see Figure 3 on page 13) (Alston, Anderson, James, & Pardey, 2010). However, this growth differed between the first and second halves of the 20th century. The outputs grew at similar rates (1.61% annually 1912 – 1948 to 1.81% annually 1949 – 2002) but the growth rate of inputs (0.47% annually 1912 – 1948 to -0.08% annually 1949 – 2002) contracted during the time period (Alston, Anderson, James, & Pardey, 2010). The second half of the 20th century saw much faster rate of measured productivity attributed to the "Green Revolution" (Evenson & Gollin, 2003).

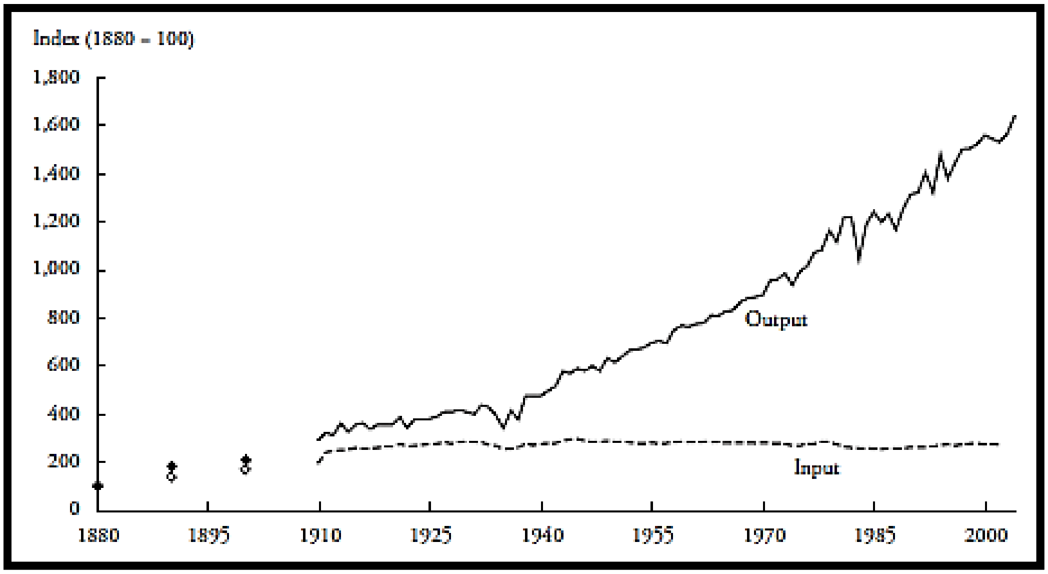

Figure 3: Aggregate Agricultural Output and Input Quantity Trends, 1880 – 2004 (Alston, Anderson, James, & Pardey, 2010)

The U.S. farm population and the average farm size changed significantly in the past 150 years. The farm population increased between 1860 at 18 million people (46.3% of the 38.9 million population) and 1916 at 32.5 million people (31.9% of the 102 million population) (Alston, Anderson, James, & Pardey, 2010). Since the 1920s, the U.S. population grew substantially while the farm population experienced a heavy decline to 2.9 million as of 2006, 1.0% of the total population of 299.4 million (see Figure 4 on page 14) (Alston, Anderson, James, & Pardey, 2010).

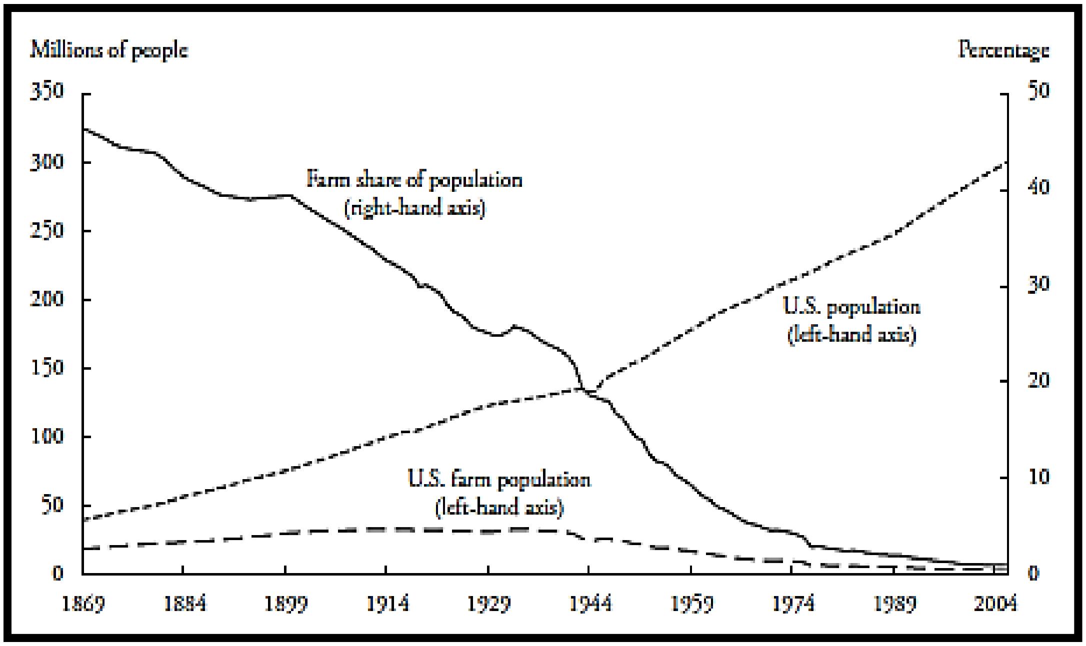

Figure 4: U.S. Population Trends, 1869 – 2006 (Alston, Anderson, James, & Pardey, 2010)

The average farm size and consequently the total number of farms, changed strikingly from the 1850s. In the 1850s, the U.S. had approximately 1.4 million farms that averaged 203 acres (82.2 hectares) per farm. For the next 85 years, the number of farms increased (6.8 million) with the population; thereafter, the average farm size decreased to approximately 162 acres (65.6 hectares). From 1935 to 2006, the number of farms declined rapidly to approximately 2.0 million farms. The average farm size increased from 162 acres to 446.1 acres (180.5 hectares) per farm in 2006 (see Figure 5 on page 15). The main contributors to the declining farm population and land consolidation are farm machinery and rising nonfarm wages. Farm machinery allowed for economies of scale that require less labor and large tracts of land, all figure in this paragraph are from Alston et al, 2010.

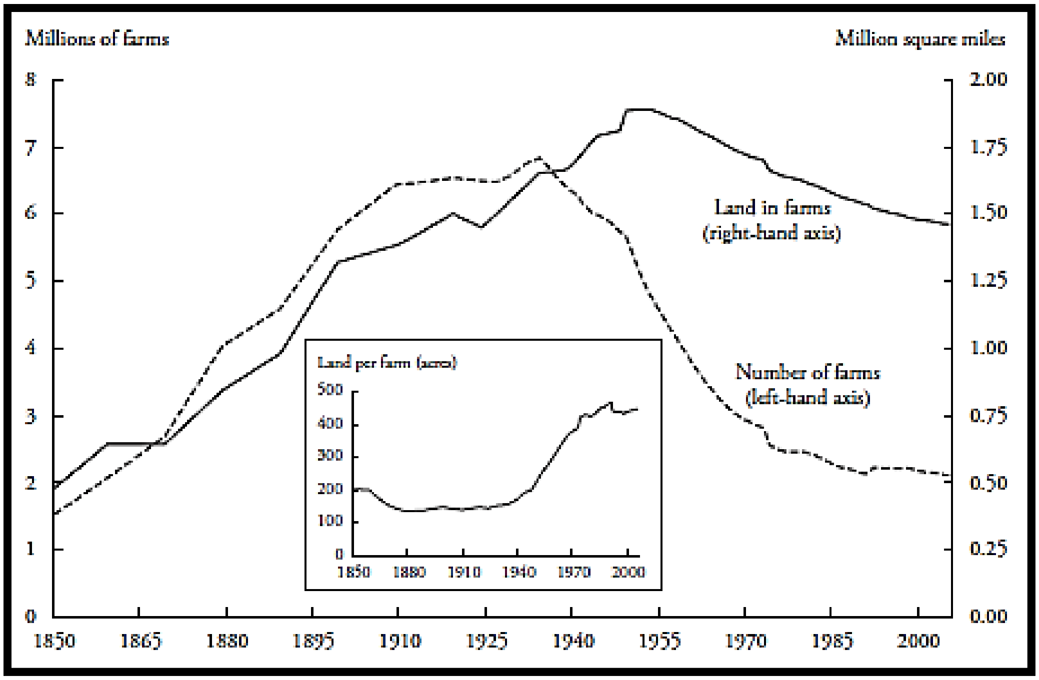

Figure 5: U.S. Farm Acres, Farm Numbers and Average Farm Size, 1850 – 2006 (Alston, Anderson, James, & Pardey, 2010)

In addition to the average farm size, the percentage of farms less than 100 acres (40.5 hectares) and greater than 1000 acres (404.7 hectares) shifted greatly. In 1900, the percentage of farms less than 100 acres was 17.5% as compared to 4.3% in 2002; while, the percentage of farms greater than 1000 acres was 24% in 1900 as compared to 67% in 2002 (see Figure 6 on page 16) (Alston, Anderson, James, & Pardey, 2010). This land consolidation led to fewer people farming larger tracts of land using industrial practices.

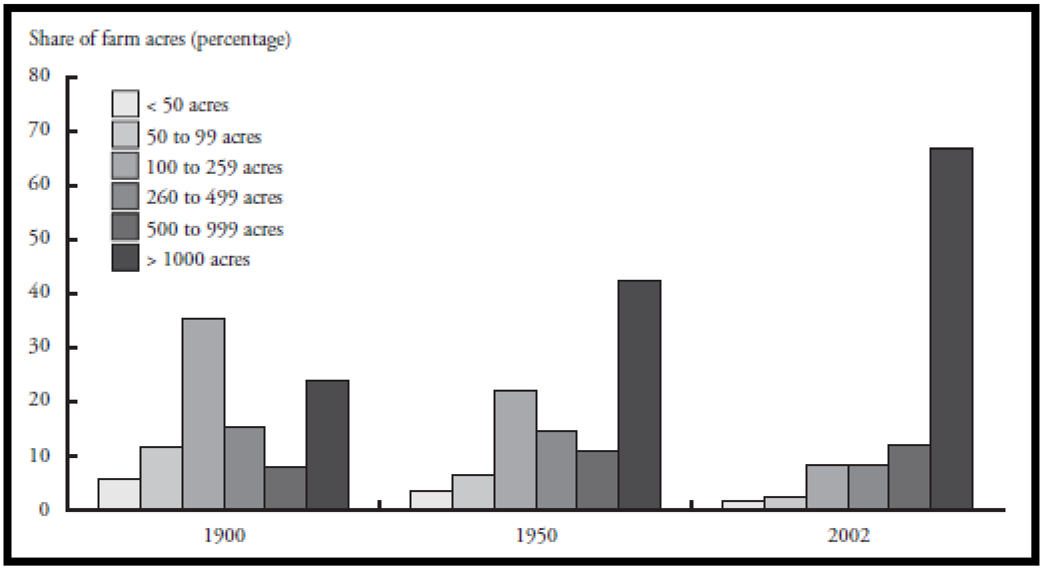

Figure 6: Distribution of Total U.S. Farm Acreage by Farm Size, 1900–2002 (Alston, Anderson, James, & Pardey, 2010)

Along with the total number of farmers and farm size, the geographic location of U.S. agricultural production shifted. During the second half of the 20th century, the production shifted to the south and west. Additionally, the population became more spatially concentrated within a handful of states: California, Illinois, Iowa, Minnesota, Nebraska, and Texas (see Figure 7 of page 17). Regional and state's total production changed dramatically after 1950, prompted by demand shifts (both foreign and domestic), off farm technology, and large population movements to the south and west. By region, Table 1 details (page 17) the shifts. As it became increasing harder to earn a living through agriculture, rural populations migrated into urban areas for better opportunities (Alston, Anderson, James, & Pardey, 2010).

Table 1: Regional Production Shares: 1924 to 1926 and 2003 to 2005 (Alston, Anderson, James, & Pardey, 2010)

Region	Time Period	Regional Shares of National Commodity Group Production	Time Period	Regional Shares of National Commodity Group Production
Pacific	1924-1926	7.8%	2003-2005	18.3%
Mountain	1924-1926	5.6%	2003-2005	7.8%
Northern Plains	1924-1926	12.1%	2003-2005	11.4%
Southern Plains	1924-1926	14.8%	2003-2005	14.0%
Central	1924-1926	32.4%	2003-2005	27.0%
Southeast	1924-1926	15.9%	2003-2005	15.4%
Northeast	1924-1926	11.2%	2003-2005	6.2%

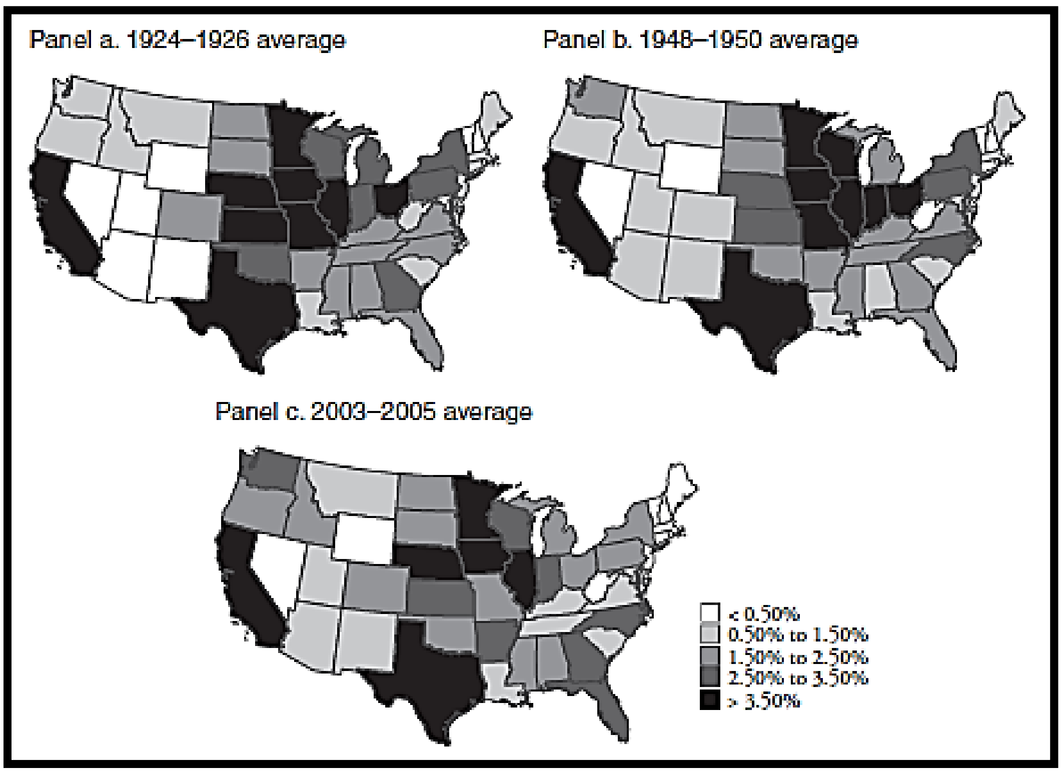

Figure 7: Shares of the Value of Agricultural Production among States (Alston, Anderson, James, & Pardey, 2010)

Current Planning and Zoning Law Trends for Agriculture.

The popularity of urban farming is increasing in the United States in forms like community and school gardens in small rural towns, commercial farms in suburbs, and rooftop gardens and bee keeping in dense cities (Hodgson, Campbell, & Bailkey, 2011). Along with urban farming, local food systems and farmland protection are gaining traction as the demand for local products grows in urban areas. Both urban farming and regional farmland protection are possible through developing and implementing planning and zoning regulations (American Farmland Trust, 2012). In developing and implementing these agricultural regulations, localities display their desire and political will for local food systems.

Urban Agricultural Trends.

Across the United States, city governments are placing support behind urban farming and local food systems through planning and zoning regulations. The following paragraphs detail the planning and zoning regulation changes in Boston, Massachusetts, Fort Collins, Colorado, and Seattle, Washington. The City of Boston is currently drafting article 89, Urban Agriculture. The purpose of the article is to "establish zoning regulations for the operation of Urban Agriculture activities and to provide standards for location design, maintenance and modification of Urban Agriculture activities that address public safety, and minimize impact on the residents and historic resources in the City of Boston" (Mercurio & Read, 2012). The article establishes regulations for urban farms at ground and roof level within residential, commercial, industrial, and institutional zones. In addition, the article establishes design requirements and guidelines to streamline the implementation of urban farms and allow for the keeping of hens within accessory buildings (maximum number of 6 adult hens) and honeybees (maximum number of 2 hives for personal consumption and 3 hives for commercial farming) (Mercurio & Read, 2012).

The City of Fort Collins, Colorado, has recently proposed changes to their land use and city codes. Fort Collins is a less dense urban area than Boston; therefore, space requirements are less of an issue. The proposed land use code changes include an urban agriculture licensing system that allows urban agriculture in all zones and farmer's markets in mixed zones (City Council of Fort Collins, 2013). The proposed changes include general standards for urban agriculture such as equipment, chemicals, fertilizers, trash, maintenance, and water conservation. The proposed city code changes "include scaling the number of allowable chickens based on lot size, allowing ducks to be raised, allowing two dwarf or pygmy goats per household for milk production, and updating the beekeeping ordinance to reflect current best practices" (City Council of Fort Collins, 2013). On less than half an acre, a person can have up to eight chickens and/or ducks. Between a half and 1 acre, a person can have up to twelve chickens and/ or ducks. Over 1 acre, a person can have an additional six chickens and/or ducks for each additional half acre (City Council of Fort Collins, 2013).

The last city discussed is Seattle, Washington. Seattle, like the cities mentioned previously, allows for urban agriculture in its land use codes. The agriculture code recognizes five different uses including animal husbandry, aquaculture, community gardens, horticulture, and urban farms (Department of Planning and Development, 2010). All commercial zones allow animal husbandry as an accessory use (except in one zone where it can be primary), and it is not allowed in residential or industrial zones. However, all residential zones allow small animals and domestic fowl with lots greater than 20,000 square feet and 10,000 square feet respectively (Department of Planning and Development, 2010).

Commercial and industrial zones permit aquaculture as a primary and accessory use. Community gardens are a primary use in all zones, but they are restricted to rooftops and walls of buildings in manufacturing and industrial centers. All zones allow urban farms. However, odors and fumes are limited to “what a reasonable individual could tolerate” at a distance of more than 200 feet from the urban farm (Department of Planning and Development, 2010). If the planting area is less than 4,000 square feet in a residential zone (accessory use) then a permit is not required. Urban farms greater than 4,000 square feet require an administrative conditional use permit to insure proper management (Department of Planning and Development, 2010).

Rural Agricultural Trends.

Farmland protection has been occurring in U.S. counties since the 1970s. It has recently gained momentum from an increase in the demand for local food systems and the alarming rate of farmland conversion. The following paragraphs detail how Suffolk, Cortland, and Guilford counties implemented farmland protection.

Suffolk County in Long Island, New York, preserves farmland through their purchase of development rights (PDR) policy. The PDR keeps the land in private ownership but awards the County any non-agricultural development rights. This means that the owner files property covenants to limit the use of the property to agricultural production, protecting the land from non-agricultural development. To date, the PDR has seen 6,000 acres come into the program (Suffolk County Government, 2013). In addition, the County has developed the Suffolk County Agricultural District program that relieves active farms of property tax for 8-year cycles. While in the program, the farms are under the protection of New York State “right-to-farm” laws (Suffolk County Government, 2013). Thus, any dwelling, business, or land use in or near a farm are subject to inconveniences or discomforts arising from agricultural operations.

The towns of Homer, Preble, and Scott within Cortland County, New York, recognized the importance of an agriculture industry within their economy and culture. The three towns developed a regional plan to preserve farmlands within the county through the Towns of Homer, Preble, and Scott Agriculture and Farmland Protection Plan. The plan sets into motion foundation actions and regional goals to protect farmland. The three foundation actions are the “creation of a Joint Implementation Committee, aggressively seek funding for plan implementation and support and coordinate implementation efforts with organizations, agencies and programs that assist farmers and farmland owners” (Plan Steering Committee, 2011). The plan ensures that land use laws and local ordinances support economic opportunities for local farmers, protect agricultural land, and educate the public about the importance of farms. In addition, the plan identifies quality farmlands at risk of conversion then adopts protection strategies, and it limits development to urban centers (Plan Steering Committee, 2011). Each town has individual, yet coordinated implementation strategies for the protection of farmlands.

Guilford County in North Carolina set out to preserve farmland through the 2020 Guilford County Farmland Protection Plan. Within the state, the impact of agriculture is $2.27 billion in revenue (Piedmont Conservation Council, Inc, 2011). The plan sets forth recommendations and an implementation schedule for the protection of farmlands. The broad recommendations of the plan are farmland protection strategies, planning polices, and proposals for Guilford County development ordinance (Piedmont Conservation Council, Inc, 2011). In addition, the plan ensures economic opportunities for local agriculture, supports local food producers, and educates through outreach (Piedmont Conservation Council, Inc, 2011). These recommendations accomplish farmland preservation by protecting the land and offering tools to help the agricultural economy thrive within the county.

Urban Agriculture

The following subsection details a general overview of urban agriculture (farming), its history within the U.S., and the different forms it takes in an urban setting. These urban agriculture forms are the vehicle for implementing the subsistence farming practices. These practices along with animal husbandry are an essential component to developing a local food system within the study areas.

Urban agriculture does not have a standard definition, but the majority of the literature agrees that urban farming can offer health, environmental, and economic advantages. Generally, urban farming is the cultivating, processing, and distribution of food in or around an urban area. According to the FAO, urban agriculture “refers to small areas within the city for growing crops and raising small livestock or milk cows for own-consumption or sale in neighbourhood markets” (FAO, 1997). These advantages include access to healthy and affordable produce, reduction in pollution from transportation and waste products, and economic revitalization of cities through the use of vacant lots and small businesses (Hendrickson & Porth, 2012) (Vaplariso University Law Review, 2012).

A Brief History of Urban Agriculture in the United States.

The first U.S. settlements introduced urban agriculture. Thus, it has always been present within American cities. During the Industrial Revolution, cities became more populated and polluted. As a result, urban gardens shrank, and cities expelled livestock due to the diminished open space. In addition, people worked long hours limiting the time for a large garden. It is only recently that urban environments allowed livestock, mainly poultry, back. The following paragraphs detail the major movements within urban agriculture in the United States since the 19th century. These movements range from immigrant customs to academic experiments for social betterment. Many of these movements are present within the City and County of Baltimore.

During the 19th and early 20th century, urban farming survived through immigrant traditions, retraining unemployed city dwellers, amateur farming, social service, urban cleanup, ways to combat rising food prices, and supplemental food supplies. During the 19th century, immigrants such as Jews and Italians conducted poultry and window box farming in tenement housing within New York City (Ziegelman, 2010). In the late 1890s, city farming schools taught lost agricultural skills to unemployed city dwellers. The ultimate aim was to return tenement dwellers back to rural farms (Chicago Daily Tribune, 1895).

In New York during the early 20th century, urban farming was practiced for supplementing the food supply and as a leisure activity, as described by the New York Times (New York Times, 1910). During this time, city farming aimed to raise the living standards of the poor. In addition, urban agriculture helped to cleanup urban eyesore real estate in the 1910s. During WWI, the Wilson Administration promoted urban gardening to combat rising world food prices, and urban farming initiatives post -WWI focused on fighting hunger and inflation (Los Angeles Times, 1920). From the 1930s to the 1970s, urban farming, while still practiced, was not in the mainstream spotlight with the exception of the victory gardens during WWII.

In the 1970s, America was undergoing its environmental revolution in light of deteriorating natural conditions. It was during this time that urban farming returned to the spotlight for many of the same reasons as during the turn of the century. San Francisco bay area saw a dramatic increase in urban farming due to local colleges and universities teaching courses in raising food in the city (Gustaitis, 1973). Again, a city's working class, unemployed, and youth utilized urban farming to supplement food supplies, fight inflation, and reutilize vacant lots. For the first time, municipalities viewed urban farming as a business model to generate profits through leasing urban spaces for farming (Gaspar, 1978). In the late 1970s, academia became involved in urban agriculture as can be seen at Fordham University when twelve students constructed a geodesic greenhouse on campus to show the ease of its construction (New York Times, 1979).

Urban Farming Varieties.

Urban farming includes a variety of farm forms including community gardens, vegetable gardens, kitchen gardens, edible landscaping, green roofs, vertical farms, community supported agriculture (CSAs), greenbelt agriculture, and permaculture. The following paragraphs detail the previously mentioned urban farm forms. It is important to note that a discussion of farming techniques per farm type is not present, but the author recommends the use of best management practices (BMPs) and holistic practices. These practices allow urban farming to be sustainable and environmentally benign as possible.

Community Gardens, Vegetable Gardens, and Kitchen Gardens.

Community, vegetable, and kitchen gardens are urban farming types that are generally small plots of land farmed by individual households for their own consumption. A community garden is any piece of land gardened by a group of people (Firth, Maye, & Pearson, 2011). The format for these gardens fluctuates from a large communal plot to many individual plots. Plot size varies, but in general, they are smaller than half a city block. The location sites vary from schools, churches, neighborhood centers, and hospitals. Generally, community gardeners grow flowers, vegetables, and herbs (Teig, Amulya, Bardwell, Buchenau, Marshell, & Litt, 2009).

A vegetable garden is an older form of a community garden, usually worked by the urban poor. These are old traditions by which monasteries, city councils, and factories provided plots for urban workers to grow food (Domene & Sauri, 2007). A kitchen garden is a "garden in which plants (as vegetables or herbs) for use in the kitchen are cultivated" (Merriam-Webster, 2013). The prominent difference between community gardens and kitchen gardens is crops within kitchen gardens are grown, processed, and consumed on the same plot of land, such as school kitchen gardens (Gibbs, et al., 2013).

Edible Landscaping, Green Roofs, and Vertical Farms.

The next urban farm types focus on developing agriculture into the built environment of the urban landscape. These farm types include edible landscaping, green roofs, and vertical farms. Edible landscaping is "the use of food-producing plants in the residential landscape" (Master Gardeners, 2010). Edible landscaping is not limited to only residential settings. Urban landscaping (medians, parks, building, and street landscaping) and a city's urban forest can utilize edible landscaping (McLain, Poe, Hurley, Lecompte-Mastenbrook, & Emery, 2012). The types of plants utilized depend on climatic and soil conditions, space restrictions, and zoning laws.

A green roof "is a flat or sloped rooftop designed to support vegetation" (Dvorak & Volder, 2010). Green roofs serve multiple functions aside from food production such as storm water management, building insulation, heat absorption, and wildlife habitats. Soil depth ranges from an inch for a mat of succulent plants to over one yard for crop cultivation (Dvorak & Volder, 2010). A downside to green roofs is the retrofitting of homes or buildings to cope with significant weight increases for cultivating crops (Bianchini & Hewage, 2012).

A vertical farm is "the business or activity of growing crops in tall buildings in cites" (Cambridge Dictionaries, 2013). The size of a farm ranges from a window unit to entire skyscrapers. Dickson Despommier of Columbia University modernized the vertical farm movement in 1999, offering proposals by 2001. Vertical farms offer many advantages over traditional horizontal farms such as year-round crop production, climate control, agriculture pollution control, reduce fossil fuel usage, and transformation of abandoned properties into sustainable food production centers (Despommier, 2010). However, the drawback of vertical farms is the expense to build a farm ($100 million for a 60-hectare vertical farm), due to the high real-estate value of core urban buildings (Despommier, 2010).

Community Supported Agriculture (CSA) and Greenbelt Agriculture.

CSAs are a partnership between a community and local farmers. The partnership benefits both, as the community gains access to local food and farmers receive better prices for products and are relieved of the burden of marketing after harvesting the crops

(Darimani, Rahaman, & Amankwah, 2012). A CSA is similar to a “Micro eco-farm” that refers to farms the size of backyards to small acreage (Darimani, Rahaman, & Amankwah, 2012). The CSA concept started in the 1960s within Switzerland and Japan. Consumers in these countries wanted safe food and developed partnerships with farmers seeking a stable market for their crops (Darimani, Rahaman, & Amankwah, 2012). Within the U.S., there are 12,549 farms marketing products through CSA as of 2007 (National Agricultural Library, 2013). The median CSAs farm size is 15 acres (6.1 hectares) of operations with 7 acres (2.8 hectares) of cropland (Lass, Bevis, Stevenson, Hendrickson, & Ruhf, 2002).

A greenbelt is a policy or land use category utilized in land use planning to preserve undeveloped, wild, or agricultural land surrounding or neighboring urban areas (Fitzsimons, Pearson, Lawson, & Hill, 2012). Greenbelt agriculture is as the name implies, cultivating crops in the greenbelt surrounding urban areas. Within the U.S., only Oregon, Tennessee, and Washington require cities to establish urban growth boundaries (greenbelts). The goal of the greenbelt is to minimize the conversion of farms and forests into urban land use. In Tennessee, the Greenbelt Program accomplishes this by not allowing the change in land use in exchange for reduce taxation for landowners (Williams, Gottfried, Brockett, & Evans, 2004).

Permaculture.

Permaculture is not a type of urban farming but rather a lifestyle that benefits the urban dweller. Permaculture is “an agricultural system or method that seeks to integrate human activity with natural surroundings so as to create highly efficient self-sustaining ecosystems” (Merriam-Webster, 2013). Key concepts of permaculture are food forests and guilds that mimic natural systems, poultry and backyard animals, rainwater harvesting, designing for multiply functions, watershed restoration, natural building design and construction, waste management, and ecological economics (Permaculture Institute, 2013). Adhering to permaculture within urban areas is challenging due to limited access to land and regulatory restrictions on farming and animal husbandry. However, permaculturalists have adopted techniques to circumvent these obstacles such as cooperative arrangement, co-ownership of assets, grafting fruit trees, worm composting, and keeping chickens when allowed (Permaculture Institute, 2013). Some examples include the backyard forester in Los Angles and the citizen pruner in New York (Permaculture Institute, 2013).

Energy Values and Nutrient Content of Crops

Crops' energy values and nutrient content provide the human body with the fuel needed to complete daily tasks (Britten, Cleveland, Koegel, Kuczynski, & Nickols-Richardson, 2012). However, not all foods are equal, and selecting the proper crops is paramount with space restrictions in urban environments. The following subsection details the process of calculating energy values in the U.S., as defined by the USDA. The discussion continues with the minimum amount of energy and required food groups a person needs on a daily basis.

Within the U.S., the total amount of protein, total carbohydrates and total fats in food products determine the energy content (Calorie or kilojoule content) (Livesey, et al., 2000). The USDA applies the general factors of 4, 4, and 9 (the Atwater method) Calories per gram of protein, total carbohydrates, and total fats respectively, as laid out in USDA Handbook No. 74 (USDA, 2009). Multiplying the nitrogen content in a food product by 6.25 derives the protein content (Livesey, et al., 2000). Total fats are the total lipid fatty acids expressed as triglycerides (Livesey, et al., 2000). Subtracting the sum of the crude protein, total fat, moisture, and ash from the total weight of the food calculates total carbohydrates (Livesey, et al., 2000).

The minimum amount of energy needed per day for individuals varies depending on age and lifestyle. Generally, a minimum baseline for a healthy person is 2,100 Calories per day (UN WFP, 2013). Active adults require varying amounts of energy ranging from 2,000 Calories per day for normal activity to 20,000 Calories for 8 hours of strenuous labor. In addition to calories for energy, people require a balanced diet of multiply food groups, such as fruits, vegetables, grains, protein, dairy, and oils, as described by the USDA My Plate Program (Britten, Cleveland, Koegel, Kuczynski, & Nickols-Richardson, 2012) (USDA, 2013).

The My Plate Program divides food into six food groups: fruits, vegetables, grains, protein, dairy, and oils (USDA, 2013). Figure 8 (page 30) displays the ratio for the food groups per meal with fruits and vegetables being half the plate with a side of dairy. The assortment of foods groups provides essential levels of protein, carbohydrates, and fats. This concept is important for local food systems in urban environment as grains, protein (meats), and dairy products are difficult to produce due to space restrictions. However, the use of CSAs can alleviate this problem by producing livestock (meat and dairy) and grains.

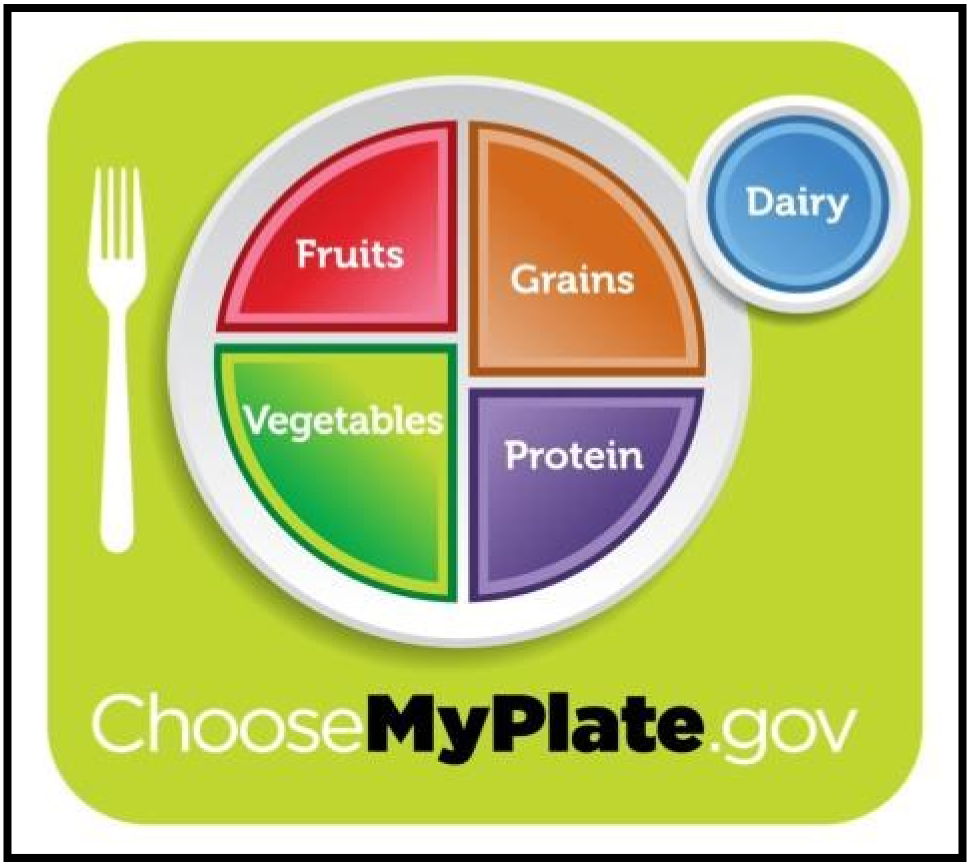

Figure 8: My Plate food group plate distribution (USDA, 2013)

In addition to the macronutrients, people need a daily intake of micronutrients known as the Dietary Reference Intakes (DRI). The essential micronutrients include vitamin A, calcium, phosphorus, magnesium, vitamin D, fluoride, thiamin, riboflavin, niacin, vitamin B_6, foliate, vitamin B_{12}, pantothenic, biotin, choline, vitamin C, vitamin E and selenium (Dunne, 2002). The micronutrients, like the macronutrients, come from a variety of food sources within the food groups (Britten, Cleveland, Koegel, Kuczynski, & Nickols-Richardson, 2012).

Political Threats to Local Farming Systems

Although local food systems are gaining ground within the U.S., industrial agriculture companies play a significant role in policymaking. Local food systems display a direct alternative from the globalized food systems of commodities developed in the second half of the 20th century (DuPuis & Goodman, 2005). Development of local food systems have little effect on the multinational agricultural firms operating within the United States as the market for their commodities is mainly outside the country (Scoppola, 1995). However, multinational corporations (MNCs) headquartered within the U.S. with operations in other countries stand to lose revenue, as consumers purchase fewer agricultural products from traditional retailers (Scoppola, 1995). The size of these firms, with both vertical and horizontal market integration, grants them resources to intervene in the political world of agricultural policymaking (Ufkes, 1993). While the full extent of their power is unknown, the firms contribute sizable funds to political campaigns and lobbying ($12.9 million in first three quarters of 2012, up 48% from last quarter of 2011) (Chroma, 2012).

While MNCs dominate the majority of agricultural operations within the U.S., there are sizable national firms in direct competition with local food systems. These firms include producers and processers like Kraft, PepsiCo, Nestle, Tyson Foods, and Mars and retailers like Wal-Mart, Kroger, Aldi's, etc. (ETC Group, 2008). In addition, other industries would suffer from a drastic increase of participation in local food systems. The additional industries losing revenue from local food systems are the chemical, pharmaceutical, and transportation (Marsden & Smith, 2005) sectors. With the local food system movement promoting organic and sustainable agricultural practices, synthetic inputs are used as a last case scenario effecting companies like DuPont and Bayer (ETC Group, 2008) (Goodman & Goodman, 2009). In addition, individuals receive higher nutrition content from produce picked at peak ripeness, food possessing fewer preservatives, and open range livestock (Goodman & Goodman, 2009). This will lead to less diet related illnesses decreasing the use of medication, thus affecting pharmaceutical companies such as Pfizer, GlaxoSmithKline, and Merck & Co Inc. (ETC Group, 2008) (Goodman & Goodman, 2009).

Lastly, there will be a substantial decrease in long distance transportation of agricultural products affecting the trucking industry. This would be due to companies downsizing inventories to match lower demand of non-local products (Coley, Howard, & Winter, 2009). However, agricultural land far removed from population centers could contribute to biofuel production or returned to natural state. All of these industries individually represent a political threat to expanding local food systems; together they could further block local food system development through their political might (Hinrichs, 2013).

The full extent of political power and influence of national and multinational corporations is only speculative, but nonetheless, these entities play a significant role in agricultural policymaking (Daugbjerg & Swinbank, 2012). The extent to which these entities will either reduce or entirely block policies and support for local food systems is unknown. These firms have the decision to oppose local food systems or integrate themselves within the movement (Barlett, 1987).

Study Areas: City of Baltimore and Baltimore County

The goals for this subsection are to disclose the geographic locations of the study areas within the United States, and provide the climate and soil conditions for the appropriate selection of cultivated crops for the development of a local food system. In addition, a brief background on each area with basic demographic information is detailed.

Furthermore, the current planning and zoning regulations concerning agriculture follows to determine the existing land use capacity for agriculture. A description of any current local food systems in the study areas follows. Lastly, the subsection ends with the study areas population growth trends and land use cover change since 1950.

The study areas locations are Baltimore City and Baltimore County. The City of Baltimore is located within Baltimore County in the state of Maryland, USA. The County resides in the north central portion of the state, while the City of Baltimore occupies the south central portion of the County. The City and the County are adjacent to the Chesapeake Bay, which grants access to the Atlantic Ocean. The climate of the City and County is continental with well-defined seasons (NCDC, 2010). Winter is the dormant season for plant growth due to low temperatures, and summer is warm or hot. The spring and fall seasons have a high degree of variability with weather characterized by a rapid succession of warm and cold fronts. Thus, indoor climate controlled growing is necessary (through vertical farms or greenhouses) for cultivation during winter.

The average monthly temperature ranges from the coldest of 33.2ºF (0.7ºC) in January to the warmest of 76.4ºF (24.7ºC) in July (National Environmental Satellite, Data, and Information Service, 2011). The months of June, July, and August have a significant number of days were the temperature is greater than 90ºF (32.2ºC). The annual total precipitation is 45.55 inches (1156.97 mm) with a mostly even distribution throughout the year ranging from a low of 3.59 inches (91.19 mm) in April to a high of 4.57 inches (116.08 mm) in May (National Environmental Satellite, Data, and Information Service, 2011). The daily precipitation is regularly equal to or less than 0.01 inches for 116.9 days or 0.10 inches for 79.2 days of the year. The growing degree units

(GDU) are highest from April to October with July having the largest at 1,128 GDU (National Environmental Satellite, Data, and Information Service, 2011). Lower base temperatures increase the accumulated annual GDU from 2,742 GDU at 55º F to 6,283 GDU at 40º F (National Environmental Satellite, Data, and Information Service, 2011). Thus, plants that tolerate lower temperatures have greater usability in the study areas.

The county of Baltimore contains nine soil associations: Chester-Glenelg, Manor Glenelg, Baltimore-Conestoga-Hagerstown, Chrome-Watchung, Legore-Aldino-Neshaminy, Beltsville-Chillum-Sassafras, Loamy and clayey land-Lenoir-Beltsville, Sassafras-Woodstown-Fallsingtion, and Mattapex-Barclay-Othello (USDA Soil Conservation Service, 1973). Figure 9 (page 36) displays the soil associations and placement within the county. The city of Baltimore contains the same soil associations, but the majority of the land cover is urban rendering the soil unavailable. However, individuals can purchase soil for growing produce in kitchen gardens, planters, and greenhouses. The following is a list of the soil associations and their characteristics.

- "Chester-Glenelg association: Dominantly gently sloping to moderately steep, deep, well-drained soils that have a subsoil of silt loam to light silty clay loam; underlain by acid crystalline rock; on uplands
- Manor-Glenelg association: Gently sloping to very steep, deep well-drained and somewhat excessively drained soils that have a subsoil of loam to light silty clay loam; underlain by acid crystalline rock; on uplands
- Baltimore-Conestoga-Hagerstown association: Dominantly level to moderately sloping, deep, well-drained soils that have a subsoil of clay loam to clay; underlain by limestone, marble, or calciferous schist, in valleys

- Chrome-Watchung association: Dominantly sloping to steep, shallow, well-drained soils that have a subsoil of silty clay loam and level to gently sloping; poorly drained soils that have a subsoil of silty clay; underlain by basic rock, on uplands
- Legor-Aldino-Neshaminy association: Gently sloping to steep, deep, well-drained soils that have a subsoil of silty clay loam to clay loam and level to moderately sloping, moderately well-drained soils that have a subsoil of silty clay loam and a fragipan; underlain by basic rock; on uplands
- Beltsville-Chillum-Sassafras association: Level to moderately sloping, moderately well-drained soils that have a subsoil to silt loam of silty clay loam and a fragipan, and well-drained soils that have a subsoil of sandy clay loam to silt loam; underlain by thick stratified sediment; on uplands
- Loamy and clayey land-Lenoir-Beltsville association: Nearly level to steep land of sandy loam to clay loam over clay and somewhat poorly drained and moderately well drained soils that have a subsoil of dominantly silty clay loam and silt loam; underlain by thick stratified sediment; on uplands Sassafras-Woodstown-Fallsington association: Well drained, moderately well drained, and poorly drained soils that have a subsoil of sandy clay loam; underlain by thick stratified sediment, on uplands
- Mattapex-Barclay-Othello association: Moderately well drained, somewhat poorly drained, and poorly drained soils that have a subsoil of silt loam or silty clay loam; underlain by thick stratified sediment; on uplands" (USDA Soil Conservation Service, 1973)

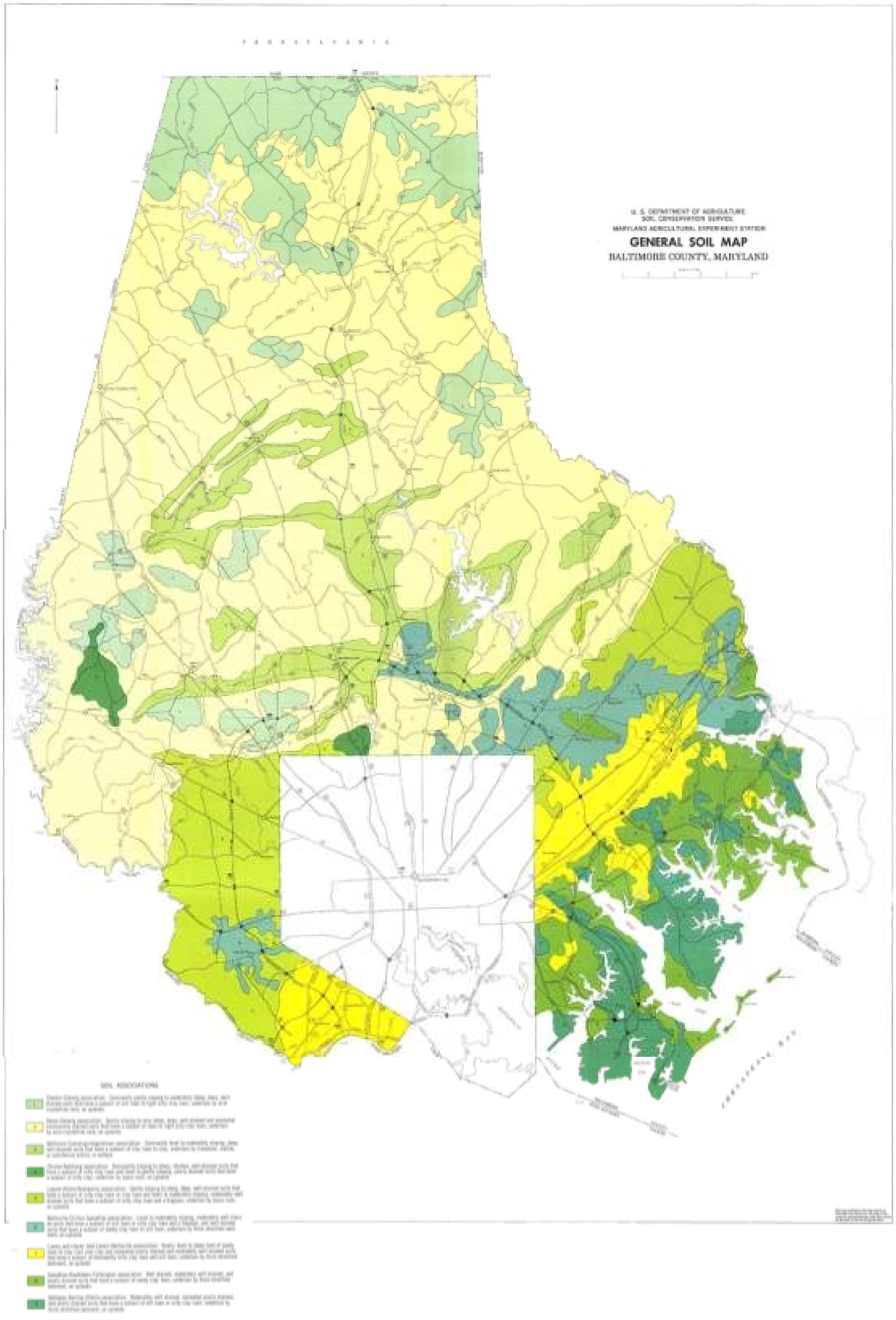

Figure 9: A soil map of the County of Baltimore (USDA Soil Conservation Service, 1973).

Baltimore City.

Baltimore is the largest city in the state of Maryland and the 24^{th} largest city in the United States (Planning Commission, 2012). The City began in 1729. Currently, it is the second largest seaport in the U.S. Mid-Atlantic. Baltimore's Inner Harbor was once the second leading port of entry for immigrants to the United States and a major manufacturing center. After declining in manufacturing post 1950s, the City shifted to a service economy with Johns Hopkins Hospital and Johns Hopkins University serving as the city's top employers. The vacant buildings left after the decline in manufacturing are suitable areas for urban agriculture. Downtown Baltimore is the economic center of Greater Baltimore and home to the city's fastest-growing neighborhoods. With hundreds of identified districts, Baltimore is "a city of neighborhoods" and known as the Charm City (Planning Commission, 2012). The existing neighborhood structure provides the framework for a local food system.

The City of Baltimore is 80.94 square miles (51,801.6 acres or 20,963.36 hectares) in size with a population of 620,961 persons giving a density of 7,671 persons per square mile (United States Census Bureau, 2010). The age distribution of the population is 6.8% under 5 years, 21.6% under 18 years, 59.8% between 19 and 64 years,11.8% 65 years and over, and 52.9% female (United States Census Bureau, 2010). The racial distribution of the population is 31.5% white, 63.6% black, 2.5% Asian, and 2.4% other races while 4.3% are of Hispanic or Latino origin (United States Census Bureau, 2010). This data is for identifying the amount of land/space needed to develop local food system.

As of 2011, the City of Baltimore had 296,450 housing units with a homeownership rate of 49.5% (United States Census Bureau, 2010). Of the 296,450 housing units, 32.8% are housing units in multi-unit structures with an overall 2.5 persons per household (United States Census Bureau, 2010). The median value of owner-occupied housing units was $163,700 between 2007 and 2011, while the median household income in the timeframe was $40,100 (United States Census Bureau, 2010). The percent of people below the poverty level is 22.4% (United States Census Bureau, 2010). The national average for population below the poverty level is 15.1%, and the state average is 10.1 as of 2011 (U.S. Census Buearu, 2011).

Planning Guides: Agriculture.

The overarching planning guideline for the City of Baltimore is the Live, Earn, Play, and Learn: The City of Baltimore Comprehensive Master Plan. The plan occurs in these four categories to focus on discrete, attainable goals. Live focuses on Baltimore's residential land use, Earn focuses on employment needs strategies, Play focuses on enhancing cultural, entertainment, and natural resource amenities, and Learn focuses on improving Baltimore's educational network (Baltimore County Council, 2010). While the plan does not directly mention any goals for agriculture, farms, or farming, the plan has visions to reduce resource consumption and focus develop in suitable areas. The suitable areas are the existing population centers and not the resource areas with emphasis on planned unit developments (PUDs) to accommodate modern mixed land use needs (Baltimore County Council, 2010).

Zoning Laws: Agriculture.

The City of Baltimore does not have a specific zone for agriculture; however, some residential zones and all industrial zones permit agricultural uses (City of Baltimore, 2013). The Baltimore Office of Sustainability (BOS) has initiated the Baltimore Food Policy Initiative (BFPI). The BFPI encourages urban farmers to use city-owned vacant and underutilized properties for urban agriculture (City of Baltimore, 2010). In 2012, the BFPI amended the zoning regulations to permit community gardens and farm stands in community-managed open spaces (City of Baltimore, 2010). The BFPI removed the permit requirement for hoop houses as well.(City of Baltimore, 2010). In community-managed open spaces, the zoning regulations prohibit permanent structures, but they allow temporary greenhouse structures to extend the growing season. There is not a limit on the number or square footage for these structures other than the lot size.

In addition, the BFPI updated the health codes to allow urban residents to raise "chickens, rabbits, goats, and bees" (City of Baltimore, 2010). The Baltimore City Health Department regulates the animal husbandry laws. A person must obtain a permit from the Office of Animal Control to keep chickens, rabbits, goats, and bees. Thus, residents can sustain part or all their meat and dairy needs, as well as keep pollinators for plants. The following list shows the amount of space required for each group:

- "No more than 4 chickens over the age of 1 month may be kept on lots less than 2,000 sq. ft. On lots greater than 2,000 sq. ft., one additional chicken is permitted for every 1,000 sq. ft. of lot area over 2,000 sq. ft. up to a total of not more than 10 chickens.

- No more than four rabbits are kept on a lot less than 2,000 sq. ft. On lots greater than 2,000 sq. ft., one additional rabbit is permitted for every 1,000 sq. ft. of lot area over 2,000 sq. ft. up to a total of not more than 10 rabbits.
- No more than two female or neutered male goats may be kept, plus any of their offspring up to 6 months of age, on lots less than 20,000 sq. ft. On lots greater than 20,000 sq. ft., one additional goat is permitted for every 5,000 sq. ft. of lot area over 20,000 sq. ft. up to a total of not more than six goats.
- No more than two 2 hives, each containing no more than 1 swarm, shall be allowed for lots up to 2,500 square feet of lot area; on lots greater than 2,500 sq. ft., one additional hive, containing no more than one swarm may be kept for every 2,500 sq. ft. of lot area over 2,500 sq. ft." (Office of Animal Control, 2012)

Current Local Food System.

The City of Baltimore currently has a small local food system. The government office responsible for the local food system movement is the Baltimore City Office of Sustainability (Baltimore Office of Sustainability, 2013). The system currently has numerous programs established in the city. These include the Real Food Farm, city farms, Virtual Supermarket Project, Baltimore City Food Policy Task Force, Baltimore City Public School System, and Community Greening Resource Network (Baltimore Office of Sustainability, 2010).

The Real Food Farm is an urban agricultural project within Clifton Park in Baltimore offering year-round education, jobs, and healthy food access. In addition, there are seven city farms providing 640 plots (150 square feet each) for urban gardeners in seven of the City's parks (Baltimore Urban Agriculture, 2009). The Virtual Supermarket

Project seeks to design food delivery access points in underserved urban neighborhoods. As of the 2010, there are two virtual supermarket sites within the City (Baltimore Office of Sustainability, 2010). The Baltimore City Food Policy Tack Force has the purpose to identify means of creating demand and equitable access to local foods.

The Baltimore City Public School System encourages students to eat and learn about healthy food choices. The school system has established Meatless Monday by teaming up with local farms and distributors. The school system also has the Great Kids Farm providing a 33-acre teaching farm (Baltimore Office of Sustainability, 2010). The Community Greening Resource Network provides communities the materials, education, and connections to garden in the City (Baltimore Office of Sustainability, 2010). Figure 10 (page 42) displays the current community gardens and urban farms within the City.

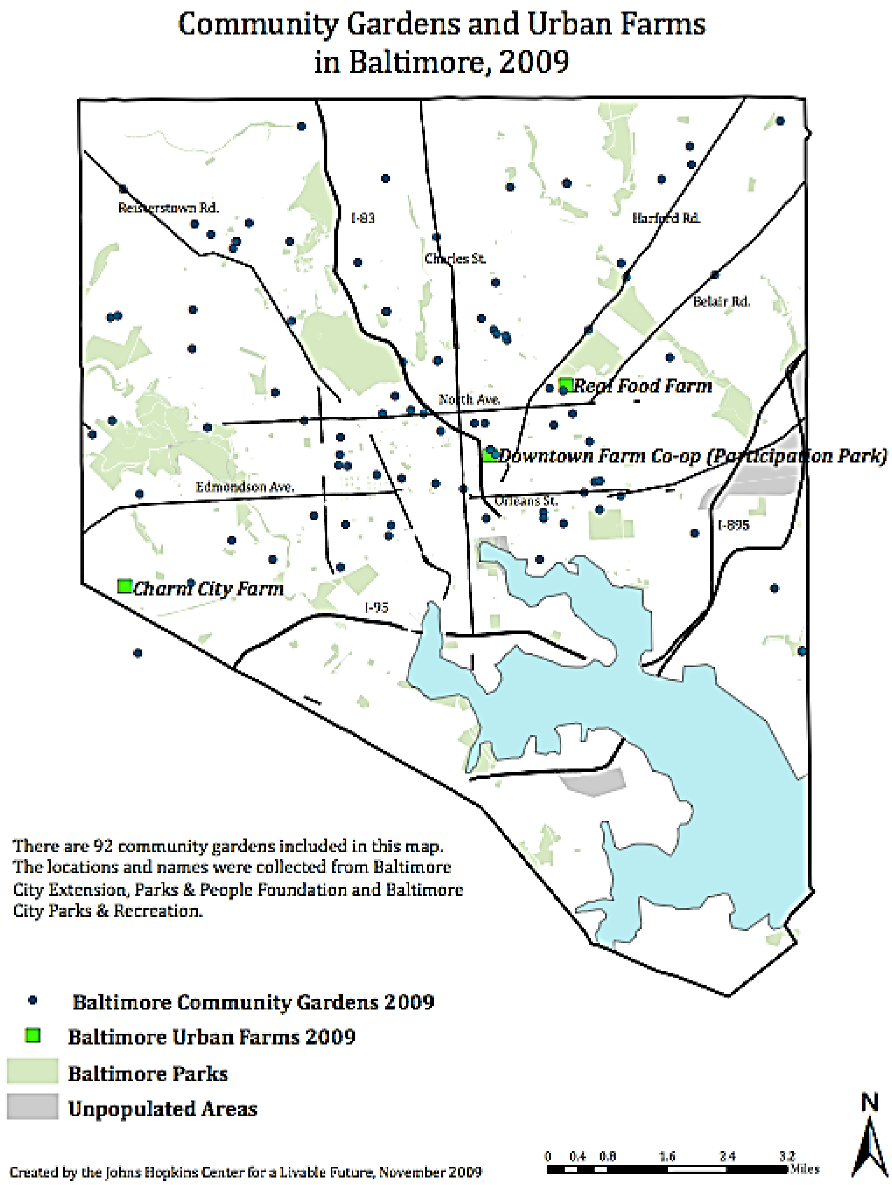

Figure 10: Community Gardens and Urban Farms in Baltimore, 2009 (Johns Hopkins Center for a Livable Future, 2013)

Although the City has begun a local food system, there still exist numerous food deserts within the City. Figure 11 (page 43) shows the vast areas that are food deserts within Baltimore City. However, the local food system is not utilizing all the available space within the City due to zoning restrictions limiting agricultural land uses within the residential and commercial zones.

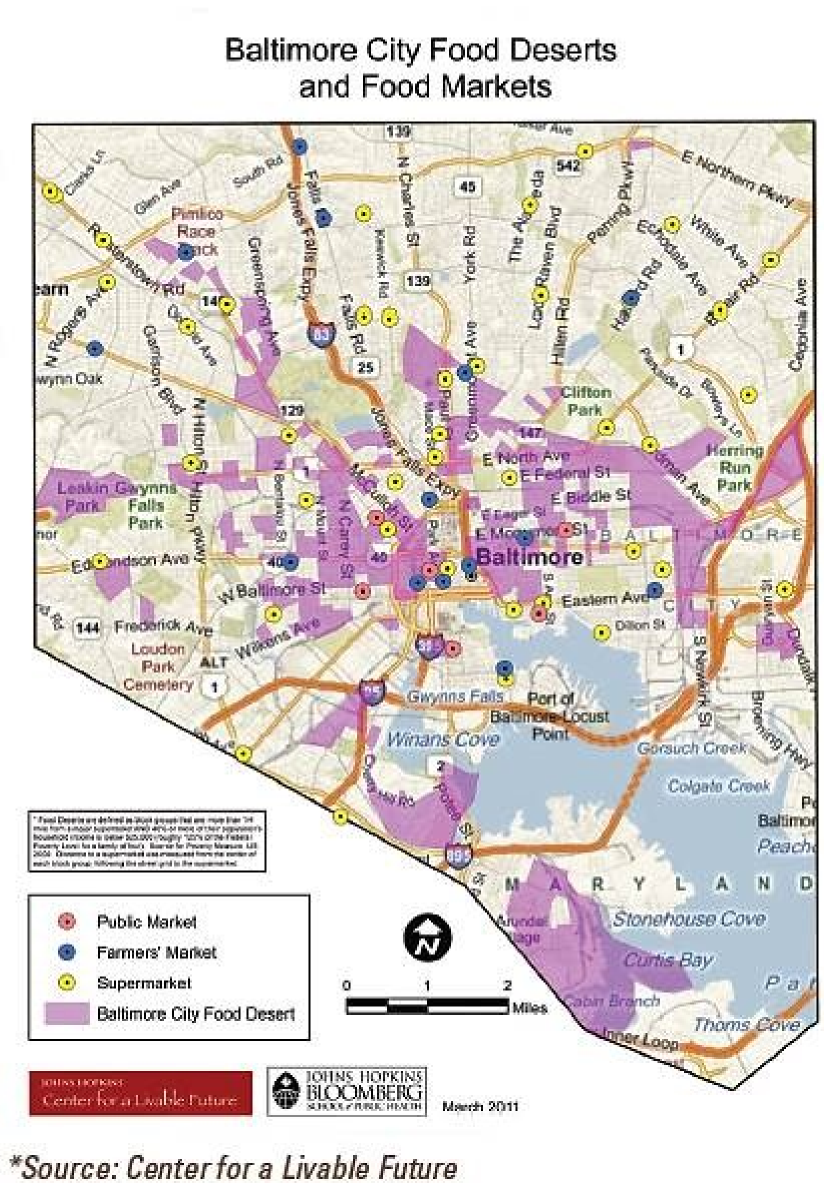

Figure 11: Baltimore City Food Deserts and Food Markets (Baltimore Office of Sustainability, 2010)

Baltimore County.

Since 1854, the county seat of Baltimore County is Towson (Baltimore County Council, 2010). The majority of Baltimore County is suburban and rural in character. The County's geographic characteristics are plateau topography in the north and coastal plane in the south. Northern Baltimore County is primarily rural with a landscape of rolling hills and deciduous forests. The county's major employers are the Social Security Administration headquartered in Woodlawn and Black & Decker in Towson. Of the 410,000-person workforce in 2009, 25% work in education, health, and human services, 10% in retailing, and less than 1% in agriculture (Baltimore County Council, 2010).

The County of Baltimore is 598.30 square miles (379,712 acres or 154,959 hectares) in size with a population of 805,029 persons giving a density of 1,345 persons per square mile (United States Census Bureau, 2010). The age distribution of the population is 6.0% under 5 years, 21.8% under 18 years, 57.5% between 19 and 64 years, 14.7% 65 years and over, and 52.7% female (United States Census Bureau, 2010). The racial distribution of the population is 65.4% white, 26.8% black, 5.2% Asian, and 2.6% other races while 4.4% are of Hispanic or Latino origin (United States Census Bureau, 2010).

As of 2011, the County of Baltimore had 336,939 housing units with a homeownership rate of 49.5% (United States Census Bureau, 2010). Of the 336,939 housing units, 28.2% of the housing units are multi-unit structures with an overall 2.48 persons per household (United States Census Bureau, 2010). The median value of owner-occupied housing units was $269,400 between 2007 and 2011, while the median household income was $65,411 (United States Census Bureau, 2010). The percent of person below the poverty level is 8.4% (United States Census Bureau, 2010). Again the national average for person below the poverty level is 15.1%, and the state average is 10.1 as of 2011 (U.S. Census Buearu, 2011).

Planning Guides: Agriculture.

Currently within Baltimore County, the planning guide is the Master Plan 2020. The purpose of the Master Plan 2020 is "to guide the coordinated, adjusted, and harmonious development of Baltimore County" (Baltimore County Council, 2010). The two policies in the plan that directly relate to agriculture are tourism and the sustainable agricultural industry. Within the Economic Vitality section of the plan, a tourism action details a policy to increase visibility and access to visitor destinations. Thus, to "support agriculture-related tourist activities such as Shawan Downs, the Maryland State Fair in Timonium, wineries, horse farms, and farmers markets" (Baltimore County Council, 2010). This promotes the preservation of local farms and the sales of their value added products.

The second policy is the sustainable agricultural industry. This policy has preserved over 50,000 acres (20,234.3 ha) of rural land and is gaining momentum to build a stronger and more sustainable agricultural economy. The county has recognized the benefits of local food production including energy conservation, food security and the potential for green jobs (Baltimore County Council, 2010). The policy lists 14 actions to foster a sustainable agricultural industry. A few of the actions are "continue to offer loans and economic support for sustainable agricultural operations and potential impacts on quality of life and permit ancillary activities that allow farmers to sell product grown on the farm directly to customers" (Baltimore County Council, 2010). Through this policy, the county creates a backbone for its local food system by protecting growers and jobs.

Zoning Laws: Agriculture.

Currently within Baltimore County, there are two zone classifications for agriculture: R.C.2 Resource Conservation – Agriculture and R.C.50 Resource Conservation – Critical Area-Agriculture. Within the R.C.2 and R.C.50 zones, a variety of land uses are permitted including agricultural operations, single-family dwellings, farmer's roadside stands, farmer's market, etc. (Baltimore County, MD, 2012). A lot cannot subdivide smaller than 2 acres. In addition, "any dwelling, business, or land use in or near a R.C.2 zone may be subject to inconveniences or discomforts arising from agricultural operations" (Baltimore County, MD, 2012). The main difference between the R.C.2 and R.C.50 zone is that the R.C.50 zone is a critical area in and around the Chesapeake Bay and its tributaries, where as R.C.2 is general rural agricultural land. In addition, limited agricultural uses are permitted in all residential zones (expect those designated for apartments), in all commercial zones adjacent to residential lots allowing agriculture and in the restricted and light industrial zones (County of Baltimore, 1955).

Agricultural land that stables and pastures animals is subject to restrictive provisions when not a commercial agricultural operation. There are three types of animal categories: large livestock, small livestock, and fowl or poultry (Baltimore County, MD, 2012). Large livestock are horses, burros, and cattle. Small livestock are sheep, goats, and pigs with the exception of Asian potbellied pig, ponies, and miniature horses. Fowl or poultry are chickens, ducks, turkeys, geese, and pigeons. Each group has a specific density limitation per acre and minimum acreage needed for pasturing (see Table 2 on page 47).

Table 2: Non-Commercial Animal Husbandry Restrictions for Baltimore County (Baltimore County, MD, 2012)

Category of Animal	Minimum Acreage	Animal Per Acre
Large Livestock	3	1
Small Livestock	3	2
Fowl or Poultry	1	No Limit

Current Local Food System.

The County of Baltimore currently has a local food system comprised of CSAs and farmer's markets. The sustainable agricultural industry policy of the County's Master Plan allows for and fosters the development of the local food system. The presence of a local food system is not surprising, given the rural characteristics of the northern portion of the County. It is unknown whether food deserts exist within the County due to lack of data.

Study Areas Growth Trends.

The following subsection details the population and land use trends in Baltimore City and County. This subsection brings to light the City of Baltimore's declining population and subsequent lot abandonment that are hosts for the previously mentioned urban farms.

Population

During the last part of the 20th century, the City of Baltimore was in a state of population decline. The United States Census Bureau did not track the population of places prior to the 1980 census; therefore, all quantified population trends for the city are post 1980. As with most U.S. cities, the City of Baltimore has seen a decline in population since World War II. While, the surrounding metropolitan areas experienced a rapid increase in population. The population of Baltimore in 1980 was 786,741 persons, and then declined to 736,014 persons in 1990 (City-Data, 2009). Again, the population decline in the 2000 Census to a population of 651,154 persons followed by the most recent decline to 620,961 persons in 2010 (City-Data, 2009). Overall, the city declined from the 10th largest city in the United States in 1980 to the 24rd largest in 2000 (City-Data, 2009).

As the City of Baltimore lost population during the latter half of the 20th century, Baltimore County grew. Again, there is limited quantified population data for Baltimore County from the U.S. Census Bureau. The earliest county population counts occurred in 1970. The population of Baltimore County in 1970 was 620,409 persons with an increase to 655,615 persons in 1980 (U.S. Census Bureau, 2012). The population continued to increase to 694,782 persons in the 1990 Census and to 755,598 persons in 2000 (Population Division, 2002). The county saw further increases in the 2000s with a population of 805,029 persons as of 2010 (U.S. Census Bureau, 2012). Figure 12 displays the population shifts in the City and County of Baltimore.

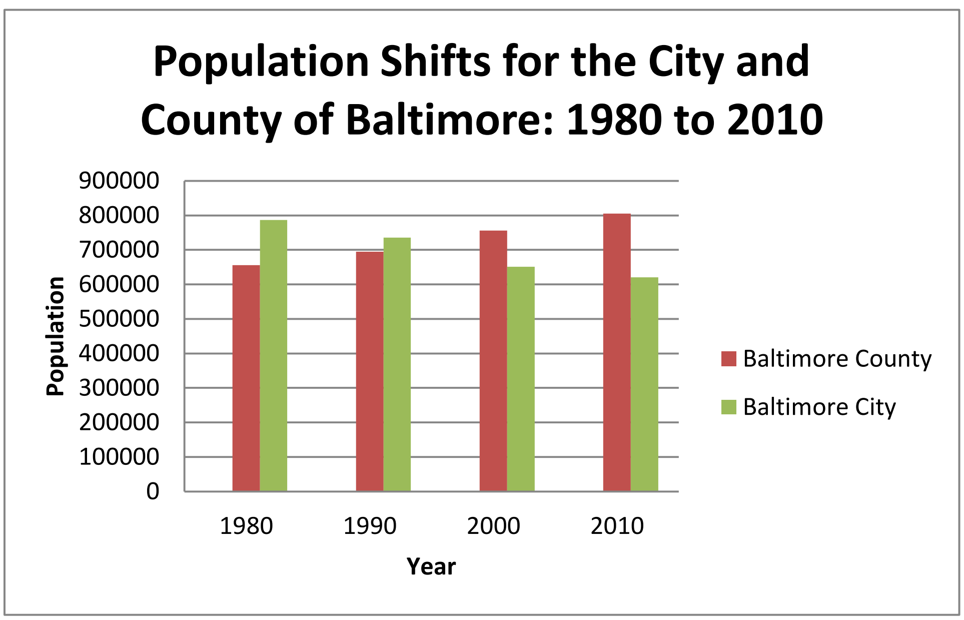

Figure 12: Population Shifts for the Study Areas: 1980-2010 (U.S. Census Bureau, 2012)

Land Cover.

The Maryland Department of Planning created their first Land Use/Land Cover map in 1973 with updates in 2002 and 2010. The map classifies the land area of Maryland into 13 distinct types of land use or land cover. The latest maps show that 1.6 million acres (27% of the state) have undergone development that has more than double from the first map in 1973 (Appler, 2011).

From the City of Baltimore's founding in 1729, it has grown considerably. However, the city has not seen significant land cover change since World War II, as development occurred on all land within the city limits of Baltimore except protected forests. The City of Baltimore hovers around 39% impervious cover since 1984 (Sexton, Song, Huang, Channan, Baker, & Townshend, 2013). Between 1973 and 2010, the total developed land for city increased by 1,413 acres to 47,461 of 51,796 acres (Appler, 2011). The increase was gained through non-residential land use (3,363 acres between 1973 and 2010), but it was offset by the decrease in residential land use (-1,950 acres between 1973 and 2010) (Appler, 2011). The main land use changes occurred in the High Density Residential, Commercial, Industrial, and Other Developed Lands/Institutional/Transportation (see Table 3 on page 50). Figure 13 (page 51) displays the land use/ land cover for the City of Baltimore for 1973, and Figure 14 (page 52) displays land use/ land cover for 2010. Figure 15 (page 53) displays the land use/land cover changes between 1973 and 2010 for the City of Baltimore.

Table 3: Land Use/Land Cover Change 2002-2010: Baltimore City (Appler, 2011)

Land Use/Land Cover Change 2002-2010: Baltimore City				
	Land Use in Acres 2002	2010	Land Use Change 2002-2010	
	Acres	Acres	Acres	Percent
Very Low Density Residential	0	0	0	0.0%
Low Density Residential	618	621	3	0.5%
Medium Density Residential	8,921	8,926	5	0.1%
High Density Residential	14,863	14,930	67	0.4%
Commercial	3,779	3,845	66	1.8%
Industrial	8,679	8,724	45	0.5
Other Developed Lands/ Institutional/Transportation	10,600	10,508	-93	-0.9%
Total Developed Lands	47,461	47,554	93	0.2%
Agriculture	1	0	-1	-100.0%
Forest	3,789	3,725	-64	-1.7%
Extractive/Barren/Bare	526	498	-28	-5.3%
Wetland	19	19	0	0.0%
Total Resource Lands	4,335	4,242	-93	-2.1%
Total Land	51,796	51,796		
Water	7,090	7,090		

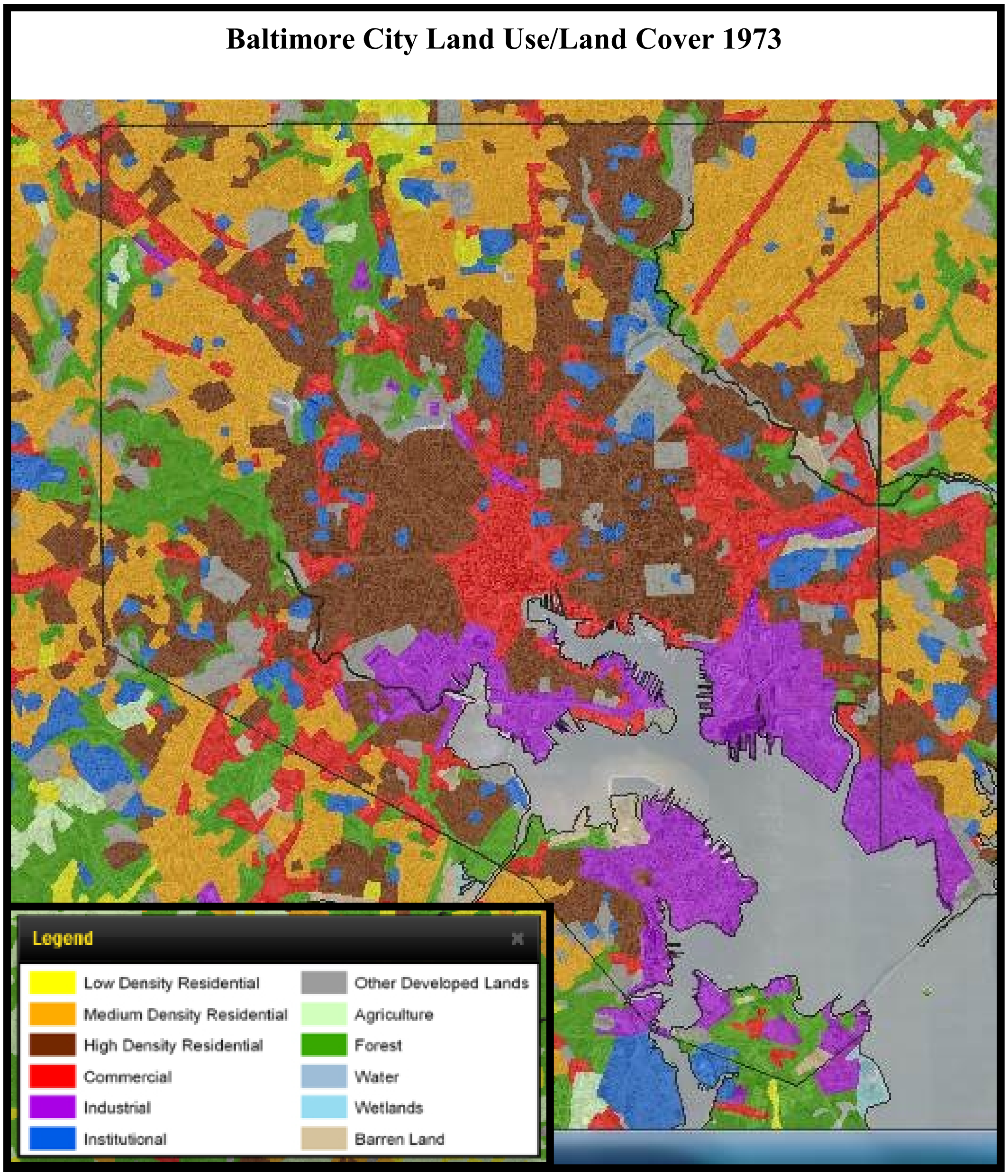

Figure 13: Baltimore City Land Use/Land Cover 1973 (Appler, 2011)

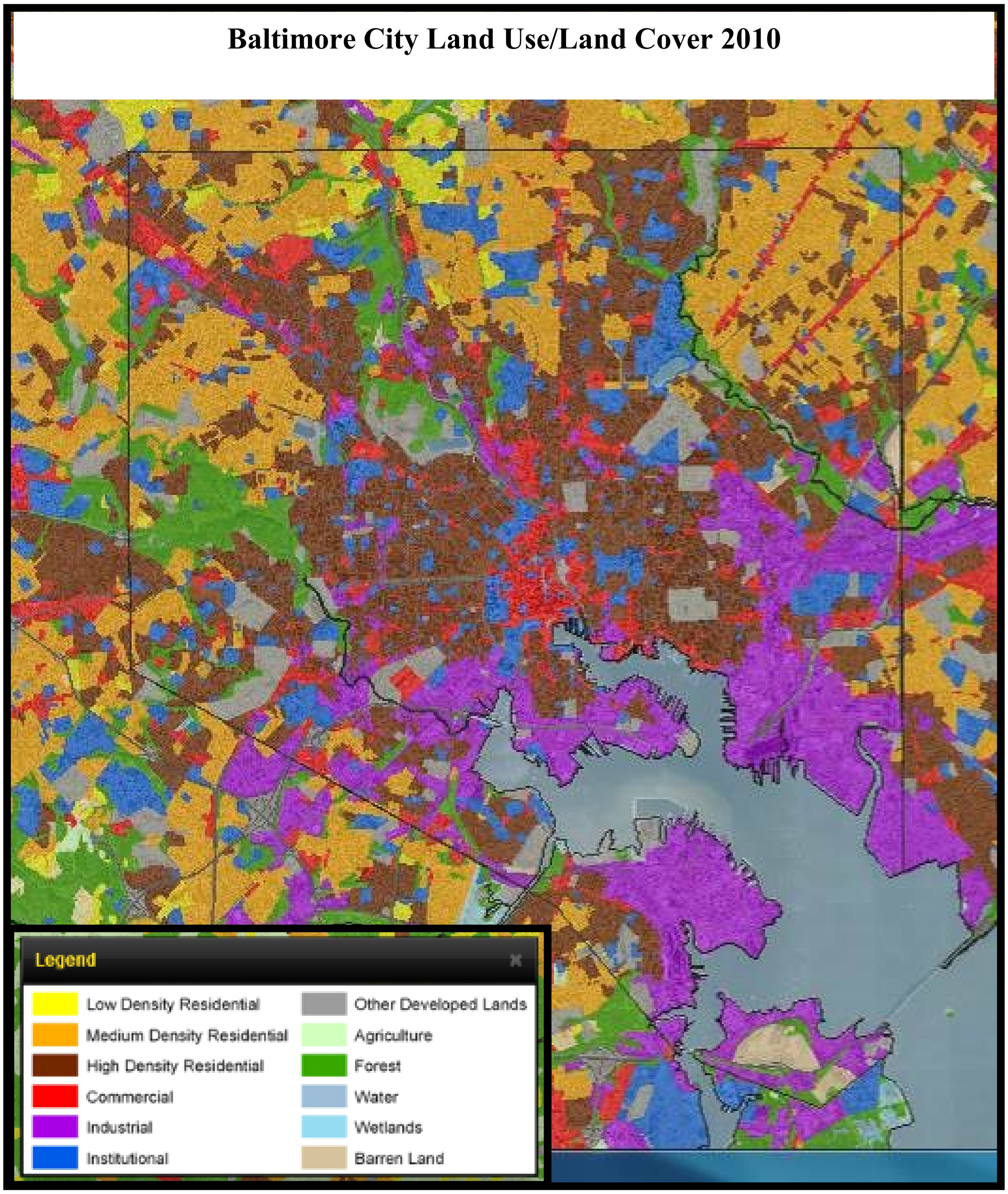

Figure 14: Baltimore City Land Use/Land Cover 2010 (Appler, 2011)

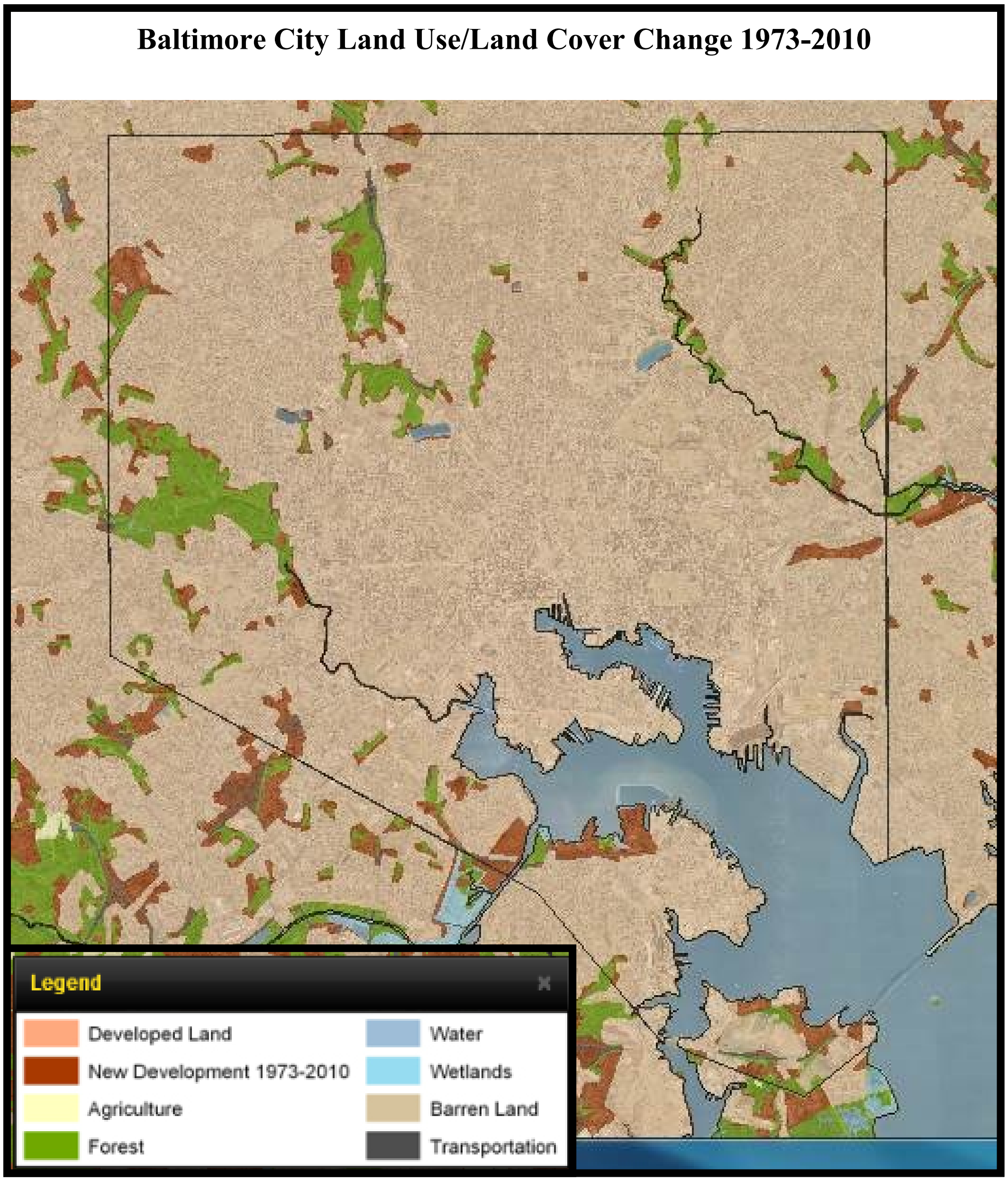

Figure 15: Baltimore City Land Use/Land Cover Change 1973-2010 (Appler, 2011)

The County of Baltimore experienced considerable growth from its inception in the 1700s. However, the county remained largely rural in the north with the majority of development occurring near the City of Baltimore. After World War II, development spread outward into the country along the interstate corridors. That pattern has continued to this day with a succession of ever-denser residential development in the south along with low-density residential development in the historic farming north. Between 1973 and 2010, the total developed lands for county increased by 80,999 acres to 181,387 of 384,785 acres (Appler, 2011). The increase came about through both residential land use (68,850 acres between 1973 and 2010) and non-residential land use (12,148 acres between 1973 and 2000) (Appler, 2011). Resource lands (agriculture, forest, extractive/barren/bare and wetlands) declined by 79,947 acres between 1973 and 2010 (Appler, 2011).

The land use changes to developed land in the county increased almost uniformly between 2002 and 2010 amongst all types (see Table 4 below). The decrease in extractive/barren/bare was double (-10.2%) that of the decrease in forests (-5.1%), although, forests lost the highest total acreage. All land uses within the resource lands saw a decline (see Table 4 on page 55). The figures below show the Land Use/Land Cover for the County of Baltimore. Figure 16 (page 56) displays the land use/ land cover for the Baltimore County for 1973, and Figure 17 (page 57) displays land use/ land cover for 2010. Figure 18 (page 58) displays the land use/land cover changes between 1973 and 2010 for the Baltimore County.

Table 4: Land Use/Land Cover Change 2002-2010: Baltimore County (Appler, 2011)

Land Use/Land Cover Change 2002-2010: Baltimore County				
	Land Use in Acres 2002	2010	Land Use Change 2002-2010	
	Acres	Acres	Acres	Percent
Very Low Density Residential	26,613	27,960	1,348	5.1%
Low Density Residential	47,457	50,430	2,974	6.3%
Medium Density Residential	38,475	40,259	1,784	4.6%
High Density Residential	16,476	17,496	1,020	6.2%
Commercial	10,695	11,424	729	6.8%
Industrial	9,926	10,590	664	6.7%
Other Developed Lands/ Institutional/Transportation	22,086	23,226	1,140	5.2%
Total Developed Lands	**171,728**	**181,387**	**9,658**	**5.6%**
Agriculture	87,682	84,290	-3,392	-3.9%
Forest	119,760	113,701	-6,059	-5.1%
Extractive/Barren/Bare	1,639	1,471	-168	-10.2%
Wetland	3,975	3,936	-39	-1.0%
Total Resource Lands	**213,057**	**203,398**	**-9,658**	**-4.5%**
Total Land	384,785	384,785		
Water	57,092	57,092		

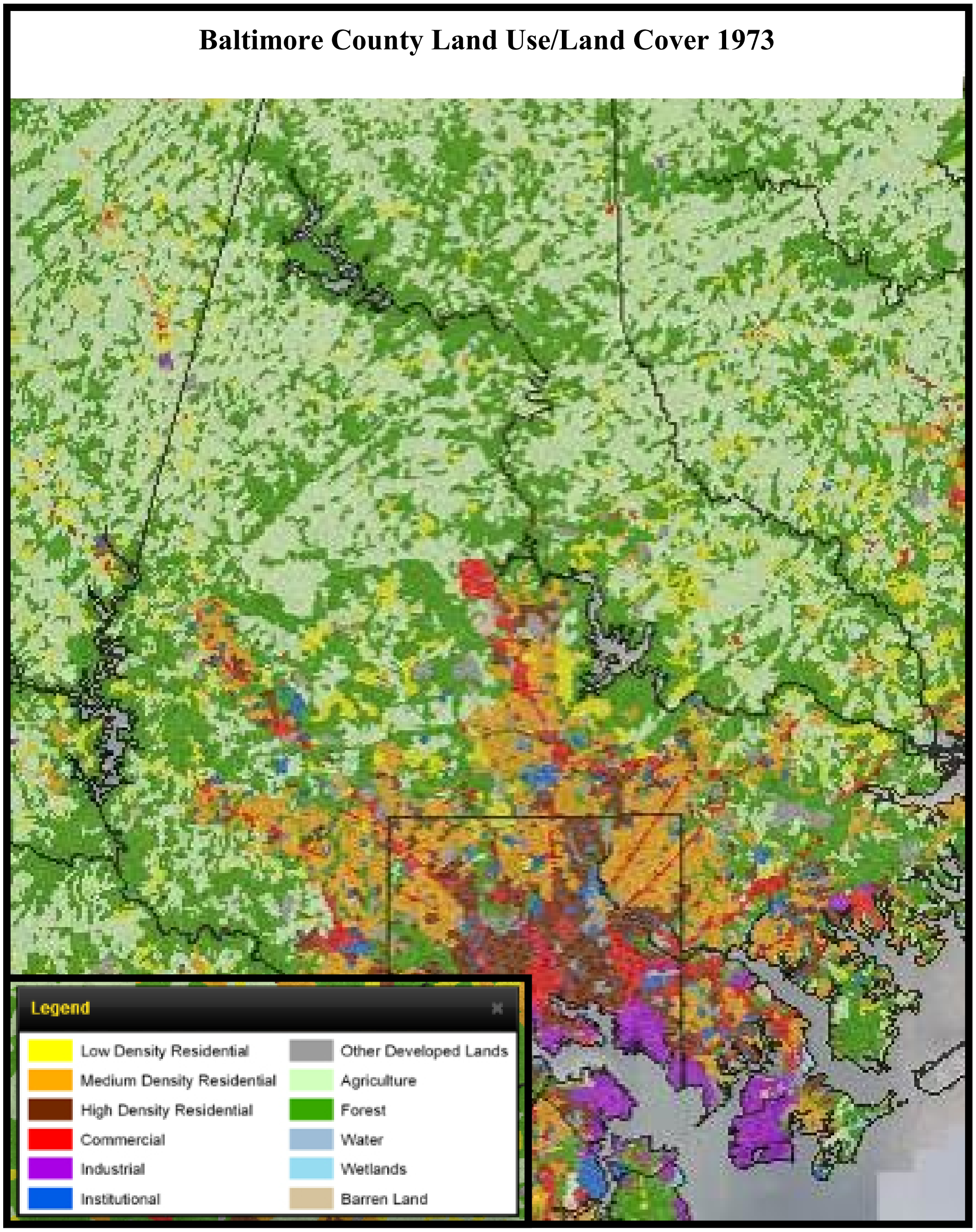

Figure 16: Baltimore County Land Use/Land Cover 1973 (Appler, 2011)

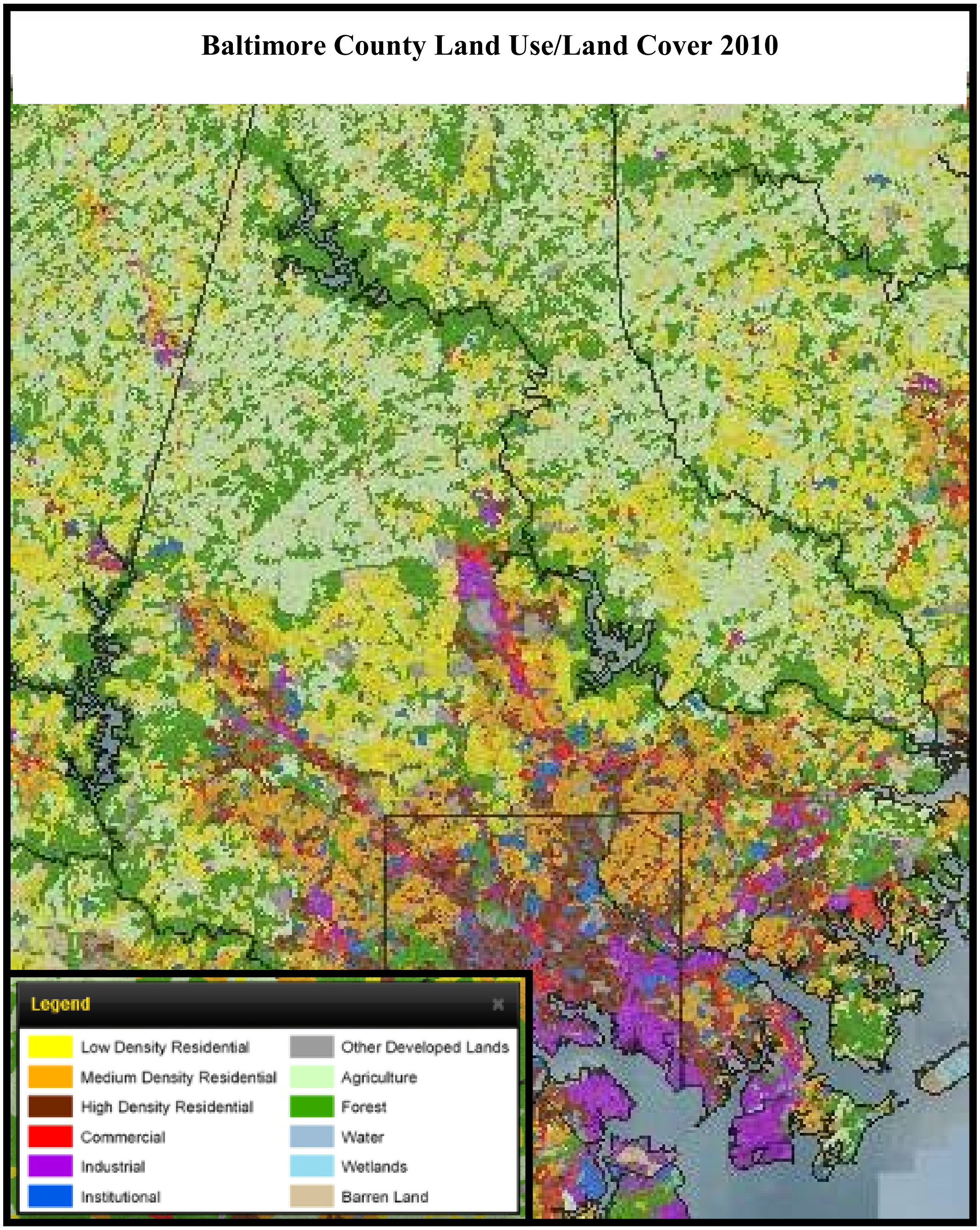

Figure 17: Baltimore County Land/Land Cover 2010 (Appler, 2011)

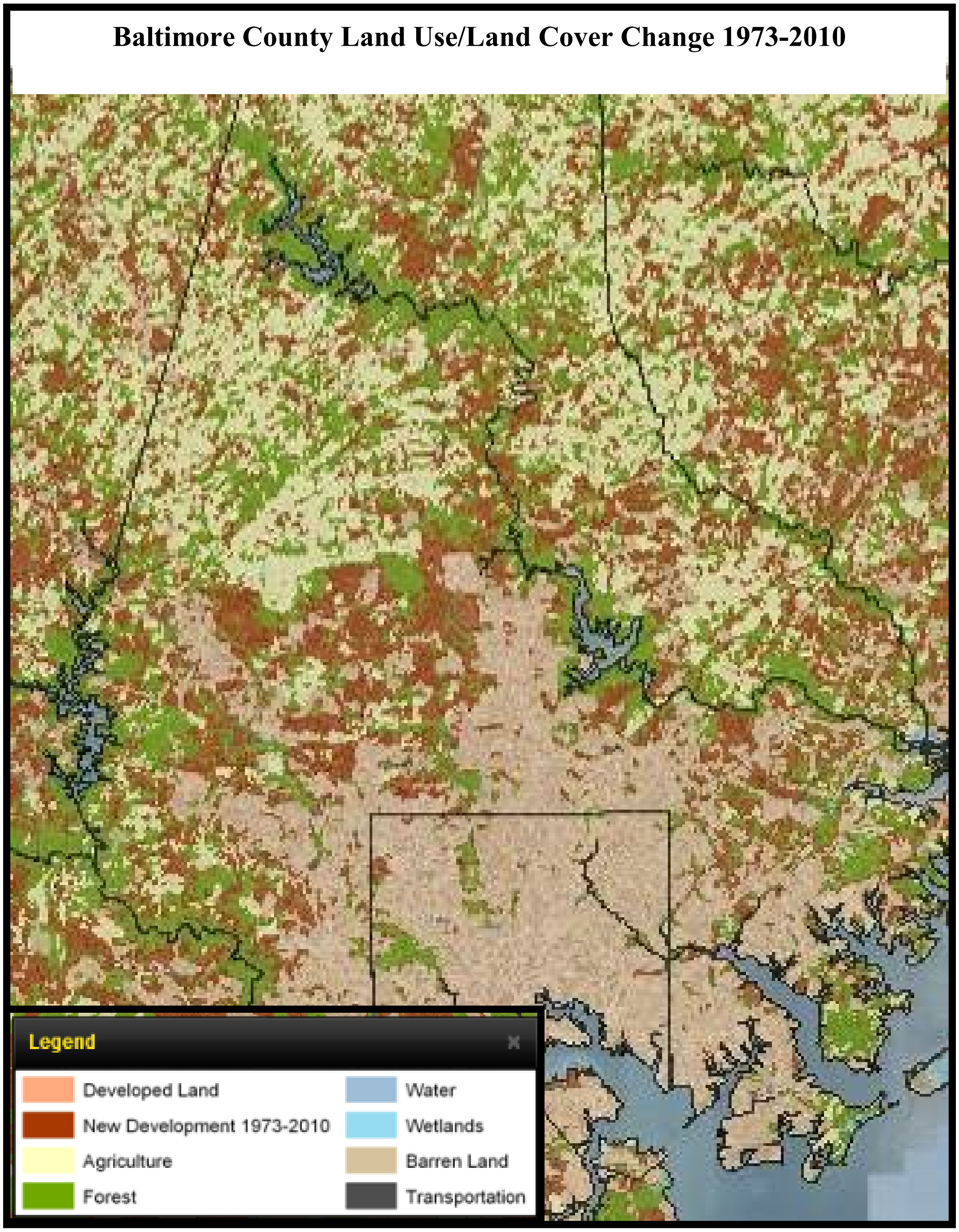

Figure 18: Baltimore County Use/Land Cover Change 1973-2010 (Appler, 2011)

III. Methodology

This section outlines the methods used to formulate the results of this paper. The methods include the interpretation of scientific journals, government documents, and mathematical models based on known facts for dietary needs of individuals, energy, and nutrition content of foods and crops grown in the U.S. The following section details the methods for determining subsistence farming practices, acreage needed to feed study areas' populations, acreage available for cultivation, crop selection, and GIS visualization.

Determination of Subsistence Farming Practices

As stated previously, subsistence farming practices are the backbone of developing or expanding a local food system (Tschamtke, et al., 2012). The basis for the selection of the subsistence farming practices is the actions of planners and government officials undertaken throughout the United States. Examples are those mentioned previously in the literature review as well as the local food movements of Detroit, Michigan and Milwaukee, Wisconsin. In addition, the views of national and regional urban farming organizations help supplement the previous data (Permaculture Institute, National Urban Agricultural Council, Baltimore Urban Agriculture, and the Baltimore Office of Sustainability). Lastly, the study evaluated the trends of agricultural businesses in developing local food systems.

Cultivated Acreage Needed to Feed Study Areas' Populations

In order to determine the feasibility of developing a self-contained local food system for Baltimore City and County, it is vital to calculate the amount of cultivated land required to feed the populations (Metcalf & Widener, 2011). In determining the amount of cultivated land required to feed the study areas' populations, total kilocalories (kcal or Calories) and Calories per cultivated acre are calculated. To calculate the total land requirement, the study divides the total kcals by Calories per cultivated acre. Lastly, to compensate for spoilage and poor harvests, the study increases the calculated land requirement by a third. The following subsections detail the processes for calculating total Calories and Calories per cultivated acre required for the study areas.

Total Kilocalories.

In calculating total kilocalories, it is important to remember that gender and age influence the recommended dietary allowance (RDA) Calorie requirements for an individual per day. For this study, the populations of Baltimore City and County are divided into males and females then further subdivided into three age groups: 18 years and under, 19 to 49 years, and 50 years and older. The 2010 U.S. Census does not subdivide persons 18 years into the age ranges that the RDA does for kcal. As seen in Table 5, the kcal increments between age groups are different for persons under 18 years.

Table 5: RDA Calories Requirements by Age per Day (Dunne, 2002)

Females Age (years)	kcal (energy)	Males Age (Years)	kcal (energy)
1-3	1,300	1-3	1,300
4-6	1,800	4-6	1,800
7-10	2,000	7-10	2,000
11-14	2,200	11-14	2,500
15-18	2,200	15-18	3,000
19-24	2,200	19-24	2,900
25-50	2,200	25-50	2,900
51+	1,900	51+	2,300

To calculate the amount of kcals, the average RDA is determined for each age group for males and females. Due to the lack of subdivision for persons under 18 years, the study assumes equal distribution for each age group in calculating the average. Again, the assumption is equal distribution throughout all subcategories among the percentage of the population that is female in the study areas. The average kcals for the male and female age groups are the same in the City and County; however, the weighted averages are different due to population sizes (see Table 6 and Table 7 on page 62). The averages for the age group are as follows: males 18 and under is 2,120 kcal, 19 to 49 is 2,900 kcal and 50 and older is 2,300 kcal. For females 18 and under it is 1,900 kcal, 19 to 49 it is 2,200 kcal and 50 and older it is 1,900 kcal. Then, the study multiplies the weighted averages by the total number of males and females and adds them together to determine the total kcal requirement per day for the study areas. Lastly, the product of Calorie requirement by 365 produced the yearly kcal requirements, see results.

Table 6: Average Kcal for Males and Females City of Baltimore (Dunne, 2002) (U.S. Census Bureau, 2012)

City of Baltimore					
Males Age (years)	**Population**	**Average Kcal**	**Females Age (years)**	**Population**	**Average Kcal**
18 and under	63,174.00	2,120.00	18 and under	70,953.00	1,900.00
19 to 49	141,885.00	2,900.00	19 to 49	159,358.00	2,200.00
50 an over	87,413.00	2,300.00	50 an over	98,178.00	1,900.00
Weighted Average		**2,552**	**Weighted Average**		**2,045**

Table 7: Average Kcal for Males and Females County of Baltimore (Dunne, 2002) (U.S. Census Bureau, 2012)

County of Baltimore					
Males Age (years)	**Population**	**Average Kcal**	**Females Age (years)**	**Population**	**Average Kcal**
18 and under	83,009.00	2,120.00	18 and under	92,487.00	1,900.00
19 to 49	165,227.00	2,900.00	19 to 49	184,091.00	2,200.00
50 an over	132,543.00	2,300.00	50 an over	147,673.00	1,900.00
Weighted Average		**2,521**	**Weighted Average**		**2,030**

Calories per Acre.

Calories per acre resulted from summing the total Calorie content of cultivated crops and dividing it by the total acreage harvested. This generates a crude national average for kcal production per acre. The information regarding the Calorie content for the crops originates from the USDA My Plate Program and nutritional almanacs. The data for the number of farms, acres, and harvested quantities comes from the 2007 U.S. Agricultural Census and National Agricultural Statistics Service (NASS). Table 8 details the total calorie content for grains harvested in 2007, unless noted differently. For the remaining tables of vegetables, melons, and potatoes, fruits and nuts, and berries see Appendix A.

Table 8: Kcal Production per Acre for Field Crops 2007 (USDA, 2013) (USDA, 2009) (Dunne, 2002)

Field Crops Harvested 2007	Farms	Acres	Quantity	Calories per Measured Unit	Total Calories
Barley for Grain (bsh)	19,848	3,521,957	207,089,232	193 per Cup	5,955,265,044,624.00
Canola (lbs)	3,123	1,149,682	1,418,549,887	124 per Tbl	5,815,260,148,763.28
Corn for Grain (bsh)	347,760	86,248,542	12,738,519,330	122 per Cup	231,560,804,380,740.00
Dry Edible Beans, excluding Limas (Cwt)	6,236	1,455,549	25,353,900	N/A	0.00
Dry Edible Peas (Cwt)	3,048	848,874	17,260,031	N/A	0.00
Flaxseed (bsh)	1,698	347,309	5,722,192	897 per cup	764,788,127,376.00
Hops (lbs)	68	31,145	60,668,474	101 per oz.	98,040,253,984.00
Lentils (Cwt)	811	301,132	3,724,878	200 per Cup	111,001,364,400.00
Mint for Oil (oil lbs)	341	89,132	8,694,739	N/A	0.00
Oats for Grain (bsh)	42,558	1,509,149	89,508,669	156 per Cup	2,080,539,502,236.00

Field Crops Harvested 2007	Farms	Acres	Quantity	Calories per Measured Unit	Total Calories
Peanuts for Nuts (lbs)	6,182	1,200,564	3,703,138,887	144 per Cup	1,023,843,839,477.76
Pineapples (2006; short tons)	30	12,600	185	49.7 per 100g	83,412,504.00
Popcorn (lbs, shelled)	968	201,623	860,878,543	55 per Cup	90,908,774,140.80
Proso Millet (bsh)	1,528	542,108	17,333,479	200 per Cup	516,537,674,200.00
Rice (Cwt)	6,084	2,758,792	198,538,690	359.2 per 100g	36,229,709,750,825.30
Rye for Grain (bsh)	5,160	267,361	6,652,604	115 per Cup	113,992,369,540.00
Safflower (lbs)	766	164,003	203,814,924	13.6 per Tbl	91,638,450,869.18
Sorghum for Grain (bsh)	26,242	6,769,834	482,452,865	437 per Cup	31,413,953,398,745.00
Soybeans (bsh)	279,110	63,915,821	2,582,423,697	172 per Cup	66,182,354,506,716.00
Sugarbeets for Sugar (tons)	4,022	1,253,817	31,937,325	9 per cube (2g)	146,026,647,849,600.00
Sugarcane for Sugar (tons)	692	846,666	31,127,405	9 per cube (2g)	142,323,460,352,640.00
Sunflower Seed, all (lbs)	6,403	2,000,153	2,820,962,445	145 per Cup	785,355,944,688.00
Wheat for Grain, all (bsh)	160,810	50,932,969	1,993,648,378	582 per 100g	7,447,205,448,602.64
Sub-Total		226,368,782			1,478,242,118,063,690

The sources display crop quantities in barrels, bushels, cwt (hundredth weight), pounds, short tons, or tons. Calories displayed in cups (nutrition almanac), per 100 grams (My Plate), or standard serving size (My Plate). It is important to note that Calories from animal products were not included. The following list of conversions transformed the harvested crop quantities into Calories:

- 1 bushels equals approximately 149 cups
- 1 pound equals approximately 453.6 grams
- 1 cwt equals approximately 50802.3 grams
- 1 pound of cooking oil equals approximately 33.06 tablespoons
- 2.71 barrels of cranberries equals approximately 1 bushel of cranberries

Using the above conversions, the equations below calculated the total Calories for each harvested crop quantity over a year.

- Bushels and Cups: (number of bushels * 149) * Calories per cup
- Pounds and Tablespoons: (number of pounds * 33.06) * Calories per tablespoon

- Cwt and Calories per 100 grams: ((number of Cwt * 50802.3)/100) * Calories per 100 grams
- Pounds and Calories per 100 grams: ((number of pounds * 453.6)/ 100) * Calories per 100 grams
- Short Tons and Calories per 100 grams: (((number of short tons *2000)* 453.6)/ 100) * Calories per 100 grams
- Tons and Calories per 100 grams: (((number of tons * 2240) *453.6)/ 100) * Calories per 100 grams
- Barrels and Cups: ((number of barrels *2.71) *149) * Calories per cup
- Tons and Cubes (sugars): ((number of tons *2240) * 453.6) * 4.5

Acreage Available for Local Food System

The acreage available for local food system is the percentage of the study areas that can contribute to a local food system. The focus of this available land is for crop cultivation. The new acreage available derived from summing the available open space within the residential zones and the agriculture zones as of 2010. It is important to note that additional acreage is available within the Developed Lands/ Institutional/ Transportation zones using edible landscaping. However, the study ignores this land due to a lack of a conversion factor for cultivable land per acre.

The acreage within the agriculture zones summed in as presented without subtracting uncultivable land. To calculate the available acreage within the residential districts, the study used the maximum lot coverage (MLC) and maximum floor area ratio (FAR). The data for the permitted land use and lot coverage derives from the zoning and building codes for the City and the County. Tables 9 (page 65) and 10 (page 69) display the complete listings. The City and the County have numerous residential districts (10 for the City and 10 for the County), but they do not disclose the acreage of each district (City of Baltimore, 2013) (County of Baltimore, 1955). However, the attribute table within the shape file for the zoning-districts of the city provides the area for each parcel. These data allow for the calculation of the acreage for each zone. After overlaying the City and County zoning maps with the Maryland Department of Planning (MDP) zoning maps, the residential districts that aligned with the MDP land use categories were determined. For the City, the R-1 is low density, R-2 through R-4 are medium density, and R-5 through R-10 are high density (Appler, 2011). For the County, R.C.5 and R.C.6 are very low density residential, D.R.1 and D.R.2 are low density residential, D.R.3.5 and D.R.5.5 are medium density residential, and D.R.10.5, D.R.16, E.A.R.1 and E.A.R.2 are high density residential (Appler, 2011).

Table 9: City of Baltimore Zoning, Permitted Land Use and Lot Coverage (City of Baltimore, 2013)

Zoning Type	Permitted Residential Land Uses	Max. Lot Coverage	Max. Floor Area Ratio	Agriculture Permitted
R-1 Single-Family Residential District	Single-family detached dwellings	30%	0.4	Yes (Non-Commercial)
R-1A Single-Family Residential District	Single-family detached dwellings	25%	0.4	Yes (Non-Commercial)
R-1B Single-Family Residential District	Single-family detached dwellings	25%	0.4	Yes (Non-Commercial)

Zoning Type	Permitted Residential Land Uses	Max. Lot Coverage	Max. Floor Area Ratio	Agriculture Permitted
R-2 General Residence District	Single-family detached dwellings	30%	0.4	Yes (Non-Commercial)
	Single-family semi-detached dwellings	30%	0.4	Yes (Non-Commercial)
	Multiple-family detached dwellings	Per Floor Area Ration	0.4	Yes (Non-Commercial)
	Housing for the elderly	Per Floor Area Ratio	0.4	Yes (Non-Commercial)
R-3 Single-Family Residential District	Single-family detached dwellings	30%	0.4	Yes (Non-Commercial)
R-4 General Residence District	Single-family detached dwellings	35%	0.4	Yes (Non-Commercial)
	Single-family semi-detached dwellings	35%	0.4	Yes (Non-Commercial)
	Multiple-family detached dwellings	Per Floor Area Ratio	0.4	Yes (Non-Commercial)
	Housing for the elderly	Per Floor Area Ratio	0.6	Yes (Non-Commercial)
R-5 General Residence District	Single-family detached dwellings	35%	0.7	No
	Single-family semi-detached dwellings	35%	0.7	No
	Single-family attached dwellings	40%	0.7	No
	Multiple-family detached dwellings	Per Floor Area Ratio	0.7	No
	Housing for the elderly	Per Floor Area Ratio	1.5	No
	Parks/ Playgrounds			

Zoning Type	Permitted Residential Land Uses	Max. Lot Coverage	Max. Floor Area Ratio	Agriculture Permitted
R-6 General Residence District	Single-family detached dwellings	35%	1.0	No
	Single-family semi-detached dwellings	35%	1.0	No
	Single-family attached dwellings	45%	1.0	No
	Multiple-family detached dwellings	Per Floor Area Ratio	1.0	No
	Housing for the elderly	Per Floor Area Ratio	2.0	No
R-7 General Residence District	Single-family detached dwellings	35%	1.2	No
	Single-family semi-detached dwellings	35%	1.2	No
	Single-family attached dwellings	50%	1.2	No
	Multiple-family detached dwellings	Per Floor Area Ratio	1.2	No
	Housing for the elderly	Per Floor Area Ratio	3.0	No
R-8 General Residence District	Single-family detached dwellings	40%	2.0	No
	Single-family semi-detached dwellings	40%	2.0	No
	Single-family attached dwellings	60%	2.0	No
	Multiple-family detached dwellings	Per Floor Area Ratio	2.0	No
	Housing for the elderly	Per Floor Area Ratio	4.5	No

Zoning Type	Permitted Residential Land Uses	Max. Lot Coverage	Max. Floor Area Ratio	Agriculture Permitted
R-9 General Residence District	Single-family detached dwellings	50%	3.0	No
	Single-family semi-detached dwellings	60%	3.0	No
	Single-family attached dwellings	70%	3.0	No
	Multiple-family detached dwellings & apartment hotels	Per Floor Area Ratio	3.0	No
	Rooming houses	Per Floor Area Ratio	3.0	No
	Housing for the elderly	Per Floor Area Ratio	5.5	No
R-10 General Residence District	Single-family detached dwellings	50%	6.0	No
	Single-family semi-detached dwellings	60%	6.0	No
	Single-family attached dwellings	70%	6.0	No
	Multiple-family detached dwellings & apartment hotels	Per Floor Area Ratio	6.0	No
	Rooming houses	Per Floor Area Ratio	6.0	No
	Housing for the elderly	Per Floor Area Ratio	9.0	No

Table 10: County of Baltimore Zoning, Permitted Land Use and Lot Coverage (County of Baltimore, 1955)

Zoning Type	Permitted Residential Land Uses	Maximum Lot Coverage	Maximum Floor Area Ratio	Agricultural Uses
R.C.5 Rural-Residential	Single-family Detached	15%	0.5 per acre	Yes
R.C.6 Rural Conservation and Residential	Single-family Detached	10%	0.2 per acre	Yes
D.R.1 Density Residential	Single-family Detached	N/A	N/A	Yes
	Single-family Semi-Detached	N/A	N/A	Yes
	Single-family Attached	N/A	N/A	Yes
D.R.2 Density Residential	Single-family Detached	N/A	N/A	Yes
	Single-family Semi-Detached	N/A	N/A	Yes
	Single-family Attached	N/A	N/A	Yes
D.R.3.5 Density Residential	Single-family Detached	N/A	N/A	Yes
	Single-family Semi-Detached	N/A	N/A	Yes
	Single-family Attached	N/A	N/A	Yes
D.R.5.5 Density Residential	Single-family Detached	N/A	N/A	Yes
	Single-family Semi-Detached	N/A	N/A	Yes
	Single-family Attached	N/A	N/A	Yes
	Multi-family Detached	N/A	N/A	Yes

Zoning Type	Permitted Residential Land Uses	Maximum Lot Coverage	Maximum Floor Area Ratio	Agricultural Uses
D.R.10.5 Density Residential	Single-family Detached	N/A	N/A	Yes
	Single-family Semi-Detached	N/A	N/A	Yes
	Single-family Attached	N/A	N/A	Yes
	Multi-family Detached	N/A	N/A	Yes
D.R.16 Density Residential	Single-family Detached	N/A	N/A	Yes
	Single-family Semi-Detached	N/A	N/A	Yes
	Single-family Attached	N/A	N/A	Yes
	Multi-family Detached	N/A		Yes
E.A.R.1 Elevator, Apartment Residential	Multi-family Detached	N/A	0.7	No
E.A.R.2	Multi-family Detached	N/A	0.2	No

After separating the residential zones into measured land use categories, the percentage of cultivatable land for each category is calculated. The basis for the percentage is the (MLC) or maximum FAR. Within each residential zone, there are multiple permitted residential land uses that have different MLC and maximum FAR. Due to a lack of data, another assumption is that each residential use has an equal probability within each zone. This assumption could lead to a discrepancy between this study's findings and the actual acres available for cultivation, especially if one permitted land use is overwhelming present over the others within the residential zones. With the current research, the findings display an estimate for acres available for cultivation. In the City, the data was available for actual acreage to calculate for each zone, but in the County, it was not available. Therefore, another assumption is equal probability between residential zones in the MDP land use categories. The study averages the MLCs for each district in the city as seen in Table 11. Table 12 (page 72) displays the averages for each MDP land use category for the County. After calculating percentage of uncultivable land for each MDP land use category, the product multiplied by the acreage for each category determines the amount of uncultivable land. The study assumes that within the category all maximum lot coverage of greater than 1.0 FAR represents 100% uncultivable land due to maximum FAR not representing specific lot coverage. Lastly, subtracting the uncultivable amount from the total land area for the category within each site determines the total cultivable land in the study areas.

Table 11: City of Baltimore Average Maximum Lot Coverage in Residential Districts (City of Baltimore, 2013)

MPD Land Use Category	City of Baltimore Residential Districts	Averaged Maximum Lot Coverage
Low Density	R-1	30%+25%+25%/3=26.67%
Medium Density	R-2	30%+30%+40%+40%/4=35%
	R-3	30%
	R-4	35%+35%+40%+40%/4=37.5%
High Density	R-5	35%+35%+40%+70%+100%/5=56%
	R-6	35%+35%+45%+100%+100%/5=63%
	R-7	35%+35%+50%+100%+100%/5=64%
	R-8	40%+40%+60%+100%+100%/5=68%
	R-9	50%+60%+70%+100%+100%+100%/6=80%
	R-10	50%+60%+70%+100%+100%+100%/6=80%

Table 12: County of Baltimore Average Maximum Lot Coverage in Residential Districts (County of Baltimore, 1955)

MPD Land Use Category	County of Baltimore Residential Districts	Averaged Maximum Lot Coverage
Very Low Density	R.C.5	15%
	R.C.6	10%
	Combined	15%+10%/2=12.5%
Low Density	D.R.1	N/A
	D.R.2	N/A
	Combined	N/A
Medium Density	D.R.3.5	N/A
	D.R.5.5	N/A
	Combined	N/A
High Density	D.R.10.5	N/A
	D.R.16	N/A
	E.A.R.1	70%
	E.A.R.2	0%
	Combined	N/A

Crop Selection

The basis for the selections of cultivated crops are climate conditions from NOAA, soil types from the USGS, current cultivated crops of Maryland and Baltimore County according to NASS, and energy and nutrient content of crops. The climate and soil conditions determine irrigation and fertilizer requirements of the selected crops. It is important not to overburden the water supply, but establish a balance between the population and additional agricultural needs for the local food system. The drainage of the soils plays an important role in its ability to retain water and support aerobic activities. The current cultivated crops of Maryland and Baltimore County establish current cultivation in the state and county. However, not all crops grown in the state grow within the county, based more than likely on grower preferences depending on economic return (Alexander & Moran, 2013). The energy and nutrient values of the crops will determine the proper planting variety to support a balanced intake of carbohydrates, proteins, and fats. In addition, the My Plate guidelines will determine proper amounts of vegetables, fruits, grains, and protein crops. Of the cultivatable crops, ones with higher energy and nutrient content per 100 grams receive higher planting preference. A model developed by this study will determine the proper planting amounts (acres) based on currently grown crops, energy and nutrient values, and My Plate Program guidelines.

The model begins with regrouping the 2007 U.S. Agricultural Census crops categories into the My Plate Food Group categories for crops planted in Maryland. This model omitted the oil category, as crops grown within the other categories process into oils. The dairy group was not included within the model as well because this study is not calculating Calories from animal products. However, dairy is an important segment of a person's diet. Therefore, when dividing the available cultivatable acres between the food groups, the model designated land for dairy production (Acosta-Alba, Lopez-Ridaura, Werf, Leterme, & Corson, 2012).

Next, the model calculates the percentage per food group for an individual's diet using recommended daily amounts (RDA) from the My Plate Program. Again as with Calories, gender and age determine the RDA for individuals (USDA, 2013). Fruits, Vegetables, and Dairy RDAs were given in cups per day while, grains and protein RDAs were given in ounces equivalent per day. To create comparable inputs, the study converted RDAs for grains and protein into cups per day using tables from the My Plate Program. One-ounce equivalent of protein equals ¼ cup per day, and one-ounce equivalent of grains equals ½ cup per day (USDA, 2013).

The model calculates the weighted average for the RDAs per food group per study area for males and females. The weighted average is then multiplied by the male and female populations of study areas and added together to show total cups per day per food group. Lastly, the percentage for each group formed by summing total cups per day then dividing each group amount by the total amount. The model repeated these steps to calculate the necessary protein, carbohydrates, and fats (macronutrients) per day for the study areas populations. The Tables 13 and 14 (page 75) display the complete listings for cups per day for each food group. Table 15 (page 75) shows the complete listing of macronutrients per day for the study areas populations.

Table 13: Cups per Day for Food Groups for the City and County of Baltimore (USDA, 2013) (U.S. Census Bureau, 2012)

City of Baltimore										
Cups per Day per Food Group										
	Fruits		**Vegetables**		**Grains**		**Protein**		**Dairy**	
Age Groups (Years)	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
18 & Under	1.50	1.375	2.00	1.75	2.75	2.375	1.094	1.00	2.625	2.625
19 - 49	2.00	1.75	3.00	2.50	3.75	3.00	1.56	1.313	3.00	3.00
50 +	2.00	1.50	2.50	2.00	3.00	2.50	1.375	1.25	3.00	3.00
Weighted Average										
	1.89	1.59	2.63	2.19	3.31	2.72	1.4	1.23	2.92	2.92
Total Number of Cups per Population Segment										
	553,357	466,282	770,536	640,093	968,036	794,226	410,646	358,735	853,726	853,726
County of Baltimore										
Cups per Day per Food Group										
	Fruits		**Vegetables**		**Grains**		**Protein**		**Dairy**	
Age Groups (Years)	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
18 & Under	1.50	1.375	2.00	1.75	2.75	2.375	1.094	1.00	2.625	2.625
19 - 49	2.00	1.75	3.00	2.50	3.75	3.00	1.56	1.313	3.00	3.00
50+	2.00	1.50	2.50	2.00	3.00	2.50	1.375	1.25	3.00	3.00
Weighted Average										
	1.89	1.58	2.61	2.16	3.27	2.69	1.39	1.22	2.92	2.92
Total Number of Cups per Population Segment										
	720,054	602,099	993,057	823,419	1,245,505	1,024,185	530,813	465,631	1,111,209	1,111,209

Table 14: Food Groups Percentage of Daily Diet

Subtotals of City and County of Baltimore					
	Fruits	**Vegetables**	**Grains**	**Protein**	**Dairy**
Subtotals	2,341,792	3,227,104	4,031,952	1,765,824	3,929,869
Percent of Diet					
	15%	21%	26%	12%	26%

Table 15: Macronutrients per Day for the City and County of Baltimore (Food and Nutrition Board, 2005)

City of Baltimore						
	Carbs (g)		**Fats (g)**		**Protein (g)**	
Age Groups (Years)	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
18 & Under	130.00	130.00	36.25	36.25	29.50	28.00
19 - 49	130.00	130.00	35.00	35.00	56.00	46.00
50 +	130.00	130.00	35.00	35.00	56.00	46.00
Weighted Average						
	130.00	130.00	35.27	35.27	50.28	42.11
Subtotal	38,021,360	42,703,570	10,315,487	11,585,806	14,704,321	13,833,340
County of Baltimore						
	Carbs (g)		**Fats (g)**		**Protein (g)**	
Age Groups (Years)	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**
18 & Under	130.00	130.00	36.25	36.25	29.5	28.00
19 - 49	130.00	130.00	35.00	35.00	56.00	46.00
50 +	130.00	130.00	35.00	35.00	56.00	46.00
Weighted Average						
	130.00	130.00	35.27	35.27	50.22	42.08
Subtotal	49,501,270	55,152,630	13,431,026	14,964,393	19,123,885	17,850,780
	Total Carbs (g)		**Total Fats (g)**		**Total Protein (g)**	
	185,378,830		50,296,713		65,512,326	

The next step in the model is to calculate the average proteins, carbohydrates, and fats per acre from the crops grown within Maryland. The model accomplishes this by inputting the amount of proteins, carbohydrates, and fats per 100 grams for each crop from the My Plate database and nutrient almanac. Next, it produces the averages by multiplying the harvested quantity of a crop by the amount of each macronutrient per 100 grams using the Calorie conversions. Lastly, the model sums and divides the amounts by the amount of cultivated acres of the crops. This model repeats this step for each food group as well as all crops combined. Table 16 (page 77) shows examples of macronutrient content for grains. Appendix B presents the complete tables of all crops.

The last stage of the model is to calculate the amount of land for each food group within the available acreage. It accomplishes this by calculating the percentage of land each food group occupies as compared to total cultivated land for all food groups. The percentage of land for each group is as follows: 1% for fruits, 2% for vegetables, 67% for grains, 29% for protein, and 0.8% for dairy. The model did not allocate land based on the percentage of recommend daily intakes for each food group due to them being measurement in volume and not weight. The amount of land needed to grow a RDA of fruit is less than the amount of land needed to grow the RDA of grains (Barrows, 2012). After the allocation of land, the crops with the highest nutrients per 100 grams will take first precedence over the others. The crops with the higher nutrients per 100 grams allow better use for the limited acreage amount in the study areas to meet nutritional the requirements of the populations. If the crops with the higher nutrient ratio are not mainstream food sources, alterations in consumer behavior are necessary to plant these crops. Even though the crops have a higher nutritional content, this reasoning may not be adequate to compel consumers to change their diet. However, USDA My Plate Program recommends growing as diverse a variety as possible to maintain a healthy diet. In consuming more of the higher nutritional crops along with local diet staples, individuals should be able to achieve nutritional requirement while consuming a lesser amount of food.

Table 16: Macronutrient Content for Grain Crops grown within Maryland (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Grains	Acres	Quantity	Protein grams per year	Carbs grams per year	Fats grams per year
Barley for Grain	3,521,957	207,089,232 (bushels)	563,614,053,811.20	3,308,189,050,250.22	98,745,182,227.72
Corn for Grain	86,248,542	12,738,519,330 (bushels)	28,118,995,340,063.40	246,664,098,362,835.00	10,613,383,741,704.00
Oats for Grain	1,509,149	89,508,669 (bushels)	216,582,679,919.21	857,885,684,167.09	91,596,154,374.95
Popcorn	201,623	860,878,543 (pounds shelled)	1,968,092,315,808.19	12,523,627,436,259.50	6,142,634,794,561.35
Rye for Grain	267,361	6,652,604 (bushels)	20,920,564,077.88	124,661,551,859.87	3,345,938,358.17
Sorghum for Grain	6,769,834	482,452,865 (bushels)	968,150,900,951.14	9,436,407,515,599.68	404,417,464,954.27
Sunflower Seed, all	2,000,153	2,820,962,445 (pounds)	232,885,118,839.46	225,207,587,449.15	682,404,581,742.23
Wheat for Grain, all	50,932,969	1,993,648,378 (bushels)	7,232,742,596,277.88	38,523,985,321,510.10	1,085,182,685,112.96
Sub Total	**151,451,588**		**3.9×10^{10}**	**3.12×10^{14}**	**1.19×10^{13}**

GIS Visualization

In order to visualize the study areas, the study uses ArcGIS software platform to generate maps of the study areas. One Baltimore, GIS Department of the County of Baltimore, and the Maryland Department of Planning provided the data for the maps. The data files used are county shape files, Baltimore City zoning and land use shape files, and Baltimore County zoning and land use shape files. The shape files were overlain to display the proposed crop arrangements on top of the study areas land uses shape files.

IV. Results

The following section details the findings from the studies performed by this paper. This section begins with the results for the subsistence farming practices, acreage required to feed study areas, total kilocalories, and Calories per cultivated acre. It concludes with the acreage available for cultivation and crop selection.

Subsistence Farming Practices

The subsistence farming practices that are transferable into the planning and zoning laws of the study areas are as follows:

- Cultivation of crops within all zones (Growing Power, 2013) (Teig, Amulya, Bardwell, Buchenau, Marshell, & Litt, 2009)
- Animal husbandry in all zones on parcels of adequate size for an animal’s health and safety (Detroit Food Policy Council, 2012) (Growing Power, 2013)
- Composting manure and green wastes by recycling them into natural fertilizers for nutrient recycling (Growing Power, 2013) (Metcalf & Widener, 2011)

- Food preservation and local processing for storage during winter season (Growing Power, 2013) (Marsden & Smith, 2005)
- Resource sharing between farmers in the County and neighborhoods in the City (Growing Power, 2013) (Sundvist, Milestad, & Jansson, 2005)
- Utilizing holistic techniques such as intercropping, multiple cropping, seed collection and local crop selection (Permaculture Institute, 2013) (Jarosz, 2008)

After the incorporation of these practices into the planning and zoning laws, a sustainable independent local food system can be legally developed and maintained within the study areas.

Acreage to Feed Study Areas

As stated previously, the acres required to feed the study areas' populations are calculated from the total kilocalories and Calories per cultivated acre. The acreage needed to feed the study areas is approximately 306,000 acres (124,000 ha) per year. The model calculates this by dividing the total kilocalories requirements for the study areas by the Calories per cultivated acre and adding one third of the total acres:

- $\dfrac{1.18\text{x}10^{12} \text{ kcal per year}}{5.14 \text{ million kcal per acre per year}} \approx 230{,}111$ acres per year
- 230,111 acres per year + (230,111 acres per year *0.33) ≈ 306,000 acres per year

The following subsections detail the findings for the total kilocalories and Calories per cultivated acre.

Total Kilocalories.

The total kilocalorie requirement for the study areas is 1.182×10^{12} kcal (4.947×10^{12} kJ) per year. The males require higher daily intakes than the females at 2,552 kcal and 2,521 kcal per day over 2,045 kcal and 2,030 kcal per day; however, the female population numbers are greater than the male population (752,740 to 673,251 persons). The greater number of females did compensate for the higher required daily needs for the males (see Tables 17 and 18). The estimated overall daily kcal requirement for the male and female populations are 1.7×10^9 kcal per day and 1.5×10^9 kcal per day respectively, totaling to 3.24×10^9 kcal (1.36×10^{10} kJ) per day (see Table 19 on page 81). It is important to note that the basis for the required daily kcal intakes is off averages that most of the U.S. population burns through daily. There exist cases were individuals require more or less than the established norm such as athletes and dieters.

Table 17: Kcals per day for the City of Baltimore (U.S. Census Bureau, 2012) (Dunne, 2002)

City of Baltimore		
Gender	**Population**	**Average Kcal per day**
Males	292,472	2,552 (10,680 kJ)
Females	328,489	2,054 (8,590 kJ)
Sub Total Males		746,400,000 Kcal per day
Sub Total Females		674,700,000 Kcal per day
Total		**1,418,000,000 Kcal per day**

Table 18: Kcals per day for the County of Baltimore (U.S. Census Bureau, 2012) (Dunne, 2002)

County of Baltimore		
Gender	**Population**	**Average Kcal per day**
Males	380,779	2,521 (10,550 kJ)
Females	424,251	2,030 (8,490 kJ)
Sub Total Males		959,900,000 Kcal per day
Sub Total Females		861,200,000 Kcal per day
Total		**1,821,000,000 Kcal per day**

Table 19: Total Yearly Kcal Requirements for Study Areas

Total Kcal per Year for Study Areas	
City of Baltimore	1,418,000,000 Kcal per day
County of Baltimore	1,821,000,000 Kcal per day
Sub Total	3,240,000,00 Kcal per day
Total	1,182,000,000,000 Kcal per year

Calories per Cultivated Acre.

The calculated Calorie per cultivated acre is 5.14 million ($2.15x10^7$ kJ) Calories per acre per year. The study calculates this by dividing the total Calorie content for harvested crops by planted land:

- $\frac{1.18x10^{12} \text{ kcal per year}}{223{,}404{,}045 \text{ acres}} \approx 5.14$ million Calories per acre per year

For the food groups, grains comprise the overwhelming majority (68%) of acres planting among crops for this study in the U.S. in 2007. Protein crops comprise 29% of the acres planted while fruits and vegetables only account for 3% of acres planted (1% and 2% respectively) (see Table 20). The study found two results for this subsection. The basis for the first result is on all plants listed in the 2007 U.S. Agricultural Census for human consumption; however, not all crops are cultivatable within the study areas. Thus, the model excludes uncultivated crops from the calculations.

Table 20: Total Calories per Acre Planted in 2007 (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Total Calories per Acre Planted in 2007			
Crops Type by Food Group	**Acres Planted in 2007**	**Total Kcal from Harvested Amount**	**Percentage of Acres Planted**
Fruits	2,233,876	2,254,827,913,504	1%
Vegetables	4,100,511	51,825,679,997	2%
Grains	151,451,588	1,023,890,773,568,880	68%
Proteins	65,628,070	121,817,612,393,826	29%
Sub Total	223,404,045	1,148,015,039,556,210	
Total		**5,139,000 Calories per acre**	**100%**

Acreage Available for Local Food System

The acreage available for a local food system in the study areas is approximately 120,500 acres (48,765 ha). As mentioned previously, the primarily designation for the acreage is crop cultivation. The model calculates this by summing the available acreage from the City and County:

- 11,730 acres (City) + 108,770 acres (County) ≈ 120,500 acres

The majority of the total acres available (approximately 84,290 acres) are located within the agricultural zones of the County. The very low-density residential zones of the County can contribute another 24,460 acres. Thus, the County provides over 90% of available land as seen in Table 21 (page 83). The residential zones of the City provide 11,730 acres (4,747 ha) with the R-1 and R-5 zones providing the greatest number of acres (see Table 22 on page 83). The study areas have nearly 40% of the land needed to have an independent local food system. Dividing total available acreage by land required to feed study areas populations yields the percentage of the land required to feed the study areas.

- $\frac{\text{120,500 acres per year}}{\text{306,000 acres per year}} = 40\%$

Further dialogue regarding the amount of land available in the other zones is in the Discussion section.

Table 21: Acreage Available for Cultivation in the County of Baltimore (County of Baltimore, 1955)(Appler, 2011)

County of Baltimore			
Land Use Category	**Acres**	**Percent Developed**	**Acreage Available**
Very Low Density Residential	27,960.00	12.50%	24,472.00
Low Density Residential	50,430.00	N/A	0.00
Medium Density Residential	40,259.00	N/A	0.00
High Density Residential	17,496.00	N/A	0.00
Commercial	11,424.00	N/A	0.00
Industrial	10,590.00	N/A	0.00
Other Developed Lands	23,226.00	N/A	0.00
Agriculture	84,290.00	0%	84,298.00
Forest	113,701.00	100%	0.00
Extractive/Barren/Bare	1,471.00	100%	0.00
Wetland	3,975.00	100%	0.00
Water	57,092.00	100%	0.00
Sub Total	441,914.00		108,770.00

Table 22: Acreage Available for Cultivation in the City of Baltimore (City of Baltimore, 2013) (Appler, 2011)

City of Baltimore			
Zone or Land Use Category	**Acres**	**Percent Developed**	**Acreage Available**
R-1	4,814.00	26.67%	3,530.11
R-2	775.00	35%	503.75
R-3	2,875.00	30%	2,012.50
R-4	3,604.00	37.50%	2,252.50
R-5	7,479.00	56%	3,290.76
R-6	7,299.00	63%	2,700.63
R-7	2,983.00	64%	1,073.88
R-8	4,395.00	68%	1,406.40
R-9	579.00	80%	115.80
R-10	170.00	80%	34.00
Commercial	5,088.41	N/A	N/A
Industrial	13,436.50	N/A	N/A
Parks/Recreation	5,193.00	100%	(5193.00)
Water	7,090.00	100%	100%
Sub Total	58,886.00		11,730.00

Crop Selection

The crop selection and cultivation percentage per food group for the study areas are as follows in Tables 23, 24 (page 85), 25 (page 86), and 26 (page 87):

Table 23: Fruit Selection for the Study Areas (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Fruit (1% of the land)	Water Requirements (Yearly in inches/acre)	Protein (g) per 100 grams	Carbohydrates (g) per 100 grams	Fats (g) per 100 grams
Apples	N/A	0.20	15.00	0.36
Apricots	21.65	1.41	11.14	0.39
Cherries, Sweet	N/A	1.20	16.55	0.96
Cherries, Tart	N/A	0.97	12.14	0.30
Figs	N/A	0.75	19.06	0.30
Grapes	N/A	0.66	17.75	0.12
Kiwifruit	N/A	0.99	14.87	0.45
Nectarines	N/A	0.94	11.76	0.46
Peaches, All	27.56	0.70	9.85	1.01
Pears, All	N/A	0.45	12.81	0.32
Persimmons	N/A	0.58	18.57	0.18
Plums and Prunes	N/A	1.68	37.51	0.56
Cantaloupes	20.00	0.88	8.39	0.28
Honeydew Melons	23.62	0.47	9.44	0.10
Watermelons	15.00	0.62	7.19	0.43
Blackberries and Dewberries	N/A	0.72	12.71	0.04
Blueberries, Tame	N/A	0.67	14.14	0.38
Blueberries, Wild	N/A	0.67	14.14	0.38
Boysenberries	N/A	1.11	12.12	0.27
Raspberries, All	N/A	0.90	11.54	0.55
Strawberries	N/A	0.60	6.84	0.36
Other Berries	N/A	N/A	N/A	N/A

Table 24: Vegetable Selection for the Study Areas (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Vegetables (2% of the land)	Water Requirements (Yearly in inches/acre)	Protein (g) per 100 grams	Carbohydrates (g) per 100 grams	Fats (g) per 100 grams
Asparagus, Bearing Age	18.00	2.66	11.95	0.15
Beans, Snap	15.00	1.82	7.14	0.02
Beets	15.00	1.47	10.00	0.15
Broccoli	25.00	2.95	5.23	0.34
Cabbage, Chinese	19.69	1.50	2.19	0.20
Cabbage, Head	30.00	1.20	3.94	0.27
Carrots	15.00	0.91	10.00	0.18
Cauliflower	30.00	1.98	4.90	0.18
Collards	14.00	2.22	5.56	0.42
Cucumbers/Pickles	25.00	0.54	2.88	0.13
Daikon	N/A	N/A	N/A	N/A
Eggplant	35.00	1.10	6.10	0.10
Escarole/Endive	N/A	1.24	3.36	0.20
Garlic	20.00	6.67	30.00	0.50
Ginseng	N/A	N/A	N/A	N/A
Herbs, Fresh Cut	N/A	N/A	N/A	N/A
Horseradish	N/A	1.33	11.33	0.67
Kale	14.00	3.30	10.00	0.70
Lettuce, All	12.00	1.27	2.63	0.19
Mustard Greens	15.00	2.68	4.82	0.01
Okra	20.00	2.00	7.60	0.10
Onions, Dry	30.00	1.18	7.31	0.16
Onions, Green	N/A	1.70	5.50	0.19
Parsley	N/A	3.67	8.50	0.67
Peppers, Bell (excluding pimientos)	35.00	0.92	5.67	0.19
Peppers, Other than Bell (including chili)	30.00	2.00	9.33	0.20
Potatoes	40.00	2.13	17.13	0.13
Pumpkins	30.00	1.00	6.47	0.01

Vegetables Cont. (2% of the land)	Water Requirements (Yearly in inches/acre)	Protein (g) per 100 grams	Carbohydrates (g) per 100 grams	Fats (g) per 100 grams
Radishes	10.00	0.60	3.56	0.53
Rhubarb	N/A	0.89	4.53	0.20
Spinach	15.00	2.87	3.33	0.35
Squash, All	10.00	1.44	9.82	0.20
Sweet Corn	35.00	3.22	18.83	1.17
Sweet Potatoes	20.00	1.47	23.53	0.28
Tomatoes in the Open	25.00	0.89	4.31	0.33
Turnips	15.00	1.00	6.62	0.10
Turnip Greens	N/A	1.51	5.45	0.31
Watercress	N/A	2.29	3.14	0.11
Vegetables, Other	N/A	N/A	N/A	N/A

Table 25: Grain Selection for the Study Areas (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Grains (59% of the land)	Water Requirements (Yearly in inches/acre)	Protein (g) per 100 grams	Carbohydrates (g) per 100 grams	Fats (g) per 100 grams
Barley for Grain (bushels)	25.60	12.50	73.37	2.19
Corn for Grain (bushels)	31.50	8.69	76.23	3.28
Oats for Grain (bushels)	25.60	16.67	66.03	7.05
Popcorn (lbs, shelled)	N/A	9.00	57.27	28.09
Rye for Grain (bushels)	N/A	12.38	73.77	1.98
Sorghum for Grain (bushels)	25.6	7.90	77.00	3.30
Sunflower Seed, all (lbs)	39.37	18.20	17.60	53.33
Wheat for Grain, all (bushels)	25.60	13.33	71.00	2.00

Table 26: Protein Selection for the Study Areas (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Protein (37% of the land)	Water Requirement (Yearly in inches/acre)	Protein (g) per 100 grams	Carbohydrates (g) per 100 grams	Fats (g) per 100 grams
Soybeans for Beans (bushels)	27.56	16.86	9.88	8.72
Almonds	N/A	18.59	19.51	54.23
Chestnuts	N/A	1.64	46.43	1.25
Hazelnuts (Filberts)	N/A	12.59	16.67	62.37
Pecan, All	N/A	9.17	14.63	71.20
Walnuts, English	N/A	14.80	15.80	64.00
Other Nuts	N/A	N/A	N/A	N/A
Beans, Green Lima's	19.69	7.45	21.28	0.37
Peas, Chinese	19.69	8.00	20.80	0.38
Peas, Green (excluding Southern Peas)	19.69	5.41	14.38	0.40
Peas, Green Southern (cowpeas)	15.00	8.12	18.12	0.79

The crops listed above meet the requirements set forth by the model. When available, the crops meet the water threshold by requiring less than the annual rainfall for Baltimore City and County of 45.55 inches (1156.97 mm). The crops with N/A lacked data for water requirements. However, farmers within Baltimore County or the State of Maryland currently cultivate these crops, meaning water resources are sufficient. The crops listed in the tables meet the My Plate Program distribution for a balanced diet by having fruits, vegetables, grains, and protein. As mentioned previously, the study excluded dairy from the crop selection model, but land is set aside for production.

The ideal acreage for the food groups throughout the study areas are as follows (see Figure 19):

- 1,205 acres (488 ha) for fruits (1%)
- 2,410 acres (975 ha) for vegetables (2%)
- 80,735 acres (32,670 ha) for grains (67%)
- 34,945 acres (14,150 ha) for protein (29%)
- 1,205 acres (488 ha) for dairy (1%)

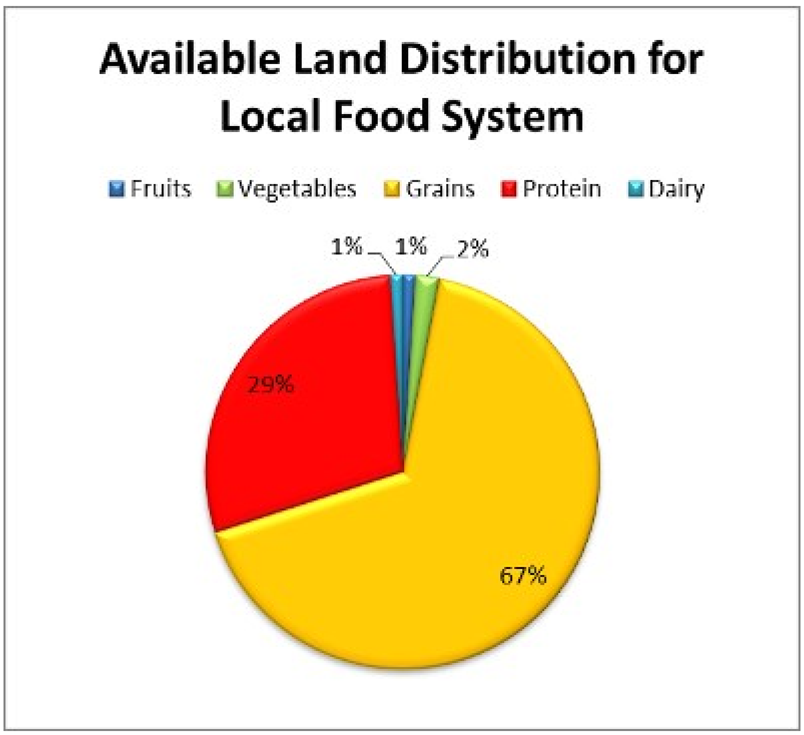

Figure 19: Available Land Distribution for Local Food System (USDA, 2009)

To compensate for the existing 14% pastureland (11,800.60 of 84,290 acres) in Baltimore County, the study reduced the land for grains by 8% (11,800.60 of 120,500 acres) and added to land for protein (USDA, 2007). The new distribution for grains and protein is 71,095 acres (28,770 ha) for grains (59%) and 44,585 acres (18,040 ha) for protein (37%) (See Figure 20 on page 89). This reduces the cultivatable acreage to approximately

108,700 acres (44,000 ha), and the amount of Calories and macronutrients to 43% ($5.05x10^{11}$ Calories per year) of the yearly requirements without animal products.

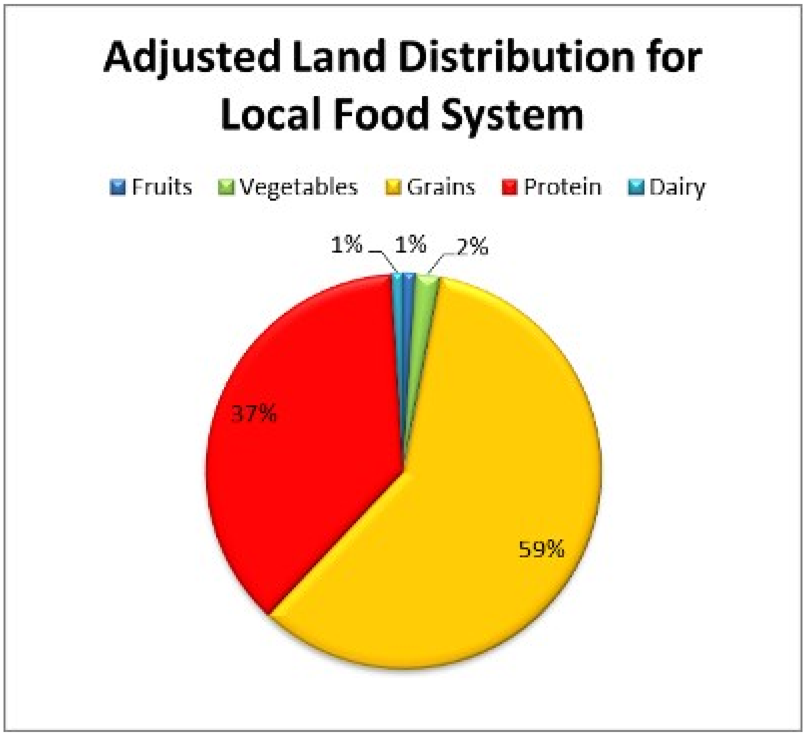

Figure 20: Adjusted Land Distribution for Local Food System (USDA, 2009)

The acreage would be arranged as follows: grains, protein (soybeans, beans, and peas), and dairy in the County, fruits (fruit trees, berries, and melons) and protein (nut trees) in the low density residential zones of the City, and fruits (berries and melons), vegetables, and protein (beans and peas) in the high density residential zones of the City. All crops are subject to rotation among the acreage in the study areas as long as the percentage of land for each food group grown remains similar. The exceptions to the crop rotation would be the fruit and nut trees grown in the low-density residential zones in the City and the dairy farms in the County. See the subsection labeled Crop Placement in the Discussion section for the maps and discussion on the above spatial arrangement for crop cover.

V. Discussion

The following section discusses the results for the research question: the transference of 18th and 19th century subsistence farming practices into modern day planning and zoning codes to develop a local food system. The first subsection discusses the selected subsistence farming practices as affected by the planning and zoning laws. The second subsection discusses the health and environmental benefits, as well as crop cover placement of the selected crops. The last subsection concludes with the cultivation of the study areas.

Subsistence Farming Practices

The subsistence farming practices listed in the Results section are discussed on the basis of why they were selected, are the practices allowed under the current planning and zoning laws in the study areas, and if the practices are not allowed, what changes need to be implemented. The transference of these practices allows for implementation and expansion of the local food system in the study areas (Allen, FitzSimmons, Goodman, & Warner, 2003). In addition, the City and County of Baltimore need to develop joint local food system legislation (Jarosz, 2008). This legislation would affirm the City's and County's commitment to implementing and maintaining a local food system without competing with the other's resources. This discussion joins the final two subsistence farming practices (resource sharing and holistic practices) from the results into resource sharing.

Cultivation of Crops.

The cultivation of crops is an important subsistence farming practice for the development of a local food system (Kremer & DeLiberty, 2011). The study selected the practice as these municipalities currently allow urban farming within residential zones of cities (Hinrichs, 2003) (Allen, FitzSimmons, Goodman, & Warner, 2003). As stated previously, the City of Baltimore started the Baltimore Food Policy Initiative (BFPI) allowing citizens to use City owned vacant and underutilized property for urban farming (City of Baltimore, 2013). In addition, the County has enacted farm preservation legislation to build a stronger, more sustainable agricultural economy (County of Baltimore, 1955). Lastly, in order to build a local food system, crops have to be grown locally.

However, not all residential districts in the study areas allow the cultivation of crops. In the residential districts of the City, R-1 through R-4 allow “agricultural uses, including nurseries and truck gardens – but only if: (i) no retail sales are made on the premises; and (ii) no offensive odor or dust is created” (City of Baltimore, 2013). In the R-5 through R-10 districts, the permitted uses are the same as in the R-1 and R-2 districts except these districts do not permit agricultural uses (see Table 26) (City of Baltimore, 2013).

In the County, agricultural uses are permitted in all residential zones except for E.A.R 1 & 2 (see Table 27 on page 92) (County of Baltimore, 1955). The density residential zones permit “farms, produce stands in association with a farm, or limited-acreage wholesale flower farms” (County of Baltimore, 1955). However, restrictions limit small lot operations due to setback requirements for internal permanent roadways (25 feet or greater) and environmentally controlled structures (50 feet of greater) (County of Baltimore, 1955). In all the residential districts (City and County), cultivation of crops is not allowed as an accessory or conditional use.

Table 27: Agriculture Use per Residential Zoning District of Baltimore City and County (City of Baltimore, 2013) (County of Baltimore, 1955)

Zoning District	Agricultural Uses Allowed
R-1 Single-Family Residential	Yes
R-2 General Residence	Yes
R-3 Single-Family Residential	Yes
R-4General Residence	Yes
R-5 General Residence	No
R-6 General Residence	No
R-7 General Residence	No
R-8 General Residence	No
R-9 General Residence	No
R-10 General Residence	No
R.C.5 Rural-Residential	Yes
R.C.6 Rural Conservation and Residential	Yes
D.R.1 Density Residential	Yes
D.R.2 Density Residential	Yes
D.R.3.5 Density Residential	Yes
D.R.5.5 Density Residential	Yes
D.R.10.5 Density Residential	Yes
D.R.16 Density Residential	Yes
E.A.R.1Elevator-Apartment Residential	No
E.A.R.2 Elevator-Apartment Residential	No

The City does not limit agricultural uses permitted in R-1 through R-4 districts by minimum yard depth requirements. The County does not specify yard restrictions either. Thus, agricultural uses can extend to the parcel boundaries without special permission or zoning violations. The County does not allow the use of roofs for agriculture (green roofs) in the E.A.R.1 & 2 districts. In the City, buildings with green roofs are subject to the green building requirements (The Office of Planning and Development, 2007). These requirements ensure public health and welfare by requiring an “integrated approach to planning, design, construction, and operation” (The Office of Planning and Development, 2007).

Thus, amending the zoning codes maximizes the available land for cultivation. The City and County need to list agriculture as a permitted use in all residential zones (see Figure 21 for visualization). Due to the limited space of lot sizes in the City, permits will be required for permanent or temporary greenhouse structures ensuring adequate space and maintaining quality of the landscape (Chen, 2012). The City and County need to allow green roofs as an agricultural use, but should be subject to any green building requirements. The zoning laws for agricultural land in the County are already adequate for development of a local food system.

Figure 21: Rooftop planters for cultivation in dense urban settings

Animal Husbandry.

Animal Husbandry is another important subsistence farming practice for developing a local food system (Jarosz, 2008). The husbandry of animals allows for production of value added products such as meat, dairy, manure, and material for clothing (Waters, 2007). In addition, farm animals are a source of energy to plow fields and turn processing equipment (Waters, 2007). In the study areas, the protein production is more important over the power due to existing farm machinery and current stable energy supply. Municipalities across the nation are incorporating animal husbandry into their zoning or health codes (Pittsburgh Department of City Planning, 2008) (City of Baltimore, 2013). As stated previously the City of Baltimore allows residents to raise chickens, rabbits, goats, and bees in all residential zones. In addition, the City allows accessory uses of animal facilities and animal fanciers in R-1 through R-4 zones (City of Baltimore, 2013). The County of Baltimore does not allow the raising of farm animals in residential zones and applies restrictions within the agricultural zones, as stated previously.

For the City of Baltimore, the current provisions under the revised health codes are suitable for transferring this subsistence farming practice into current law (see Figure 22 on page 95 for visualization). However, the County of Baltimore needs to enact similar legislation within its density residential zones (D.R1 – D.R.16). Additionally, the County needs to extend its current non-commercial animal husbandry laws into the resource conservation residential zones (R.C.5 and R.C.6). The basis for adopting two animal husbandry laws is the similarities of the zones due to the density of development affecting the welfare of the animals (Fraser, et al., 2013). The density residential zones of the County are similar to the residential zones of the City. While the rural residential zones of the County are similar to the agricultural zones. The space requirements and animal selection currently implemented provide adequate blends of meats, dairy, manure, and material for clothing (Fraser, et al., 2013) (Waters, 2007).

Figure 22: Example of Chicken Coops Operations

Composting Manure and Green Waste.

Returning nutrients back to the soil is a vital subsistence farming practice for a local food system, as nutrient-rich soil produces healthy crops (Jarosz, 2008) (Miller & Welch, 2013). The best way to return nutrients back to the soil and reduce the local waste stream to landfills is through the composting of manure and green wastes (Metcalf & Widener, 2011). Composting is uncommon in urban planning and residential zoning (normally excluded in urban municipalities) due to the perceived notion of unpleasant aesthetics and odors. Nonetheless, the existing recycling programs in the study areas can expand to include composting.

In the City, agricultural use cannot produce offensive odors; therefore, composting can be a contested use depending on surrounding neighbors' perception of offensive odor (City of Baltimore, 2013). The City permits recycling collection stations in all residential zones. It must be a conditional use (by Board approval) when it is an "accessory use to a school, church, recreation facility, or public facility" (City of Baltimore, 2013). The County of Baltimore allows composting in all resource conservation and density residential zones but must be “stored at least 150 feet from all boundary lines of the lot” (County of Baltimore, 1955).

The City and County of Baltimore will need to update their laws to reflect dramatic increases in green wastes from expanded local food system. The updates to the City of Baltimore zoning codes will allow composting as a permitted agricultural use. Due to the density of residential units in Baltimore, central composting locations in neighborhoods are ideal (see Figure 23 for visualization) (Seng, Hirayama, Katayama-Hirayama, Ochiai, & Kaneko, 2013). There will be a need for trained individuals to manage the compost at the stations. The locations need to be able to contain the odors produced from the compost. The County needs to expand composting laws into the E.A.R. zones and keep the setback restriction of 150 feet. The County would benefit from centralized composting locations in the medium to high-density residential zones where the 150 feet setback is difficult to achieve.

Figure 23: Composting and Recycling Center at a local school

Food Preservation and Local Processing.

Preserving food for the winter season along with local processing have been staples of subsistence farmers for centuries (Waters, 2007). Preserving foods is easier today than any time in history due to freezers and chemical preservatives; however, the local food system should preserve foods with the least amount of chemical processing (Edwards-Jones, et al., 2008). The local processing of food for preservation or into value added products is a central component of a local food system (Jarosz, 2008). Anyone in the study areas can undertake food preservation for personal use, as the planning or zoning laws do not govern the action. Local processing on a personal use level is not specified either, as long as it does not create a nuisance. Local processing on a neighborhood level within residential zones is consistent with small to medium sized enterprises and thus, is an accessory use as a home occupation or accessory shop (Martikaninen, Niemi, & Pekkanen, 2013).

The City and County allow home occupations as an accessory use in all residential zones except the E.A.R zones (City of Baltimore, 2013) (County of Baltimore, 1955). The zoning codes do not specify allowable home occupations, but a home occupation does require a permit from the City or County (see Figure 24 on page 98 for visualization). The City of Baltimore allows accessory shops (accessory use) in all residential structures with 50 or more dwelling units as long as it is one of the following “dining room, cocktail lounge, drug store or pharmacy, newsstand, retail food shops, beauty shops, barber shops, and similar personal service shops” (City of Baltimore, 2013). The County has similar regulations for the E.A.R. zones for residential structure with more than 50 dwelling units; expect the shops are a permitted use not an accessory use (County of Baltimore, 1955). Food processing can occur in these accessory shops.

Figure 24: Visualization of local processing mixed with homes and cultivation

The current zoning laws of the study areas allow the local processing of foods, although mainly as accessory and personal use. The City and County would benefit if food processing where an accessory use in all residential structures with fewer than 50 dwelling units and a permitted use in structures with 50 or more dwelling units. This separates the food processing from home occupations, but requires a permit to ensure public health and safety of processing operations (Miewald, Ostry, & Hodgson, 2013). The accessory shops would be small businesses, requiring business permits along with compliance of health codes for processing, handling, and serving food products (Miewald, Ostry, & Hodgson, 2013).

Resource Sharing.

Resource sharing is an important aspect of subsistence farming and local food systems (Jarosz, 2008) (Waters, 2007). Sharing resources allows communities to purchase capital-intensive resources such as mechanical equipment for cultivating and processing and share the burden of maintenance (Ali, Dom, & Sahrum, 2012). Sharing of resources extends beyond physical resources into knowledge resources regarding seed selection, holistic practices, harvest periods, animal care, and value added agricultural products (Permaculture Institute, 2013).

The law does not govern the purchasing and sharing of physical capital; however, use contracts would be necessary to ensure fair distribution of purchase and maintenance costs (Waters, 2007). The City can divide the resource sharing between the existing neighborhood structures. In the County, agricultural resource sharing zones can be created between residential neighborhoods. Each zone would have a centralized property designated for the storage of farming equipment. The study areas allow garages as an accessory use or multi-purpose neighborhood centers (City) or community buildings as a conditional use (Board approval) in residential zones (County) (City of Baltimore, 2013) (County of Baltimore, 1955). These neighborhood centers and community buildings encourage knowledge sharing for farming, gardening, animal care courses, and agricultural information repositories (see Figure 25 on page 100 for example) (Ali, Dom, & Sahrum, 2012). The information repositories will house documents on proper farming techniques for neighborhoods or agricultural resource sharing zones to reflect density limitations. The farming techniques would include urban farming practices, permaculture practices, and holistic practices such as intercropping, multiple cropping, and seed collections.

The current planning laws of the study areas need changes to implement this subsistence farming practice. The Comprehensive Master Plan for the City of Baltimore needs updating to reflect the goal of creating a local food system (Jarosz, 2008). The City can insert resource sharing into the Live and Learn sections of their plan. The sharing of physical capital enables a way to live in a local food system, and sharing of knowledge creates ways to learn about growing, raising, and processing agricultural products. The County currently has sufficient legislation under the sustainable agricultural industry policy within their master plan to create a resource sharing local food system.

Figure 25: Example of possible resource sharing center in Downtown Baltimore

Crop Selection

Crop selection is vital to maximize the limited space in an urban farming environment (Morrison, Nelson, & Ostry, 2011). Another important aspect is the placement of crops within the study areas as the fruit and nut trees are a long-term investment (Morrison, Nelson, & Ostry, 2011). The following subsection details the arrangement of cultivated crops within the study areas along with their health and environmental benefits.

Crop Cover Placement.

As stated in the Results section, the initial placements for the crops are as follows:

- Grains, protein (soybeans, beans and peas) and dairy in the County
- Fruits (fruit trees, berries, and melons) and protein (tree nuts) in the low density residential zones in the City
- Fruits (berries and melons), vegetables and protein (beans and peas) in the high density residential zones in the City

The basis for the reasoning of the initial placements is spatial requirements and ease of growth. The fruit and nut trees require the largest amount of space per plant for the cultivated crops (Barrows, 2012). The low-density residential zones of the City offer adequate available space for the planting of multiple trees in yards and parks (Barrows, 2012). In addition, the trees are difficult to move and reestablish in a short period. Most trees take between two to five years to bear fruits and nuts (Barrows, 2012).

The berries, vegetables, and protein grown in the medium to high-density residential zones are easier to grow than the grain and soybean in the County (Barrows, 2012). Most likely, the majority of the residents of the City do not have experience growing grains or soybeans. The difficulty and/or small harvest could discourage residents from participating in the system. Additionally, the vast amount of acreage required for growing grains and soybeans matches well with the space available in the farmlands of the County. Again, crop rotations are necessary to minimize crop losses to pests and maintain soil health (Leroux, Benolt, & Banville, 1996). The following Figures (26-29 on page 102 – 105) display the residential land uses of the City and County as well as proposed crop cover.

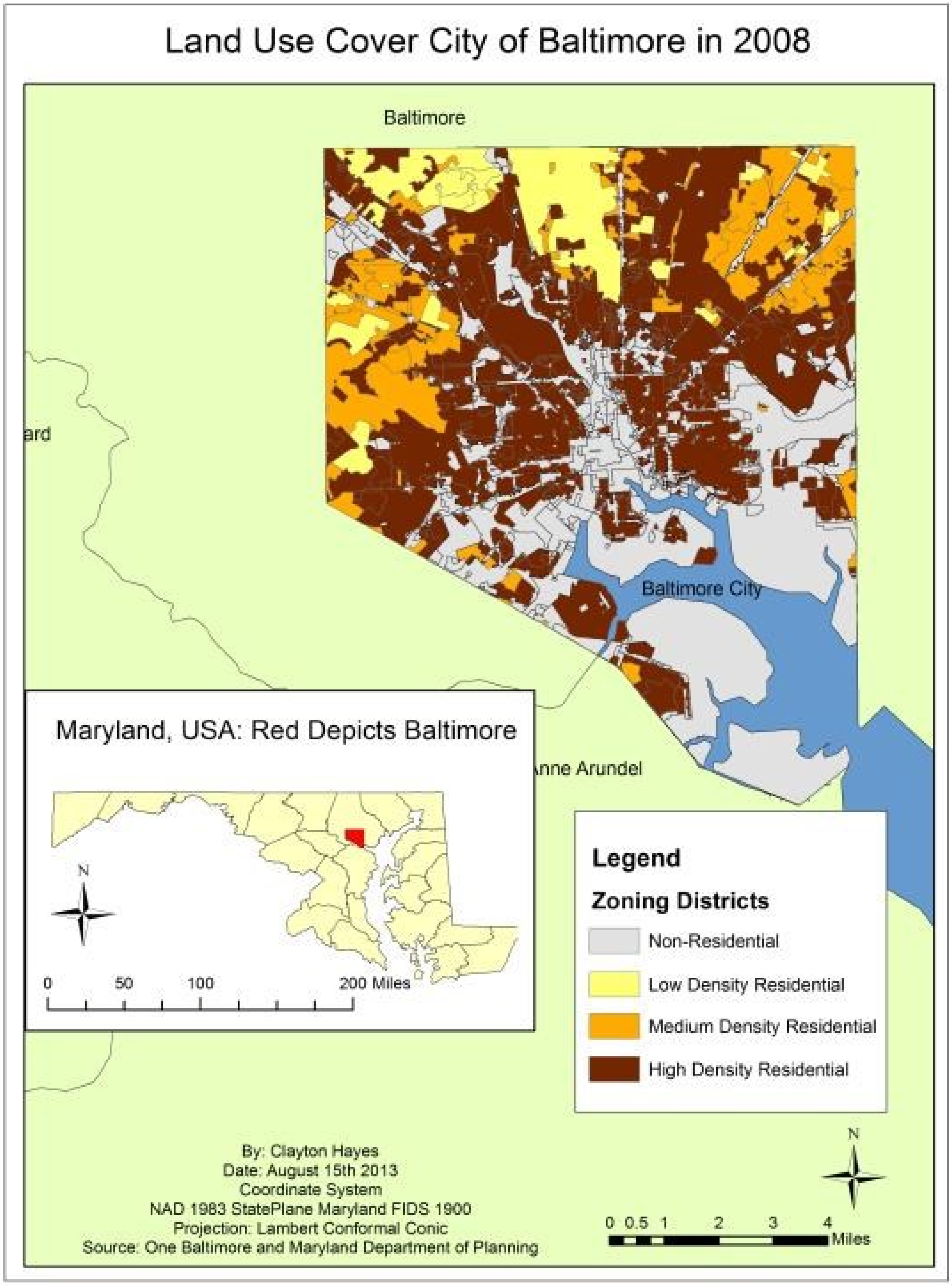

Figure 26: Land Use Cover City of Baltimore: 2008 Map

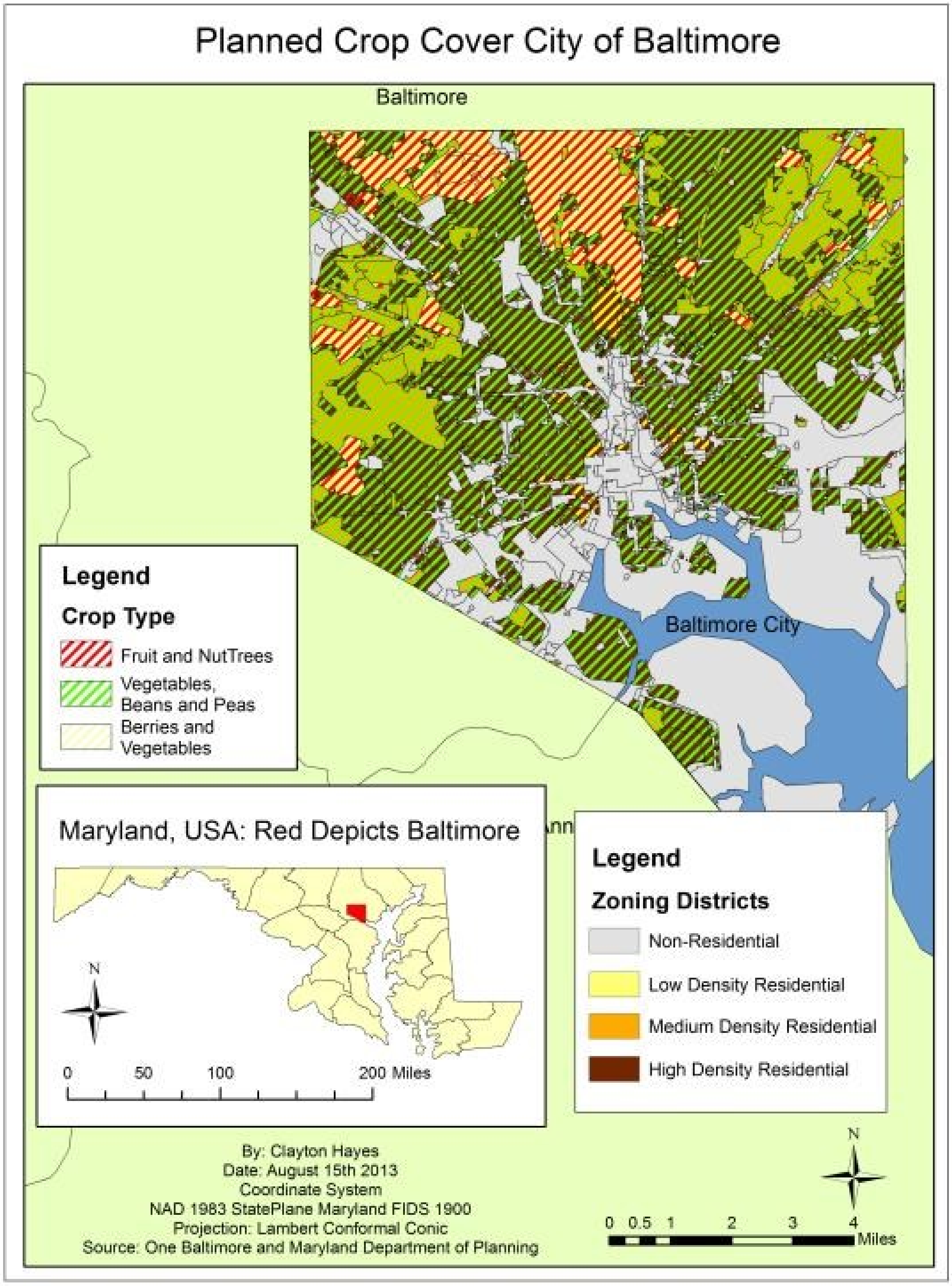

Figure 27: Planned Crop Cover City of Baltimore

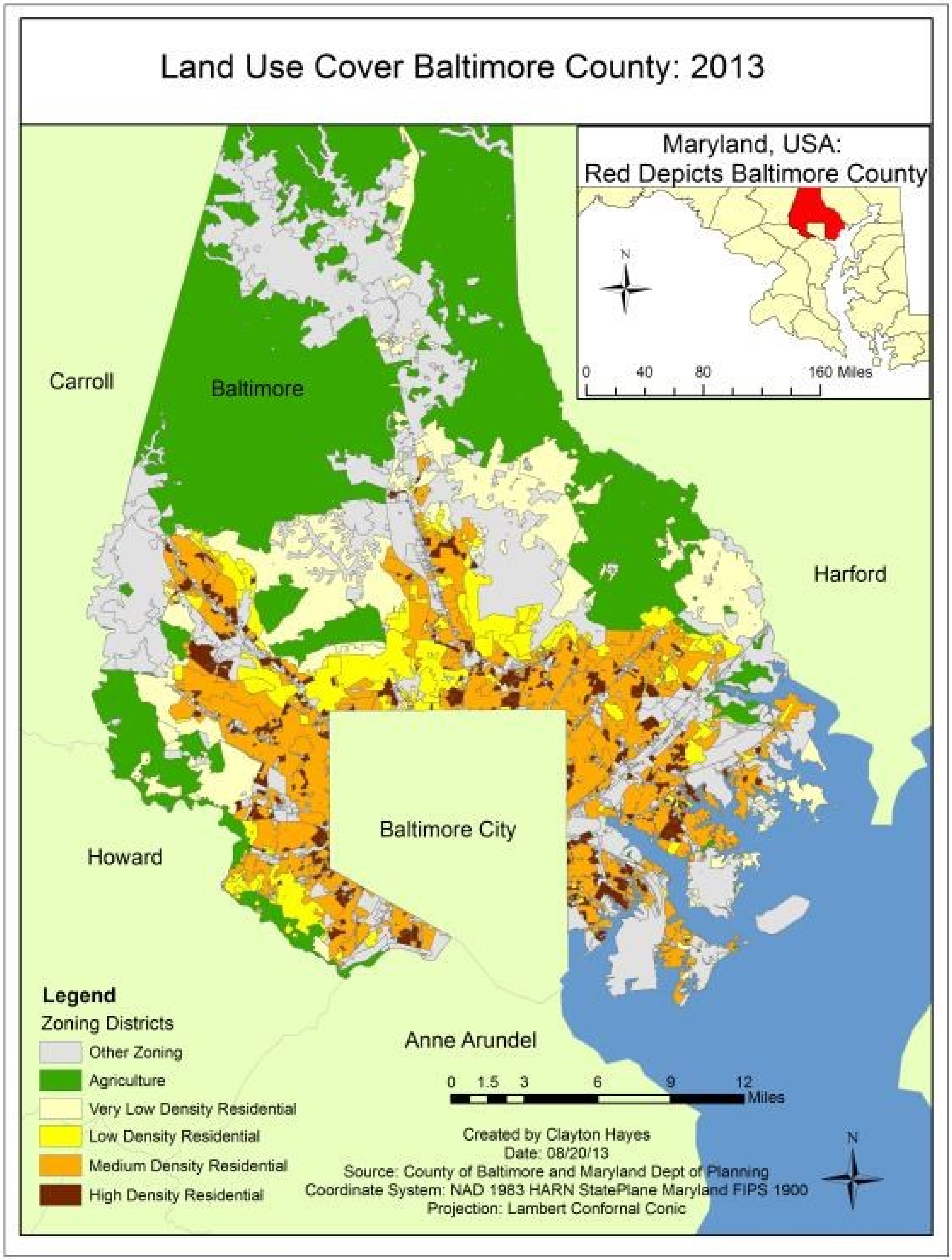

Figure 28: Land Use Cover Baltimore County: 2013

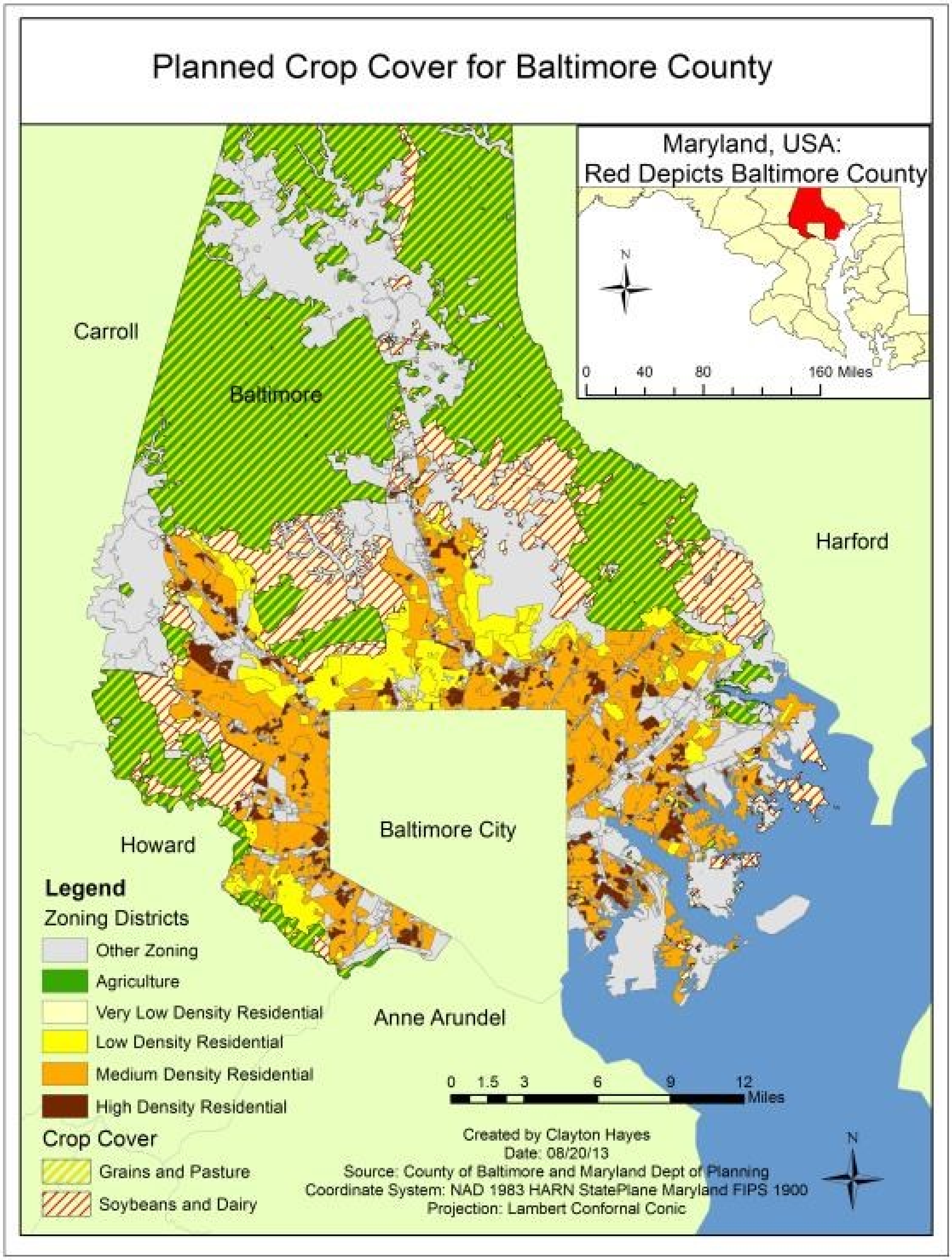

Figure 29: Planned Crop Cover for Baltimore County

Health Benefits.

Locally grown agricultural products generally contain a higher nutritional value when compared to industrially processed goods (Edwards-Jones, et al., 2008). The main reason is the shorter supply chain between producer and consumer. The long supply chains of industrial producers force the preservation of products through methods like quick freezing, “gas and controlled modified atmosphere, chlorination, electrolyzed water treatments, ionizing radiation, application of film packaging and surface coating” (Edwards-Jones, et al., 2008). These techniques extend the shelf life of fresh vegetables; however, foods do not retain energy and nutrient values after processing. This does not infer that agricultural products from a farm bordering the local food system have significantly lower energy and nutrient values. Rather, the quicker a consumer can receive a product with the least amount of processing, the higher the energy and nutrient values (Edwards-Jones, et al., 2008).

In the local food system, consumers (i.e. farmers, gardeners, and participants) have access to agricultural products grown or raised within the City or the County. The size of the study areas allows local products to travel no more than an hour and a half by vehicle to reach any local destination (U.S. Census Bureau, 2012). In addition, consumers can harvest or process products as needed from personal or community gardens and local processing centers, guaranteeing maximum energy and nutritional content. The widespread participation would effectively neutralize the food deserts within the City of Baltimore. The residents would no longer have to rely on fast food restaurants and convenience stores for close to half of their dietary needs (Corrigan, 2011).

Of the crops selected, the crops planted more heavily will have higher energy and nutritional content. This practice maximizes the available acreage for cultivation, while fulfilling the dietary requirements of the study areas' populations with less food (Sundvist, Milestad, & Jansson, 2005). However, this practice requires changing of dietary preferences and consumer behavior for individuals who eat mainly highly processed goods (Sundvist, Milestad, & Jansson, 2005). Thus, gradually introduce the higher nutritional products that are not staples of a normal diet, and give them increased land throughout the study areas. Table 28 shows the list of the higher nutritional crops in the crop selection.

Table 28: Higher Energy and Nutrient Crops for Greater Cultivation in Baltimore City and County (Dunne, 2002) (USDA, 2013)

Crop Type	Energy Content	Macronutrient Content		
Fruits	**Calories per 100 grams**	**Protein (g) per 100 grams**	**Carbohydrates (g) per 100 grams**	**Fats (g) per 100 grams**
Apples	58.70	0.20	15.00	0.36
Blackberries and Dewberries	51.40	0.72	12.71	0.04
Blueberries, Tame	56.60	0.67	14.14	0.38
Cherries, Sweet	71.70	1.20	16.55	0.96
Figs	74.00	0.75	19.06	0.30
Grapes	71.30	0.66	17.75	0.12
Persimmons	127.00	0.58	18.57	0.18
Vegetables	**Calories per 100 grams**	**Protein (g) per 100 grams**	**Carbohydrates (g) per 100 grams**	**Fats (g) per 100 grams**
Beets	44.10	1.47	10.00	0.15
Carrots	43.60	0.91	10.00	0.18
Garlic	133.30	6.67	30.00	0.50
Horseradish	48.00	1.33	11.33	0.67
Kale	49.30	3.30	10.00	0.70
Parsley	43.30	3.67	8.50	0.67
Potatoes	76.00	2.13	17.13	0.13
Squash, All	46.00	1.44	9.82	0.20
Sweet Corn	85.70	3.22	18.83	1.17

Vegetables	Calories per 100 grams	Protein (g) per 100 grams	Carbohydrates (g) per 100 grams	Fats (g) per 100 grams
Sweet Potatoes	104.60	1.47	23.53	0.28
Grains	**Calories per 100 grams**	**Protein (g) per 100 grams**	**Carbohydrates (g) per 100 grams**	**Fats (g) per 100 grams**
Barley for Grain (bushels)	352.90	12.5	73.37	2.19
Oats for Grain (bushels)	389.10	16.67	66.03	7.05
Rye for Grain (bushels)	347.01	12.38	73.77	1.98
Protein	**Calories per 100 grams**	**Protein (g) per 100 grams**	**Carbohydrates (g) per 100 grams**	**Fats (g) per 100 grams**
Almonds	597.90	18.59	19.51	54.23
Hazelnuts (Filberts)	634.10	12.59	16.67	62.37
Peas, Green Southern (cowpeas)	107.90	8.12	18.12	0.79
Soybeans for Beans (bushels)	173.00	16.86	9.88	8.72

The access to higher nutritional food helps combat diseases and conditions cause by malnutrition or a diet of highly processed foods (undernourishment, micronutrient deficiencies, and overweight and obesity) (Gomez, et al., 2013). The fewer diseases individuals incur throughout a lifetime the lower their potential health care costs (Kammitt, 2008). It is important to note, people can negate or enhance health benefits by their chosen lifestyle and any pre-dispositions for diseases and conditions including social and hereditary factors (Edwards-Jones, et al., 2008).

Environmental Benefits.

Local food systems boast environmental benefits including a reduction in carbon dioxide levels, reduction of agricultural pollution, water conservation, and greater biodiversity (Edwards-Jones, et al., 2008) (Kremer & DeLiberty, 2011). Growing foods locally benefits the environment by reducing food miles in transportation of crops. The average delivery distance a piece of food travels is 1,020 miles in America (Weber & Matthews, 2008). The distance is approximately 41 times greater than the length of Baltimore County (approximately 25 miles wide) (U.S. Census Bureau, 2012). If the study areas produced approximately 43% of the food locally that would reduce the traveled food miles by up to 3,980% (995 miles) for almost half of the food. The decrease in food miles reduces the carbon dioxide and energy consumption from the vehicle transportation and point sources of mining and refining operations as well (Edwards-Jones, et al., 2008).

In addition, the energy required for short food chains (urban and periurban environments) is less than industrial scale long food chains (Mundler & Rumpus, 2012). The main energy saver is the reduction in warehousing of goods between the farm and place of retail and storage at the place of retail (Mundler & Rumpus, 2012). The local food system method of distribution allows for minimal warehousing and storage as well as consumer travel. Thus, local food systems benefit the environment by reducing energy consumption and preventing pollution for energy production. The urban and periurban CSAs total energy consumption was 13.50 and 17.40 Gram of Oil Equivalent per Euro (GOE/€) respectively compared to private commercial business at 17.50 GOE/€ (Mundler & Rumpus, 2012).

The crop selection is environmentally beneficial due to appropriateness with climate conditions, not using synthetic inputs, and utilizing a variety of heritage seeds for a diversity of crops. The farmers within the County or State cultivate the crops listed in the Results section; therefore, with lack of data, the study assumes that all listed crops do not burden the local water resources. The study areas historically receive a uniform distribution of rainfall throughout the year and additional irrigation needs are small. The soils in the County mostly exhibit good drainage patterns with a silty clay loam subsoil with the exception of the Woodstown-Fallsingtion and Mattpex-Barclay-Othello associations that have poor drainage (USDA Soil Conservation Service, 1973). Growers need to import soil into the City due to the impervious surface structures of pavement and buildings. Thus, adding the additional cultivated land should not degrade the water resources. The increase in soil bearing plants reduces storm water runoff from urban areas.

This paper is not treading into specific farming practices other than to state that growers should use specified best management practices (BMPs) and holistic practices within the local food system. This conclusion is due to the close proximity of people to cultivated acreage in the urban areas. The use of pesticides, fungicides, and herbicides in close proximately to people adversely affects human health (Edwards-Jones, et al., 2008). In addition, the increased use of 108,700 acres of land with well-drained soils could increase eutrophication potential downstream in the Chesapeake Bay through chemical runoff and leaching (Kaswan, Kaswan, & Kumar, 2012). This affects the potential for aquaculture and degrades the critical ecosystem. Energy use and pollution are adverted by not manufacturing, transporting, and using synthetic inputs (Pimentel, Hepperly, Hanson, Douds, & Seidel, 2005).

The crop varieties selected benefit people by providing the necessary food variety and biodiversity as a whole. It ensures the survival of the crop species against pests by propagating a wide genetic pool (Fischer, Brittain, & Klein, 2013). In addition, by using holistic practices, non-targeting species of pesticides, fungicides, and herbicides are not affected. (Fischer, Brittain, & Klein, 2013). The cultivation of already developed land prevents the destruction of forests for new cropland and provides additional wildlife sanctuaries within the newly developed croplands (Schmitzberger, Wrbka, Steurer, Aschenbrenner, Peterseil, & Zechmeister, 2005).

Cultivation of the Study Areas

The total amount of acreage available for cultivation (108,700 acres) is not sufficient to feed the study areas. However, the study could not calculate all the acreage for cultivation in the study areas due to a lack of information. Once the study areas use all the available acreage, how much land can be cultivated in the study areas? Lastly, how will the study areas implement the changes presented by this paper? The following subsection seeks to answer these questions by detailing the additional acreage for cultivation and implementation changes for local food system.

Additional Acreage.

The following sub-subsections detail possible additional acreage available for cultivation within the local food system in the residential, commercial, and industrial zones. These acres were not included in the calculation for the available acreage due to a lack of information; however, the acres in these zones are available for cultivation.

Residential Zones.

The 108,700 acres available in the study areas account for 40% of the energy and nutrient required by the populations. Additional cultivation in the residential zones is required to close the gap to 306,000 acres for complete self-sufficiency. The study is currently counting all residential zones within the City as potentially farmed in the local food system; however, in the County, there are 108,185 acres in the low, medium, and high-density residential zones that are unaccounted for in the system. The reason is due to the County not specifying maximum lot coverage for dwellings structures within these zones (County of Baltimore, 1955) (Chen, 2012). The County does specify density controls for each zone, i.e. one dwelling per acre in D.R.1 and so on. However, the percentage a specific lot amount a dwelling unit can occupy is not detailed, i.e. 30% of a lot (County of Baltimore, 1955).

If the study applies the same City residential zones conversion factors in the County, approximately 73,100 acres are available for cultivation (see Table 29 for acres per zone). Additionally, green roofs are additional land for cultivation within all residential zones (Castleton, Stovin, Beck, & Davison, 2010). The study is unable to calculate the space without knowing the percentage of suitable roofs in the residential zones (Castleton, Stovin, Beck, & Davison, 2010). The additional acres bring the potential total available acreage to 181,900 acres, only 124,200 acres from the goal.

Table 29: Acreage Available for Cultivation in the Low, Medium and High Density Residential Zones in Baltimore County (County of Baltimore, 1955)

Land Use	Acres	Percent Developed As per City Zones	Acreage Available for Cultivation
Low Density Residential	50,430.00	26.67%	36,980.32
Medium Density Residential	40,259.00	34.17%	26,502.50
High Density Residential	17,496.00	45.00%	9,622.80

Commercial Zones.

Like the residential zones in the County, the commercial zones lack a conversion factor as to the amount of cultivatable acreage. For this reason, the study does not count these acres in the summation of available acreage. However, this does not mean that there is not land that can be cultivated. Within the City, the easiest land to calculate is the vacant and underutilized acres in the commercial zones. According to the City of Baltimore's master plan there is currently 104 acres of vacant and 136 acres of underutilized land in these zones (Baltimore County Council, 2010). Residents of the City can use the Baltimore Food Policy Initiative (BFPI) to use city-owned vacant and underutilized properties for urban agriculture. A downside is that the city can develop these acres at any time rendering the land unusable for urban agriculture. The County of Baltimore has no such policy for any city owned vacant or underutilized land.

The vacant or underutilized land only represents a small fraction of the commercial land within the study areas. The most practical way to cultivate the 15,000 acres of commercial land is through green roofs and edible landscaping (Grewal & Grewal, 2013) (Appler, 2011). Currently, there is not a database for the potential acreage available from green roofs for Baltimore City and County; therefore, the study cannot calculate the available acreage for cultivation. Green roof potential includes any buildings with flat roofs that can support the weight of crop cultivation (Castleton, Stovin, Beck, & Davison, 2010). Growers can retrofit Buildings with green roofs, but it is an expensive investment with a long-term payback period (Castleton, Stovin, Beck, & Davison, 2010). In addition, edible landscaping can add the land used for landscaping to the cultivatable land. Again, the study cannot calculate the acreage amount due to the lack of knowledge regarding maximum lot coverage.

The next way to utilize the commercial land is through the supplementary functions of the local food system such as processing centers, seed stores, and greenhouses. The study cannot calculate the land for these functions without knowledge of the lot, building it would occupy, and in which zone it is located. However, with most of the supplementary functions located in the commercial zones, the agricultural and residential zones can focus on crop cultivation.

The City of Baltimore has five commercial zones, B-1 through B-5 (City of Baltimore, 2013). Each of these zones offers a specific function and permitted uses for utilization in the system. Table 30 lists the commercial zones and the permitted uses for supplementary functions in the system. The County of Baltimore has eight commercial zones not including maritime operations, O.R.-1, O.R.2, O.3, O.T., B.L., B.M., B.R., and R.C.C. (County of Baltimore, 1955). Again, each zone has specific functions and permitted uses for utilization in the system for supplementary and primary functions. Table 31 (page 115) displays the details.

Table 30: Permitted Uses for Utilization in the Local Food System within the Commercial Zones of the City of Baltimore (City of Baltimore, 2013)

Commercial Zone	Permitted Use that can be used for Supplementary LFS Functions
Neighborhood-Business - B-1	Food stores and multi-purpose community centers
Community-Business - B-2	Garden supply, tool and seed stores
Community-Commercial - B-3	Greenhouses and artisan's and craft work
Central-Business - B-4	Processing, cleaning, servicing, testing or repair or products, materials and goods
Central-Commercial - B-5	All supplementary functions listed previously

Table 31: Permitted Uses for Utilization in the Local Food System within the Commercial Zones of Baltimore County (County of Baltimore, 1955)

Commercial Zone	Permitted Use that can be used for Supplementary LFS Functions
Residential-Office - O.R.1	Same as in D.R.5.5 (agricultural uses)
Residential-Office - O.R.2	Same as in D.R.10.5 (agricultural uses)
Office - O.3	Same as in O.R.2 except no dwellings, agricultural uses
Office-Technology - O.T.	Research facility, to study urban farming
Business, Light - B.L.	Same as neighboring residential district (agricultural uses except by E.A.R 1&2), food store and garden center
Business, Major - B.M.	Same as in B.L.
Business, Roadside - B.R.	Same as in B.M., Greenhouse
Resource Conservation Commercial - R.C.C.	Auction building, farm market, garden center, produce stand in association with a farm, veterinarian's office and veterinarium

Industrial Zones.

The industrial zones, similar to the commercial zones, represent additional land for cultivation (Grewal & Grewal, 2013). The amount of industrial land in the study areas is 8,724 acres in the City and 10,590 acres in the County (Appler, 2011). Again, the land available within the industrial zones lacks a conversion factor to calculate the land available for cultivation. In the industrial zones, it is not the land on the outside of the buildings but the building themselves that could be greenhouses and indoor vertical farms. The acreage gained is difficult to calculate, as it is unknown the number of levels that could be cultivated within each potential structure.

Currently, the City has three industrial zones, M-1 through M-3, that allow the cultivation and processing of crops in all zones (City of Baltimore, 2013). The County has four industrial zones, M.R through M.H. that permits the cultivation and processing of crops in all zones (County of Baltimore, 1955). Tables 32 and 33 (page 116) display the full details regarding potential uses the for local food system within each industrial zone. The industrial zones play an important role in the local food system, especially as they could provide cultivatable and processing facilities in the same structure. This would bring the total potential cultivatable land to over 200,000 acres within the study areas.

Table 32: Permitted Uses for Utilization in the Local Food System within the Industrial Zones of the City of Baltimore (City of Baltimore, 2013)

Industrial Zone	Uses concerning a Local Food System
Industrial District – M-1, Permitted	Food products: manufacturing and processing, greenhouses, milk and dairy: processing and distribution and candy manufacturing
M-1, Conditional	Recycling collection stations
M-1, Accessory	Animal facilities as permitted by Baltimore Health Codes
Industrial District – M-2, Permitted	Same as in M-1, garage, storage, repair and servicing of motor vehicles and brewery
M-2, Conditional	Same as in M-1, animal hospitals
M-2, Accessory	Same as in M-1,
Industrial District – M-3, Permitted	Same as in M-2, animal byproduct processing, feed manufacturing, grains milling and storage, oils and fats (animal and vegetable) manufacturing and processing and yeast processing
M-3, Conditional	Same as in M-2
M-3, Accessory	Same as in M-1

Table 33: Permitted Uses for Utilization in the Local Food System within the Industrial Zones of Baltimore County (County of Baltimore, 1955)

Industrial Zone	Uses Concerning a Local Food System
Manufacturing, Restricted M.R., Permitting	Manufacture, compounding, packaging or treatment of candy, cosmetics, drugs, perfumes and food products
Manufacturing, Light, Restricted M.L.R., Permitted	Same as M.R.
Manufacturing, Light M.L., Permitted	Brewery, candy manufacturing, food processing, grain processing, greenhouse (wholesale) and poultry killing
M.L., Special Exception	Farms or limited-acreage wholesale flower farms
Manufacturing, Heavy M.H., Permitting	Animal boarding, brewery and manufacturing of yeast, pickles, sauerkraut, vinegar and soda products

Implementing Changes for Local Food System.

The transference of 18th and 19th century subsistence farming practices to create a local food system will be difficult to implement. The changes to the zoning codes, however minor they may be, present nuisances that could prove hard to overcome. The key would be to enact the changes slowly, overtime within the zoning codes. The government would host public meetings to gauge the feelings for amending the zoning codes allowing for agricultural practices and explaining the purpose of a local food system. It is important to emphasize that the local food system is not going to transform the City and County of Baltimore into a completely agrarian society. The intent of the systems is to provide the residents with a fresh, affordable and energy rich local food source.

The next stage is expanding the local food system to the study areas' available acreage for cultivation by promoting CSA systems along with the other urban farming techniques (Metcalf & Widener, 2011). A good expansion point is the school system and the Great Kids Farm. This allows for the educating and provides food to a vulnerable segment of the population. Lastly, it allows for feedback from the residents, as to the amount of food generated by the system.

The next step is to implement changes within the Comprehensive Master Plans for the City and County to reflect the commitment to a joint local food system. The most difficult aspect of implementation is the coordination of the CSAs and keeping the agricultural products affordable for all residents (Jarosz, 2008). Organic and local foods have had a reputation for being more expensive for the end consumer than industrial produced goods due to high volume discounts and international sourcing (Jarosz, 2008).

However, while local goods are more expensive ("although it is possible for food stamp recipients to purchase food at farmer's markets"), the money supports the local economy and livelihood of local farmers and artisans (Jarosz, 2008). The final step of the implementation is to systematically monitor and evaluate the CSA network and amount of food produced to ensure efficiency and effectiveness.

VI. Conclusion

The City and County of Baltimore are at an interesting crossroads. They both currently have a local food system allowed by piecemeal planning and zoning regulations. The local food systems do not have the capacity to provide the City and County populations with the necessary energy and nutrient requirements of 1.18×10^{12} kcals per year. However, the systems do not utilize the full land available within the study areas. The amount of measurable land available for cultivation is approximately 108,700 acres per year. In addition, the study areas have cultivatable land this study could not measure in the residential, commercial, and industrial zones. With the additional land, the study areas have over 200,000 acres usable by the local food system.

The use of centrally located resource centers provides the system with organization, materials, and agricultural knowledge. These aspects are important to the populations that have little experience cultivating crops or raising farm animals. The expansion of the local food system into one for the City and County should help to alleviate the food deserts within the City. In addition, the more food grown locally using holistic practices grants lesser dependence from industrial foods. This reduces the negative effects of industrial agriculture. However, the study areas current planning and zoning laws do not allow for the creation of a unified local food system.

To implement the local food system, the study areas must amend their laws. The guidelines for amending the planning and zoning laws are the subsistence farming practices of the 18th and 19th centuries. By integrating the following subsistence farming practices into the planning and zoning laws, they can create a unified local food system:

- Cultivation of crops within all zones (Growing Power, 2013) (Teig, Amulya, Bardwell, Buchenau, Marshell, & Litt, 2009)
- Animal husbandry in all zones on parcels of adequate size for an animal's health and safety (Detroit Food Policy Council, 2012) (Growing Power, 2013)
- Composting manure and green wastes recycling into natural fertilizers for nutrient recycling (Growing Power, 2013) (Metcalf & Widener, 2011)
- Food preservation and local processing for storage during winter season (Growing Power, 2013) (Marsden & Smith, 2005)
- Resource sharing between farmers in the County and neighborhoods in the City (Growing Power, 2013) (Sundvist, Milestad, & Jansson, 2005)
- Utilizing holistic techniques such as intercropping, multiple cropping, seed collection and local crop selection (Permaculture Institute, 2013) (Jarosz, 2008)

The majority of the changes need to take place in the zoning laws within the residential and commercial zones of the City and County. The most important change will be to the study areas' master plans, to write in a section for the creation of a unified local food system. Thus, allowing for the expansion of the system within a single joint planning regulation.

The City and County of Baltimore can test the expanded local food system by increasing the food-to-school partnership already in place within the City. The partnership will now include County schools with the goal of a quarter of the yearly meals sourced locally. The purpose of legalizing and expanding the local food system is not to isolate the study areas. Its purpose is to provide independence and food security from the volatile nature of global food systems. While, the acreage available for cultivation is positive, it is not the true reflection of the land available within the study areas. Additional studies need to take place to calculate the exact amount of cultivatable open space within the City and County, the number of buildings suitable for green roofs, and the percent of the populations that are willing to participate in the local food system. By integrating the subsistence farming practices into the planning and zoning laws, the City and County of Baltimore set themselves on a path to food independence.

VII. Appendix A

Tables 34, 35 (page 123), and 36 (page 125) detail the total Calorie content for vegetables, melons and potatoes, fruits and nuts and berries. The information was gathered from the 2007 U.S. Agricultural Census, National Agricultural Statistics Service yearbooks, USDA Calorie database Food-a-Pedia and a nutritional almanac. The conversion for calculating total Calories is the same as listed in the Methodology section.

Table 34: Vegetables, Potatoes, and Melons 2007 Agricultural Statistics and Calorie Quantities (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Vegetables, Potatoes, and Melons Harvested 2007	Farms	Acres	Quantity (cwt)[1]	Calories per 100 grams[2]	Total Calories
Artichokes (excluding Jerusalem)	118	9,687	820	47	19,579,206.42
Asparagus, Bearing Age	2,605	43,010	2420	22.4	27,538,910.78
Beans, Green Limas	1,020	42,529	409	110.6	22,980,623.61
Beans, Snap	17,300	303,997	2923	30.9	45,884,992.98
Beets	2,744	8,412	259	44.1	5,802,587.90
Broccoli	3,087	130,603	9538	27.3	132,282,788.11
Brussels Sprouts	483	11,480	458	43.2	10,051,539.87
Cabbage, Chinese	620	11,480	1340	12.9	8,781,685.58
Cabbage, Head	4,086	80,620	12707	22.9	147,829,765.18
Cabbage, Mustard	53	66	N/A	36 per Cup	0.00
Cantaloupes	9,148	84,290	26489	34	457,538,722.40
Carrots	2,543	90,292	9762	43.6	216,226,374.93
Cauliflower	1,136	39,515	3944	24	48,087,425.09
Celery	326	29,907	16491	15	125,667,109.40
Chicory	46	2,118	N/A	22.8	0.00

[1] Quantity in cwt (hundredth weight) except where noted differently
[2] Calories measured in amount per 100 grams except where noted differently

Vegetables, Potatoes, and Melons Harvested 2007	Farms	Acres	Quantity (cwt)	Calories per 100 grams	Total Calories
Collards	1,374	11,223	2391	30.6	37,169,299.59
Cucumbers and Pickles	11,202	151,759	15538	13.5	106,564,428.55
Daikon	139	624	N/A	18	0.00
Eggplant	2,904	6,038	2040	26.8	27,774,633.46
Escarole/Endive	133	3,627	933 (2001)	16	7,583,767.34
Garlic	2,277	26,172	4104	133.3	277,920,688.05
Ginseng	225	674	N/A	N/A	0.00
Herbs, Fresh Cut	2,053	13,573	N/A	N/A	0.00
Honeydew Melons	396	17,344	5714	36	104,502,363.19
Horseradish	112	3,692	1930 (short tons)	48	840,430,080.00
Kale	954	3,994	32255 (short tons)	49.3	14,426,035,848.00
Lettuce, All	3,839	313,036	62963	13.7	438,217,134.44
Mustard Greens	871	8,323	N/A	26.8	0.00
Okra	2,555	2,444	1138	38	21,968,946.61
Onions, Dry	4,249	166,484	48320	33.8	829,711,291.97
Onions, Green	1,558	5,704	2931	26	38,714,400.74
Parsley	370	4,240	63408 (short tons)	43.3	24,907,778,380.80
Peas, Chinese	863	8,859	299 (short tons)	41	111,213,648.00
Peas, Green (excluding Southern Peas)	4,532	214,057	609 (short tons)	80.8	446,407,718.40
Peas, Green Southern (cow peas)	3,061	27,089	497	107.9	27,243,393.80
Peppers, Bell (excluding pimientos)	9,572	62,363	17860	25.8	234,090,902.12

Vegetables, Potatoes, and Melons Harvested 2007	Farms	Acres	Quantity (cwt)	Calories per 100 grams	Total Calories
Peppers, Other than Bell (including chili)	6,124	37,372	6097	40	123,896,649.24
Potatoes	15,014	1,131,963	172582	76	6,663,347,529.34
Pumpkins	15,088	92,955	11458	25.9	150,762,023.13
Radishes	818	14,599	984	15.6	7,798,356.26
Rhubarb	574	1,404	N/A	21.3	0.00
Spinach	1,202	44,071	1264	20	12,842,821.44
Squash, All	11,821	54,454	7008	46	163,770,358.46
Sweet Corn	28,241	622,946	1346	85.7	58,601,570.70
Sweet Potatoes	1,910	105,284	5944	104.6	315,859,439.28
Tomatoes in the Open	25,809	442,225	50861	19.5	503,851,877.16
Turnips	914	3,632	3669 (short tons)	30	998,555,040.00
Turnip Greens	836	9,365	N/A	27.3	0.00
Watercress	62	679	N/A	20	0.00
Watermelons	12,808	142,359	39910	30	608,255,937.90
Vegetables, Other	6,846	47,663	N/A	N/A	0.00
Sub Total		**4,690,296**			**53,760,000,000**

Table 35: Fruits and Nuts 2007 Agricultural Statistics and Calorie Quantities (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Fruits and Nuts by Acres 2007	Farms	Acres	Quantity	Calories per 100 grams[3]	Total Calories
Apples	21,716	360,195	9,089,400,000 pounds	58.7	242,017,273,008.00
Apricots	2,458	12,830	88,460 short tons	48.6	39,001,943,232.00
Avocados	7,670	72,747	193,080 short tons	160	280,259,481,600.00
Bananas	1,175	2,100	25,600,000 pounds	89	10,334,822,400.00

[3] Calories measured in amount per 100 grams except where noted differently

Fruits and Nuts by Acres 2007	Farms	Acres	Quantity	Calories per 100 grams[4]	Total Calories
Cherries, Sweet	6,687	84,040	306,210 short tons	71.7	199,178,091,504.00
Cherries, Tart	2,309	37,412	248,700,000 pounds	49.5	63,924,260,400.00
Coffee	1,404	6,652	N/A	6 per Cup	0.00
Dates	140	7,669	N/A	282	0.00
Figs	828	9,315	47,800 short tons	74	32,089,478,400.00
Grapes	22,947	973,638	7,058,000 pounds	71.3	2,282,675,774.40
Guavas	441	799	4,300,000 pounds	68	1,326,326,400.00
Kiwifruit	373	4,307	24,500 short tons	61	13,558,104,000.00
Mangoes	736	1,845	N/A	60	0.00
Nectarines	1,864	28,432	269,000 short tons	39	95,174,352,000.00
Olives	1,470	31,217	132,500 short tons	81	97,365,240,000.00
Papayas	520	1,926	33,400,000 pounds	43	6,514,603,200.00
Passion Fruit	129	93	N/A	97	0.00
Peaches, All	11,102	126,226	2,231,800,000 pounds	39	394,814,347,200.00
Pears, All	7,882	62,995	871,900 short tons	57	450,862,977,600.00
Persimmons	1,195	3,451	N/A	127	0.00
Plums and Prunes	5,623	97,901	233,000 short tons	143	302,269,968,000.00
Pluots	258	3,843	N/A	90 per Cup	0.00
Pomegranate	432	12,103	N/A	83	0.00
Other Non-citrus Fruit	4,312	8,278	N/A	N/A	0.00
Grapefruit	2,751	96,675	1,798,483 short tons	32	522,106,808,832.00
Kumquats	129	164	N/A	71	0.00
Lemons	2,364	62,718	619,000 short tons	29	162,851,472,000.00
Limes	756	1,135	N/A	30	0.00
Oranges, All	11,612	742,625	11,287,900 short tons	47	4,812,979,953,600.00

[4] Calories measured in amount per 100 grams except where noted differently

Fruits and Nuts by Acres 2007	Farms	Acres	Quantity	Calories per 100 grams[5]	Total Calories
Tangelos	737	8,932	183,080,000 pounds	47	39,031,191,360.00
Tangerines	1,756	30,072	612,920,000 pounds	53	147,350,871,360.00
Temples	114	1,198	N/A	N/A	0.00
Other Citrus Fruit	359	792	N/A	N/A	0.00
Almonds	5,956	649,953	1,390,000,000 pounds	597.9	3,769,783,416,000.00
Chestnuts	845	2,072	N/A	200	0.00
Hazelnuts (Filberts	1,218	31,903	37,000 tons	634.1	238,385,887,488.00
Macadamia Nuts	1,042	16,732	41,000,000 pounds	701.5	130,462,164,000.00
Pecan, All	19,248	506,181	387,305,000 pounds	687	1,206,932,234,760.00
Pistachios	1,070	117,044	416,000,000 pounds	577.3	1,089,351,244,800.00
Walnuts, English	6,385	225,106	328,000 short tons	651	1,937,126,016,000.00
Other Nuts	887	4,500	N/A	N/A	0.00
Sub-Total			**4,447,816**		**16,290,000,000,000**

Table 36: Berries 2007 Agricultural Statistics and Calorie Quantities (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Berries Harvested 2007	Farms	Acres	Quantity	Calories per 100 grams[6]	Total Calories
Blackberries and Dewberries	4,471	10,728	58,000,000 pounds	51.4	13,522,723,200.00
Blueberries, Tame	7,516	60,353	71,600,000 pounds	56.6	18,382,412,160.00
Blueberries, Wild	728	23,492		56.	

[5] Calories measured in amount per 100 grams except where noted differently
[6] Calories measure in amount per 100 grams except where noted differently

Berries Harvested 2007	Farms	Acres	Quantity	Calories per 100 grams[7]	Total Calories
Boysenberries	270	823	5,070,000 pounds	50	1,149,876,000.00
Cranberries	1,088	38,597	6,554,000 barrels	46 per Cup	121,736,224,360.00
Currants	276	253	N/A	63.4	0.00
Loganberries	89	77	3,650,000 pounds	54.4	900,668,160.00
Raspberries, All	5,719	19,363	78,750,000 pounds	49.6	17,717,616,000.00
Strawberries	7,807	55,601	24,453,000 cwt	29.6	367,711,518,002.40
Other Berries	691	503	N/A	N/A	0.00
Sub-Total		**209,790**			**541,100,000,000**

[7] Calories measure in amount per 100 grams except where noted differently

VIII. Appendix B

Tables 37 (page 128), 38 (page 129), and 39 (page 132) detail the total macronutrient content for fruits, vegetables, and grains. The information was gathered from the 2007 U.S. Agricultural Census, National Agricultural Statistics Service yearbooks, USDA Calorie database Food-a-Pedia and a nutritional almanac. The conversion for calculating total Calories is the same as listed in the Methodology section.

Table 37: Fruits 2007 Agricultural Statistics and Macronutrient Content (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Fruits	Acres	Quantity	Protein grams per year	Carbs grams per year	Fats grams per year
Apples	360,195	9,089,400,000 pounds	824,590,368.00	61,844,277,600.00	1,484,262,662.40
Apricots	12,830	88,460 short tons	1,131,537,859.20	8,939,951,596.80	312,978,556.80
Cherries, Sweet	84,040	306,210 short tons	3,333,524,544.00	45,974,859,336.00	2,666,819,635.20
Cherries, Tart	37,412	248,700,000 pounds	1,252,657,224.00	15,677,586,288.00	387,419,760.00
Figs	9,315	47,800 short tons	325,231,200.00	8,265,208,896.00	130,092,480.00
Grapes	973,638	7,058,000 pounds	21,129,958.08	568,267,812.00	3,841,810.56
Kiwifruit	4,307	24,500 short tons	220,041,360.00	3,305,065,680.00	100,018,800.00
Nectarines	28,432	269,000 short tons	2,293,945,920.00	28,698,727,680.00	1,122,569,280.00
Peaches, All	126,226	2,231,800,000 pounds	7,086,411,360.00	99,715,931,280.00	10,224,679,248.00
Pears, All	62,995	871,900 short tons	3,559,444,560.00	101,325,521,808.00	2,531,160,576.00
Persimmons	3,451	N/A	N/A	N/A	N/A
Plums and Prunes	97,901	233,000 short tons	3,551,143,680.00	79,287,737,760.00	1,183,714,560.00
Other Non-citrus Fruit	8,278	N/A	N/A	N/A	N/A
Cantaloupes	84,290	26489 short tons	11,842,178.70	112,904,408.26	3,767,965.95
Honeydew Melons	17,344	5714 short tons	1,364,336.41	27,402,841.90	290,284.34
Watermelons	142,359	39910 short tons	12,570,622.72	145,778,673.12	8,718,335.11
Blackberries and Dewberries	10,728	58,000,000 pounds	189,423,360.00	3,343,848,480.00	10,523,520.00

Fruits	Acres	Quantity	Protein grams per year	Carbs grams per year	Fats grams per year
Blueberries, Tame	60,353	71,600,000 pounds	217,600,992.00	4,592,355,264.00	123,415,488.00
Blueberries, Wild	23,492				
Boysenberries	823	5,070,000 pounds	25,527,247.20	278,729,942.40	6,209,330.40
Raspberries, All	19,363	78,750,000 pounds	321,489,000.00	4,122,203,400.00	196,465,500.00
Strawberries	55,601	24,453,000 cwt	7,453,611,851.40	84,971,175,105.96	4,472,167,110.84
Other Berries	503	N/A	N/A	N/A	N/A
Sub Total	**2,223,876**		**31,830,000,000**	**551,200,000,000**	**24,970,000,000**

Table 38: Vegetables 2007 Agricultural Statistics and Macronutrient Content (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Vegetables	Acres	Quantity (cwt)[8]	Protein grams per year	Carbs grams per year	Fats grams per year
Asparagus, Bearing Age	43,010	2420	3,270,245.66	14,691,517.14	184,412.35
Beans, Snap	303,997	2923	2,702,611.24	10,602,551.78	29,699.02
Beets	8,412	259	193,419.60	1,315,779.57	19,736.69
Broccoli	130,603	9538	14,294,293.95	25,342,087.25	1,647,477.95
Cabbage, Chinese	11,480	1340	1,021,126.23	1,490,844.30	136,150.16
Cabbage, Head	80,620	12707	7,746,537.91	25,434,466.15	1,742,971.03

[8] Quantity measured in cwt (hundredth weight) unless noted differently

Vegetables	Acres	Quantity (cwt)[9]	Protein grams per year	Carbs grams per year	Fats grams per year
Carrots	90,292	9762	4,512,981.68	49,593,205.26	892,677.69
Cauliflower	39,515	3944	3,967,212.57	9,817,849.29	360,655.69
Collards	11,223	2391	2,696,596.24	6,753,637.44	510,166.86
Cucumbers and Pickles	151,759	15538	106,564,428.55	106,564,428.55	106,564,428.55
Daikon	624	N/A	N/A	N/A	N/A
Eggplant	6,038	2040	1,140,003.61	6,321,838.21	103,636.69
Escarole/Endive	3,627	933 (2001)	587,741.97	1,592,591.14	94,797.09
Garlic	26,172	4104	13,906,459.03	62,547,791.76	1,042,463.20
Ginseng	674	N/A	0.00	0.00	0.00
Herbs, Fresh Cut	13,573	N/A	N/A	N/A	N/A
Horseradish	3,692	1930 (short tons)	23,286,916.80	198,376,516.80	11,731,003.20
Kale	3,994	32255 (short tons)	965,637,288.00	2,926,173,600.00	204,832,152.00
Lettuce, All	313,036	62963	40,623,048.23	84,124,895.15	6,077,463.91
Mustard Greens	8,323	N/A	N/A	N/A	N/A
Okra	2,444	1138	1,156,260.35	4,393,789.32	57,813.02
Onions, Dry	166,484	48320	28,966,252.20	179,443,477.64	3,927,627.42
Onions, Green	5,704	2931	38,714,400.74	38,714,400.74	38,714,400.74
Parsley	4,240	63408 (short tons)	2,111,121,169.92	4,889,517,696.00	385,409,041.92

[9] Quantity measured in cwt (hundredth weight) unless noted differently

Vegetables	Acres	Quantity (cwt)[10]	Protein grams per year	Carbs grams per year	Fats grams per year
Peppers, Bell (excluding pimientos)	62,363	17860	8,347,427.52	51,445,558.72	1,723,925.25
Peppers, Other than Bell (including chili)	37,372	6097	6,194,832.46	28,898,893.44	619,483.25
Potatoes	1,131,963	172582	186,749,082.07	1,501,883,462.86	11,397,831.30
Pumpkins	92,955	11458	5,820,927.53	37,661,401.14	58,209.28
Radishes	14,599	984	299,936.78	1,779,624.89	264,944.15
Rhubarb	1,404	N/A	N/A	N/A	N/A
Spinach	44,071	1264	1,842,944.88	2,138,329.77	224,749.38
Squash, All	54,454	7008	5,126,724.26	34,961,411.31	712,045.04
Sweet Corn	622,946	1346	2,201,832.64	12,875,934.38	800,044.78
Sweet Potatoes	105,284	5944	4,438,942.41	71,053,275.39	845,512.84
Tomatoes in the Open	442,225	50861	22,996,316.44	111,364,184.13	8,526,724.07
Turnips	3,632	3669 (short tons)	33,285,168.00	220,347,812.16	3,328,516.80
Turnip Greens	9,365	N/A	N/A	N/A	N/A
Watercress	679	N/A	N/A	N/A	N/A
Vegetables, Other	47,663	N/A	N/A	N/A	N/A
Sub Total	**4,100,511**		**3,649,000,000**	**10,720,000,000**	**792,600,000**

[10] Quantity measured in cwt (hundredth weight) unless noted differently

Table 39: Protein 2007 Agricultural Statistics and Macronutrient Content (USDA, 2009) (USDA, 2013) (Dunne, 2002)

Protein	Acres	Quantity	Protein grams per year	Carbs grams per year	Fats grams per year
Soybeans for Beans	63,915,821	2,582,423,697 (bsh)	11,834,080,547,840.00	6,934,799,277,144.65	6,120,592,074,564.91
Almonds	649,953	1,390,000,000 pounds	117,210,693,600.00	123,011,330,400.00	341,922,319,200.00
Chestnuts	2,072	N/A	0.00	0.00	0.00
Hazelnuts (Filberts)	31,903	37,000 tons	4,733,130,931.20	6,266,981,145.60	23,447,607,321.60
Pecan, All	506,181	387,305,000 pounds	16,109,997,951.60	25,702,210,472.40	125,085,262,176.00
Walnuts, English	225,106	328,000 short tons	44,039,116,800.00	47,014,732,800.00	190,439,424,000.00
Other Nuts	4,500	N/A	0.00	0.00	0.00
Beans, Green Limas	42,529	409 (cwt)	1,547,971.48	4,421,588.34	76,879.12
Peas, Chinese	8,859	299 (short tons)	21,700,224.00	56,420,582.40	1,030,760.64
Peas, Green[11]	214,057	609 (short tons)	29,889,427.68	79,447,314.24	2,209,939.20
Peas, Green Southern	27,089	497 (cwt)	2,050,197.94	4,575,072.25	199,465.07
Sub Total	**65,628,070**		**12,020,000,000,000**	**7,137,000,000,000**	**6,801,000,000,000**

[11] Excludes Southern Peas (Cow peas) (USDA, 2009)

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