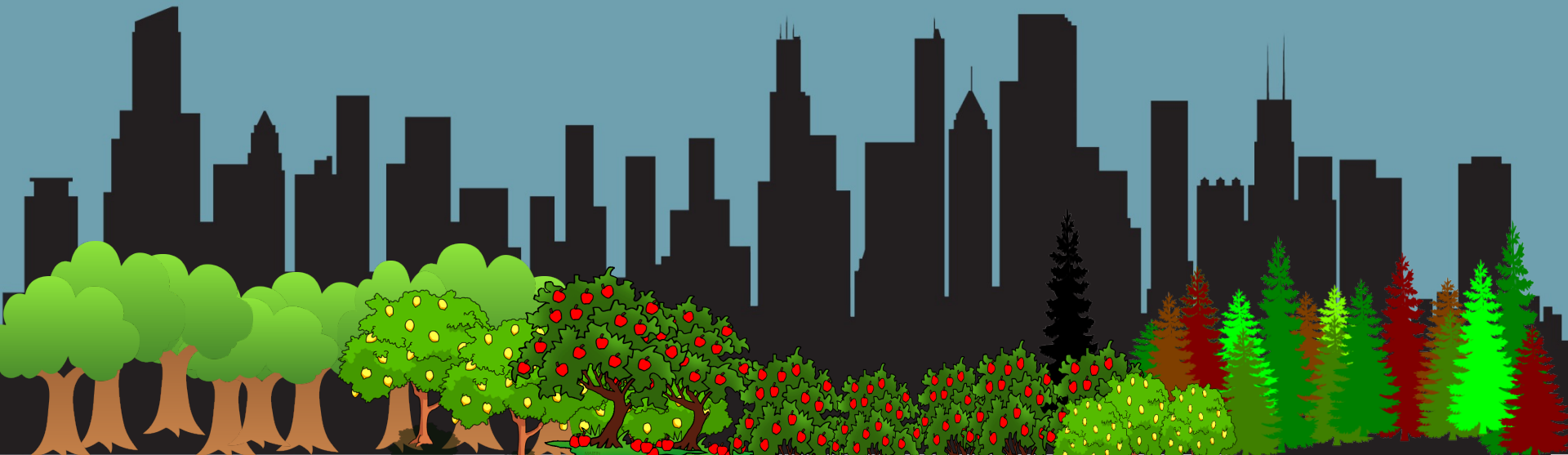


Tree Crops Offer a Resilient Solution for Urban Agriculture

Sarah Taylor Lovell, Associate Professor

Department of Crop Sciences, University of Illinois



Do opportunities exist to create a “closed system” for cities?



Do opportunities exist to create a “closed system” for cities?

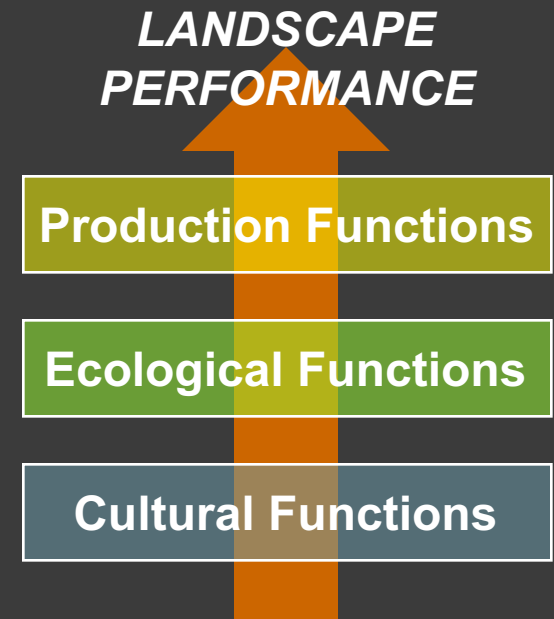


Urban agriculture is difficult to justify based on food production alone



Landscape Multifunctionality offers a framework for planning urban spaces

Landscapes that integrate ecological, cultural, and production functions, *considering the site-specific context and needs of the users*



Landscape Multifunctionality offers a framework for planning urban spaces



Multifunctional
 \approx Sustainable

**LANDSCAPE
PERFORMANCE**

Production Functions

Ecological Functions

Cultural Functions



Landscape Multifunctionality offers a framework for planning urban spaces

Production Functions

- Fresh food, herbs
- Food for processing
- Medicinal products
- Fuel and firewood
- Feed for livestock
- Fiber in many forms
- Cut flowers



Ecological Functions

- Biodiversity
- Nutrient cycling
- Microclimate control
- Water quality
- Carbon sequestration
- Soil conservation
- Water storage



Cultural Functions

- Recreation
- Visual Quality
- Artistic Expression
- Education
- Historic Preservation
- Ethnic reflection
- Cultural heritage



PREVIOUS WORK:

Characterizing UA in Chicago



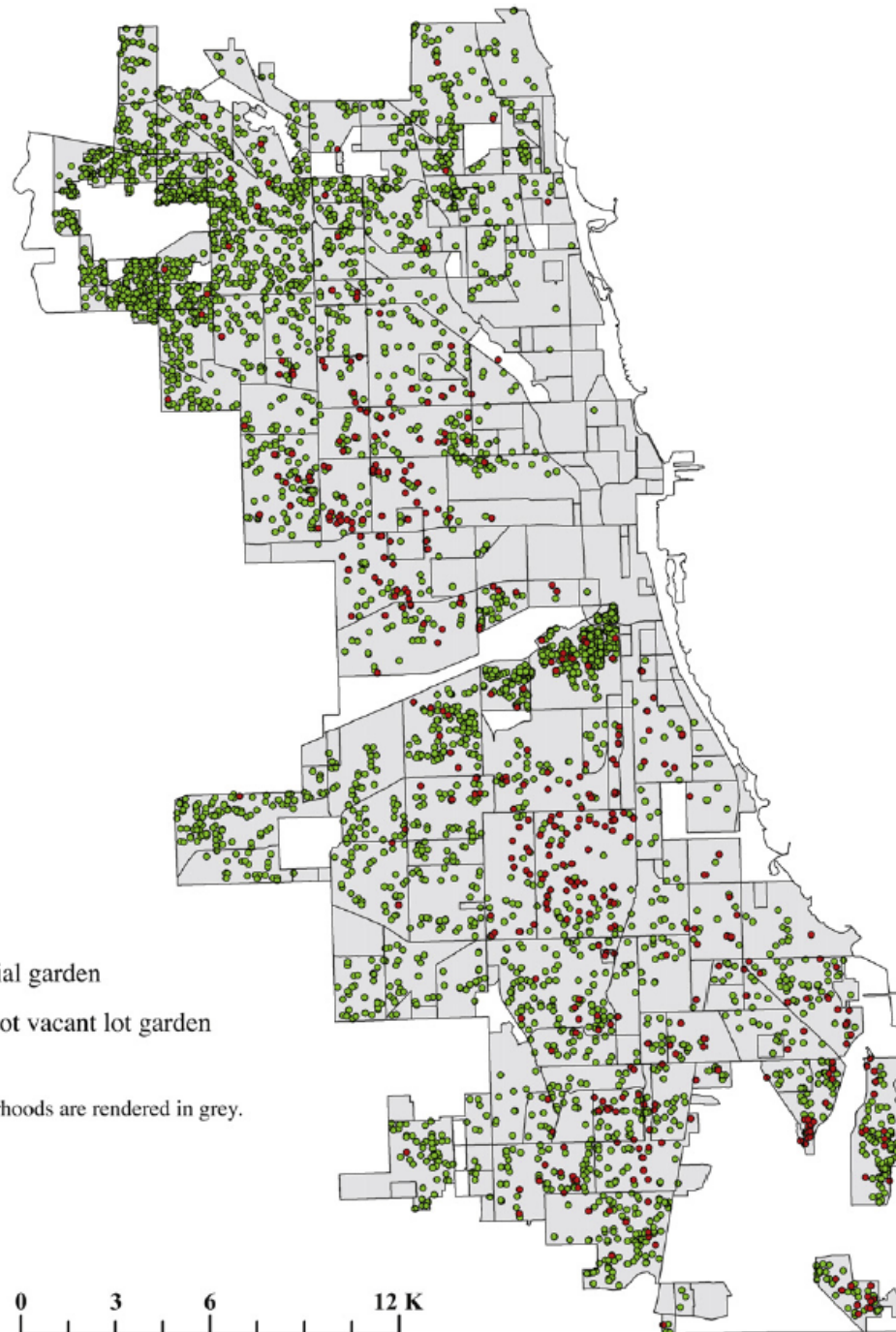
Research in Chicago indicates urban agriculture is a prevalent land use type

- Satellite imagery scanned for signature food production sites, including backyard gardens
- Known community garden sites were verified
- Distribution correlated with demographic data



Food production was extensive, and residential was dominating

Classification	N (%)	Area in m ² (%)
Community food garden	135 (2.9)	54,518 (20.6)
Urban farm	20 (0.4)	12,352 (4.7)
School garden	50 (1.1)	4385 (1.7)
Miscellaneous	7 (0.2)	1731 (0.7)
Multi-plot vacant lot garden ^a	7 (0.2)	32,319 (12.2)
Single-plot vacant lot garden ^b	428 (9.2)	39,607 (15.0)
Small (<20 m ²)	25 (0.5)	419 (0.2)
Medium (20–49 m ²)	145 (3.1)	5084 (2.0)
Large (50–100 m ²)	138 (3.0)	9676 (3.7)
Very large (>100 m ²)	120 (2.6)	23,951 (9.1)
Residential garden	4001 (86.0)	119,269 ^c (45.1)
Small (<20 m ²)	1852 (39.8)	29,076 ^d (11.0)
Medium (20–49 m ²)	1729 (37.2)	59,132 ^d (22.4)
Large (50–100 m ²)	359 (7.7)	23,909 ^d (9.0)
Very large (>100 m ²)	61 (1.3)	7,152 ^c (2.7)
Total	4648 (100.0)	264,181 ^c (100.0)



- Residential garden
- Single-plot vacant lot garden

Note: Neighborhoods are rendered in grey.



0 3 6 12 K

Three communities were studied: field observation and interviews

Table 3. Sample characteristics of the gardeners and gardens selected for a study of 59 African American, Mexican-origin and Chinese-origin households with home food gardens in Chicago, IL (updated from Taylor and Lovell, 2015).

	African American sample	Chinese-origin sample	Mexican-origin sample
Gardener characteristics			
Sample size	17	23	19
Gender ratio			
Male (%)	35.3	9.5	36.8
Female (%)	64.7	90.5	63.2
Age range	Late 40s to late 80s	Late 40s to early 80s	Early 30s to mid-80s
Foreign born (%)	5.9	100	100
Household income <2 × poverty level (%)	42.9	53.8	63.2
Garden characteristics			
Sample size	18	24	19
Location			
Single family lot (%)	55.6	66.7	5.3
Multifamily lot (%)	11.1	33.3	68.4
Vacant lot (%)	33.3	0	26.3
Lot size			
Mean (m ²)	452.9	236.1	360.1
Range (m ²)	275.2–1153.9	51.6–414.7	261.2–871.0

Plant assemblages and structure were unique to ethnic groups



Figure 1. Examples of home food gardens of African American (top left), Mexican-origin (bottom left) and Chinese-origin (right) households in Chicago, IL.

Plant assemblages and structure were unique to ethnic groups

Table 3. Assemblages of unique food crops observed in the home gardens of African American, Mexican-origin and Chinese-origin households in Chicago, IL.

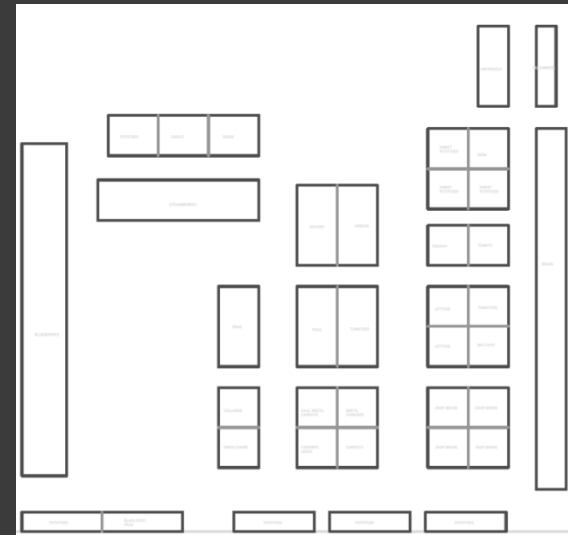
African American	Mexican-origin	Chinese-origin
Black-eyed pea (<i>Vigna unguiculata</i> subsp. <i>unguiculata</i>)	Amaranth, green (<i>Amaranthus</i> sp.)	Amaranth, green and red (<i>Amaranthus</i> sp.)
Collards (<i>Brassica oleracea</i> Acephala Group)	Chilies—10+ varieties (<i>Capsicum</i> sp.)	Bitter melon (<i>M. charantia</i>)
Kale (<i>Brassica oleracea</i> Acephala Group)	Epazote (<i>D. ambrosioides</i>)	Bunching onion (<i>Allium fistulosum</i>)
Mustard greens (<i>Brassica juncea</i> cvs)	'Frailes' (unidentified)	Chinese broccoli (<i>Brassica oleracea</i> Alboglabra Group)
Okra (<i>Abelmoschus esculentus</i>)	Hierba buena (<i>Mentha spicata</i> subsp. <i>spicata</i>)	Chinese cabbage (<i>Brassica rapa</i> subsp. <i>chinensis</i>)
Poke sallet (<i>P. americana</i>)	Hoja santa (<i>P. auritum</i>)	Chinese celery (<i>Apium graveolens</i>)
Sweet potato (root) (<i>Ipomoea batatas</i>)	Lambsquarters (<i>C. album</i>)	Chinese lettuce (<i>Lactuca sativa</i> cvs)
Turnip (top and root) (<i>Brassica rapa</i> subsp. <i>rapa</i>)	Pápalo (<i>P. ruderale</i>)	Chinese mustard (<i>Brassica juncea</i> cvs)
	Sugarcane (<i>Saccharum</i> sp.)	Chrysanthemum, edible (<i>Glebionis coronaria</i>)
	Tropical corn (<i>Zea mays</i> subsp. <i>mays</i>)	Mustard spinach (<i>Brassica rapa</i> var. <i>perviridis</i>)
		Garlic chives (<i>Allium tuberosum</i>)
		Lemongrass (<i>Cymbopogon</i> sp.)
		Malabar spinach (<i>Basella alba</i>)
		Perilla (<i>Perilla frutescens</i>)
		Pomegranate, dwarf (<i>Punica granatum</i> var. <i>nana</i>)
		Sweet potato (leaves) (<i>Ipomoea batatas</i>)
		Watercress (<i>Nasturtium officinale</i>)
		White and yellow cucumber (<i>Cucumis sativus</i> cvs)
		Winter/hairy melon (<i>B. hispida</i>)
		Yardlong bean (<i>Vigna unguiculata</i> subsp. <i>sesquipedalis</i>)
		<i>Yu choy sum</i> (<i>Brassica rapa</i> var. <i>parachinensis</i>)

Concluded Home Gardens can supply ecosystem services and disservices

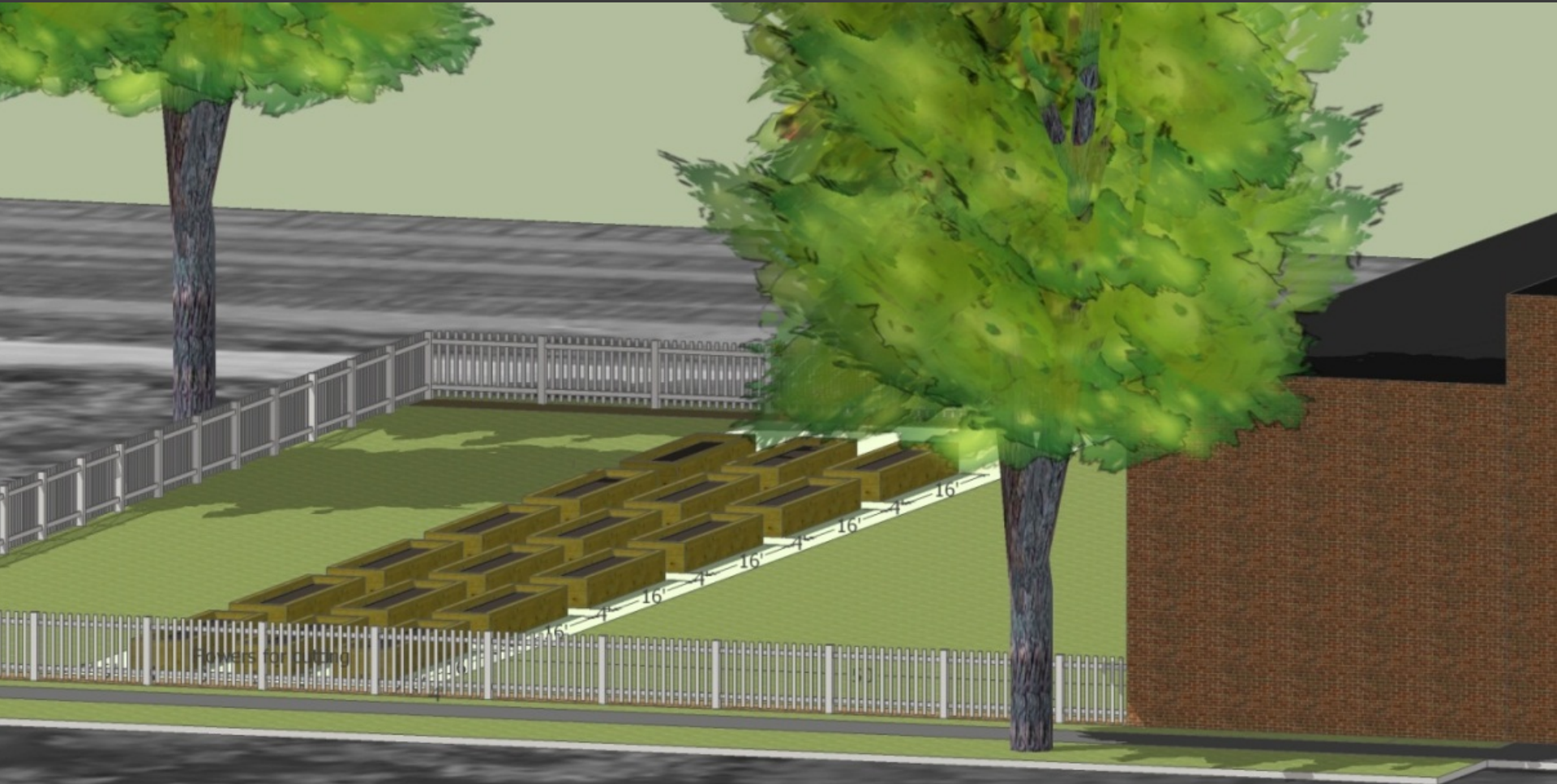
- HG contribute to local food systems
- HG provide culturally appropriate foods
- HG rely heavily on external inputs
- Soil contamination could threaten food safety
- HG conserve biodiversity, but mostly lack trees and shrubs to provide structural diversity

Food gardens mostly lack trees and shrubs to offer structural diversity

- Crops may displace native or ornamental plants
- Gardeners avoid planting trees or shrubs due to the need for full sun to cultivate most food plants
- *Is UA incompatible with urban forestry efforts?*



CURRENT WORK: Beyond Annual Production



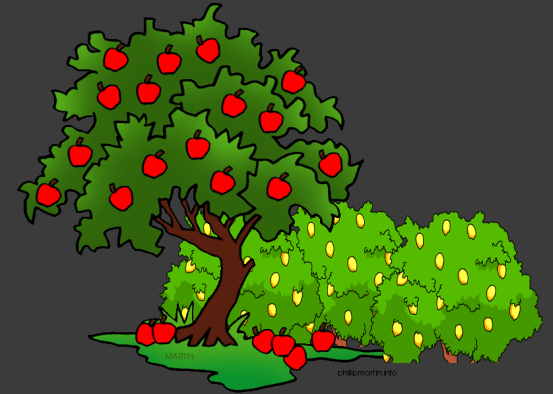
Trees and shrubs provide unique ecosystem services for cities

- Microclimate control to mitigate urban heat island
- Carbon sequestration in woody biomass
- Habitat and food resources for urban wildlife
- Visual quality greater in settings with trees



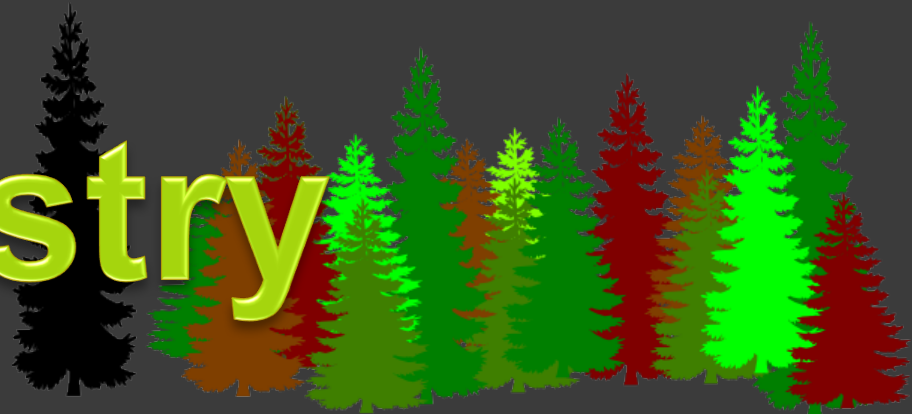
Drawing on several disciplines,
an alternative solution is possible

Horticulture



Permaculture

Agroforestry



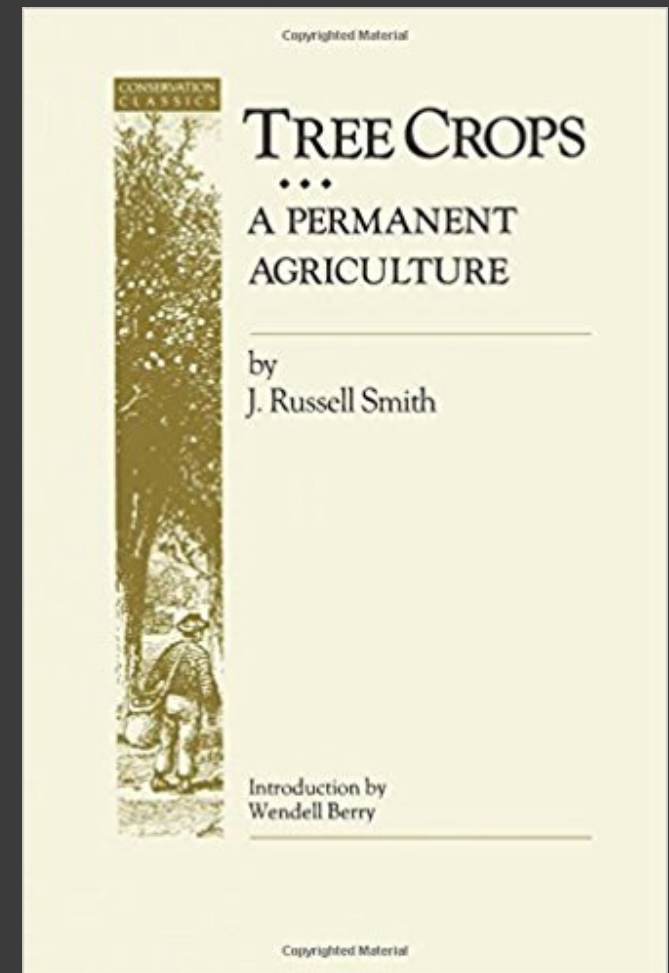
Agroforestry is the integration of trees and/or shrubs with crops and/or livestock



<https://forest-atlas.fs.fed.us/benefits-agroforestry.html>

Tree crops can offer a production function, providing fruits and nuts

- Trees can themselves be a productive component
- Tree crops are diverse and healthy options for human or livestock consumption



Agroforestry for Food = agroforestry + tree/shrub crops



AGRICULTURAL TRANSFORMATION?

Annual → Perennial
Herbaceous → Woody
Monoculture → Polyculture
Open System → Closed System



**Conventional
Agriculture**



**Multifunctional
Solution**

Can “Agroforestry for Food” work for temperate regions (Midwest US)?

- Mimic the structure of **savanna** ecosystem
- Select species that **replace functions** of current crops: corn and soybean
 - Chestnut – high starch (corn)
 - Hazelnut – high oil (soybean)
- Evaluate additional **ecosystem services**
 - Carbon sequestration, water quality and quantity, biodiversity conservation, etc.
- Focus on **marginal lands** for early transition

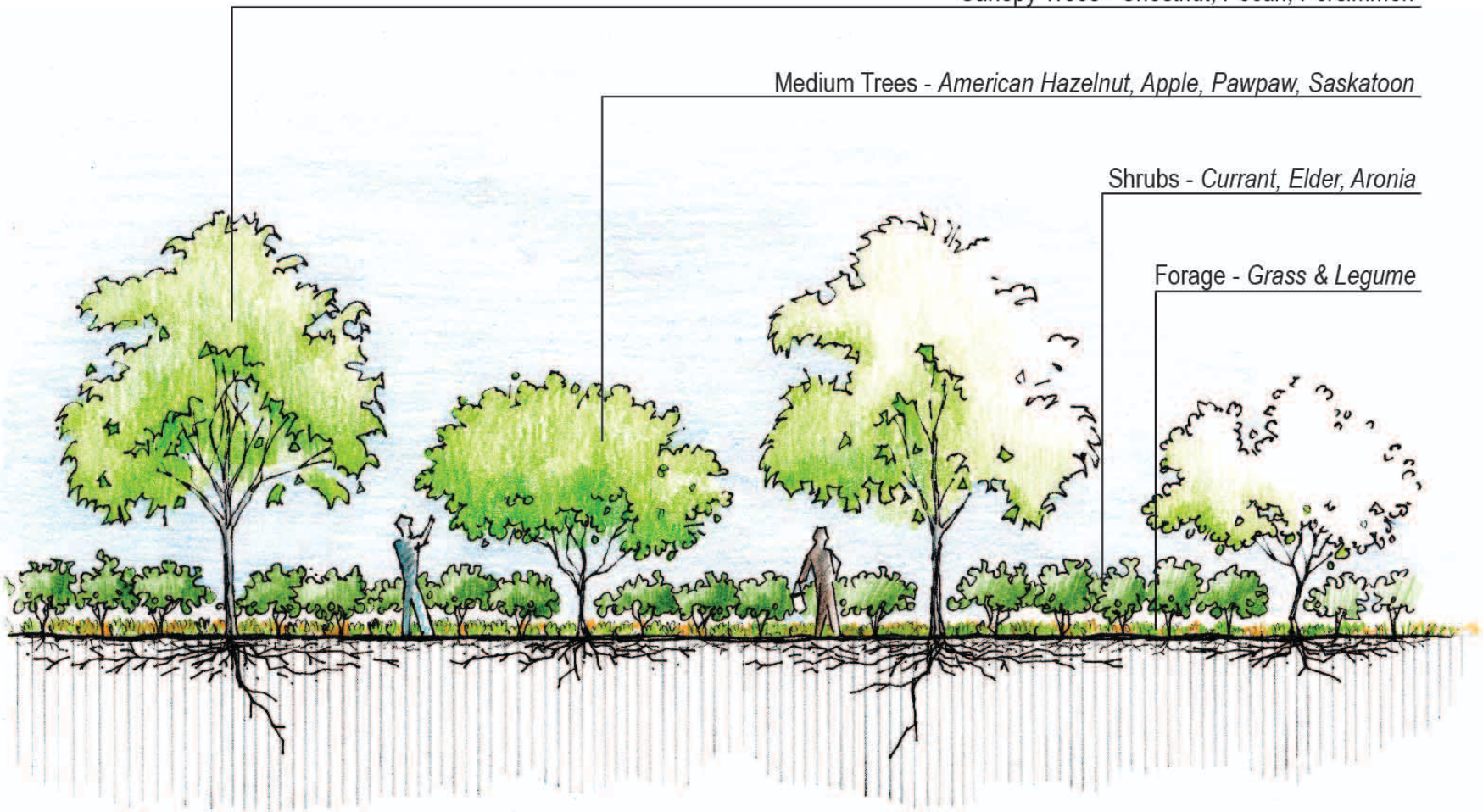
Designing woody polyculture systems for multifunctionality

Canopy Trees - *Chestnut, Pecan, Persimmon*

Medium Trees - *American Hazelnut, Apple, Pawpaw, Saskatoon*

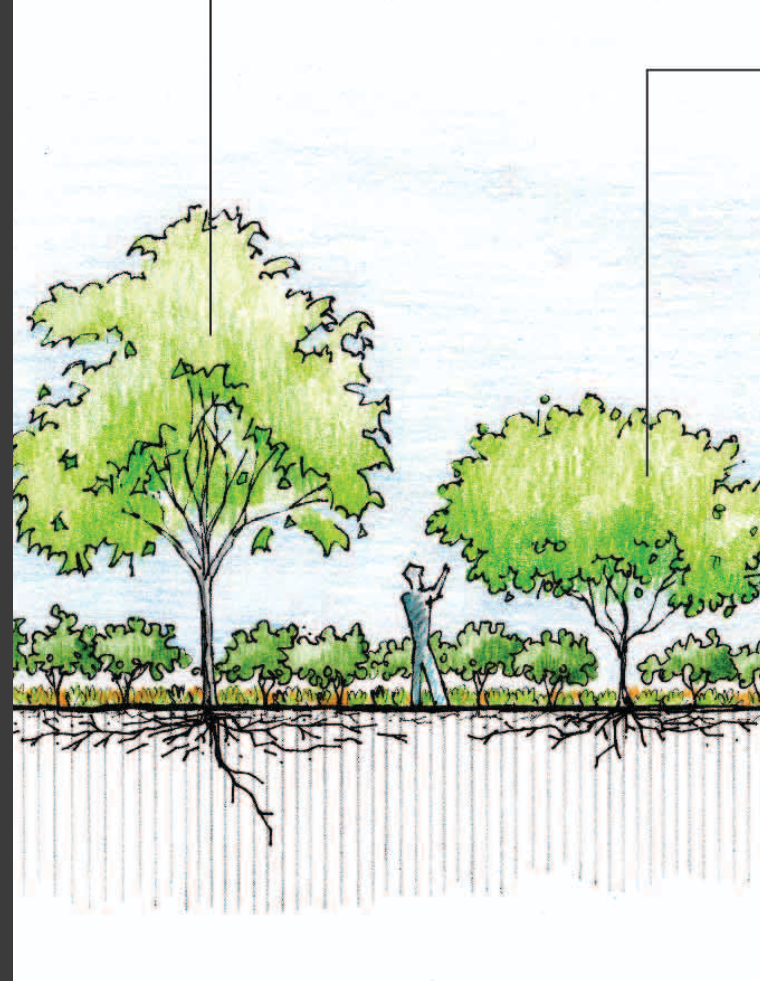
Shrubs - *Currant, Elder, Aronia*

Forage - *Grass & Legume*



Multi-layered system allows plants to explore different niches

- Carbon sequestration
- Biodiversity conservation
- Water use efficiency
- Nutrient use efficiency
- Water quality
- Adaptation to climate change
- Diversification of enterprises
- Healthier food options



“Agroforestry for Food” field trial will test plant interactions



Race Street

Curtis Road

715

720

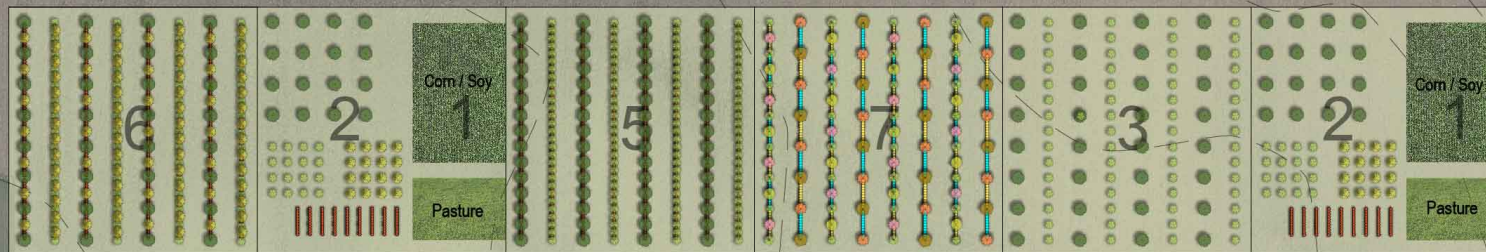
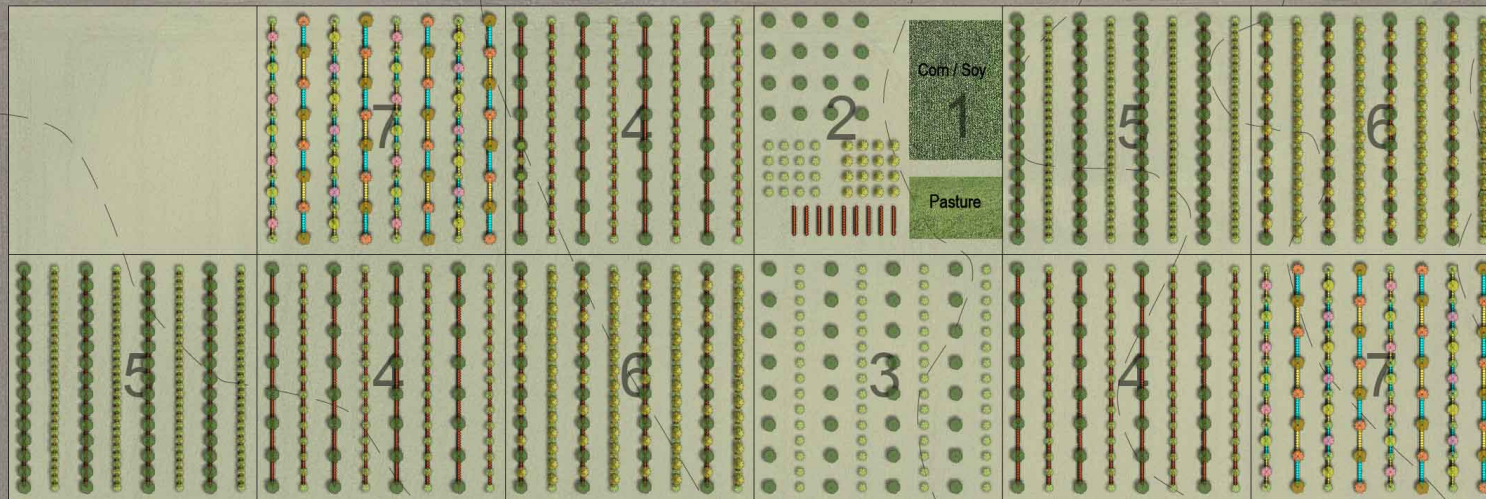
725

730

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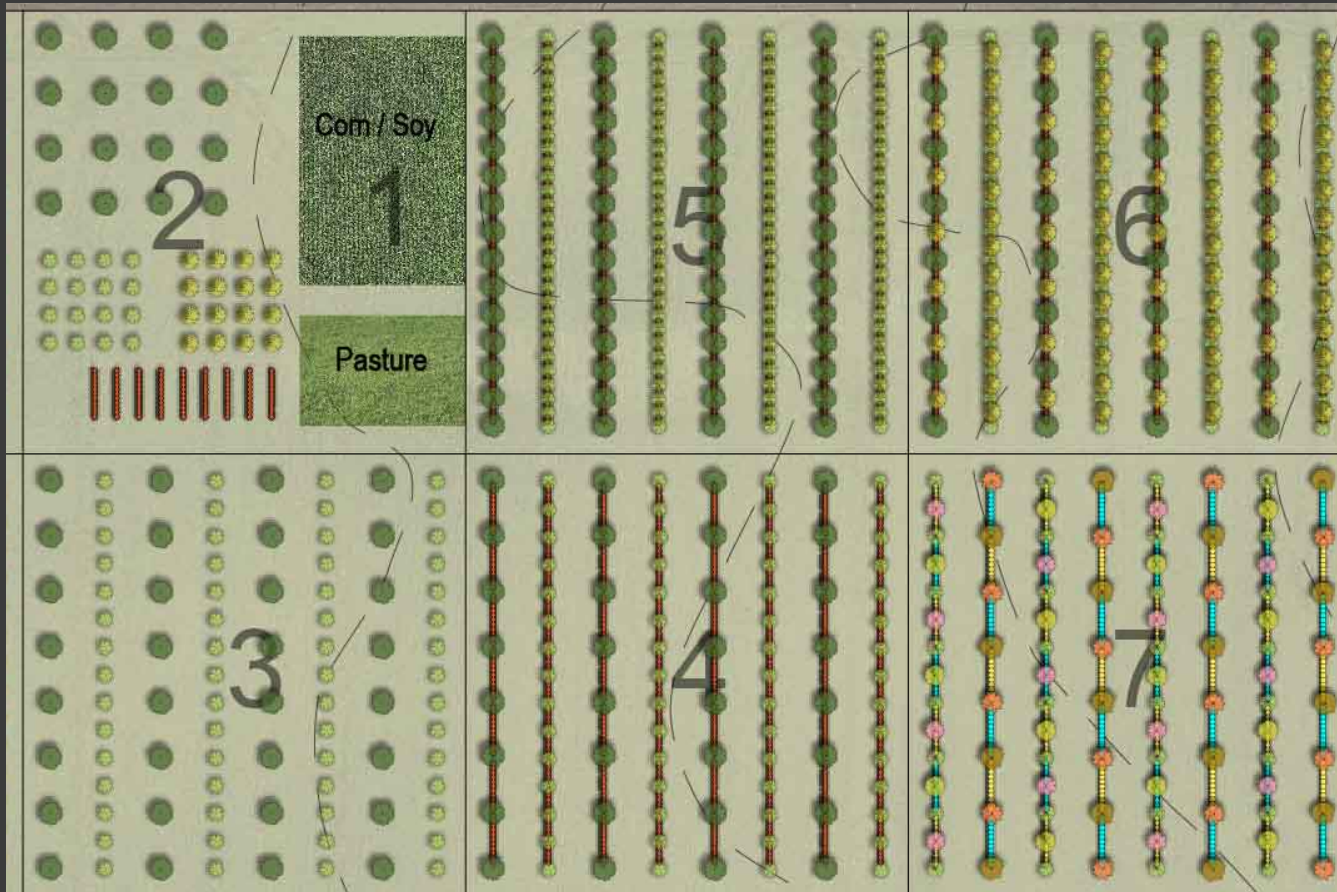
- Treatment 7 Native Plants**
- Amelanchier
 - American Hazelnut
 - Aronia
 - Elder
 - Pawpaw
 - Pecan
 - Persimmon
 - Plum

Multifunctional Woody Polyculture

- Apple
- Chestnut
- Currant
- Hybrid Hazelnut
- Contour Line
- Area ~40 acres



“Agroforestry for Food” field trial will test plant interactions



“Agroforestry for Food” field trial will test plant interactions



Facebook page for "Agroforestry for Food". The page header includes the name "Agroforestry for Food", a search icon, a user profile picture for "Sarah", and navigation links for "Home", "Messages", "Notifications" (with a red badge showing 9), "Insights", and "Publishing Tools". The main content area features a large 3D visualization of a field trial layout, showing a grid of plots with different combinations of crops and trees. A smaller inset image in the bottom left shows a close-up of red berries on a branch, with the ISEE logo below it. The page title "Agroforestry for Food" and category "Farming/Agriculture" are displayed below the main image. At the bottom, there are buttons for "Create Call to Action", "Liked" (with a dropdown arrow), and "Mess". The footer contains navigation links for "Timeline", "About", "Photos", "Likes", and "More" (with a dropdown arrow).

Agroforestry for Food
Farming/Agriculture

Agroforestry for Food field trial layout visualization.

Agroforestry for Food
Farming/Agriculture

ISEE

Create Call to Action

Liked

Mess

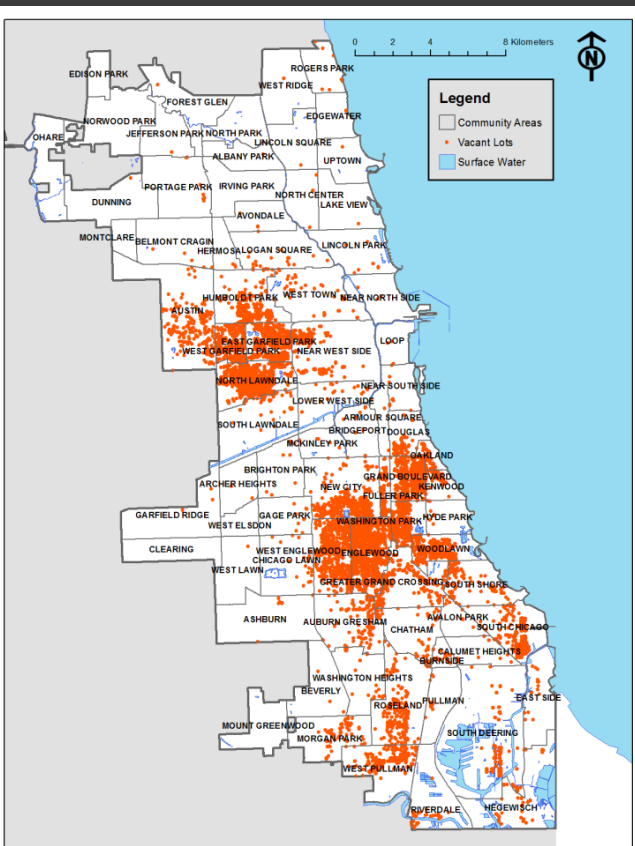
Timeline About Photos Likes More

Designing for Resilience in Urban Settings



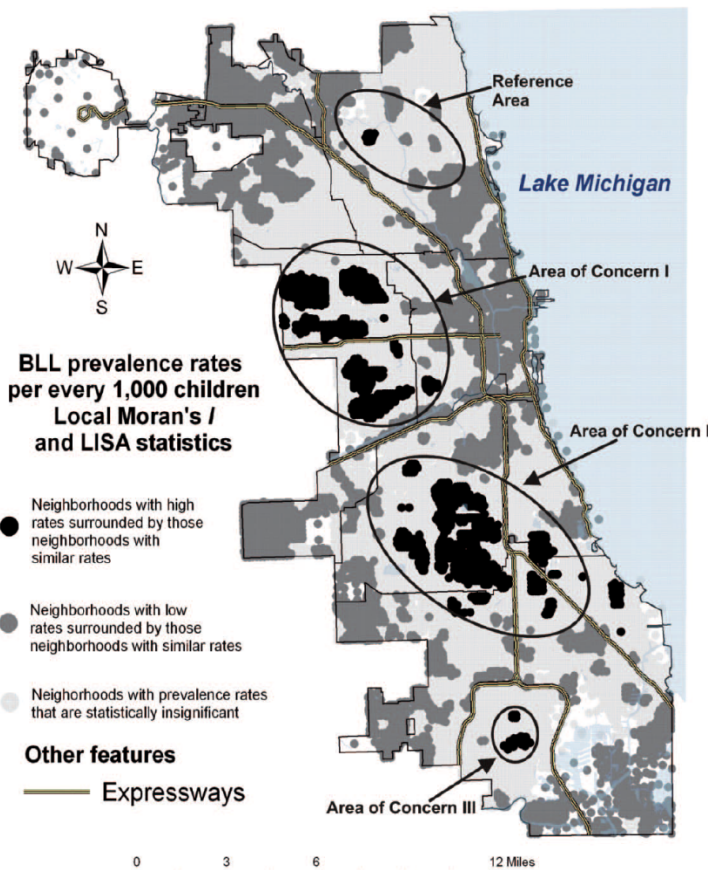
Marginal and underutilized land could be planted with tree crops

In Chicago 70-80,000 vacant lots; 11,000 city-owned

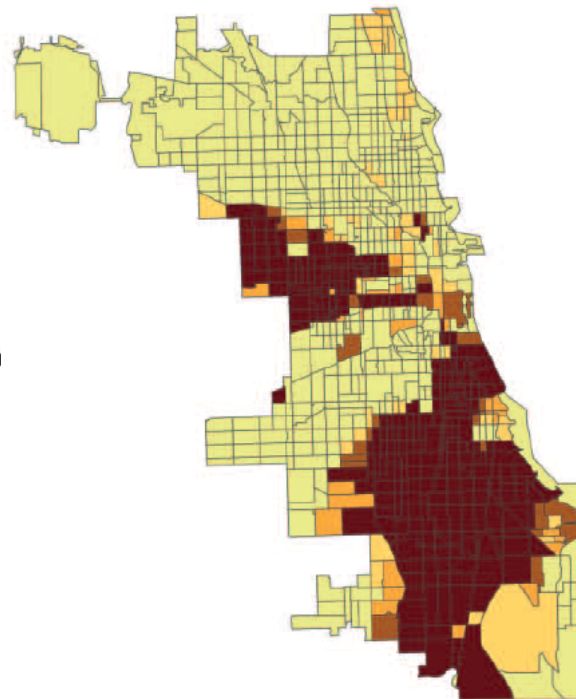


Tree crops lessen food safety issues related to soil contamination

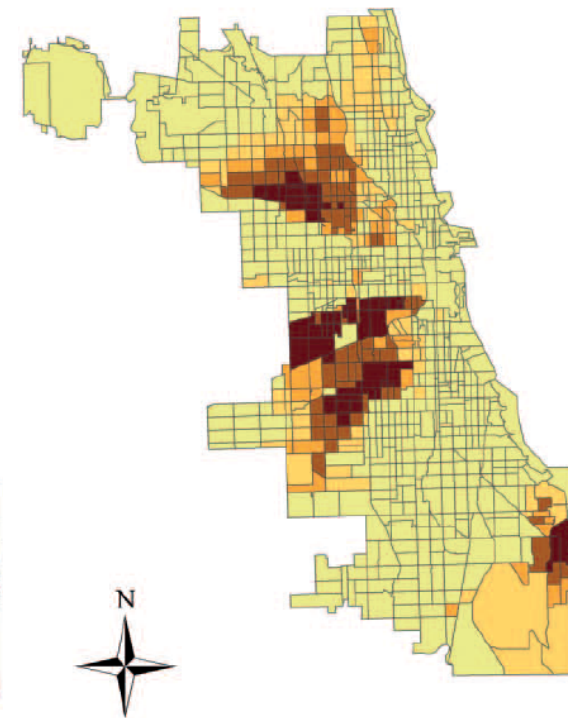
Oyana, T.J., Margai, F.M., 2010. Spatial Patterns and Health Disparities in Pediatric Lead Exposure in Chicago: Characteristics and Profiles of High-Risk Neighborhoods, *The Professional Geographer*, 62:1, 46-65



Distribution of Blacks

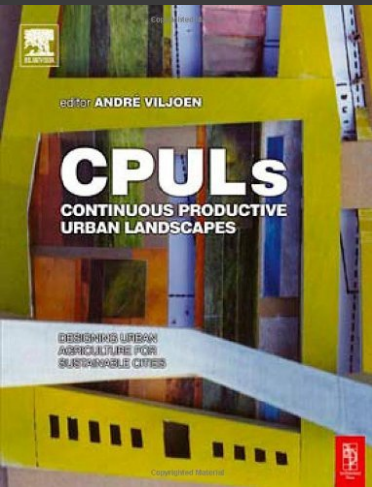


Distribution of Hispanics

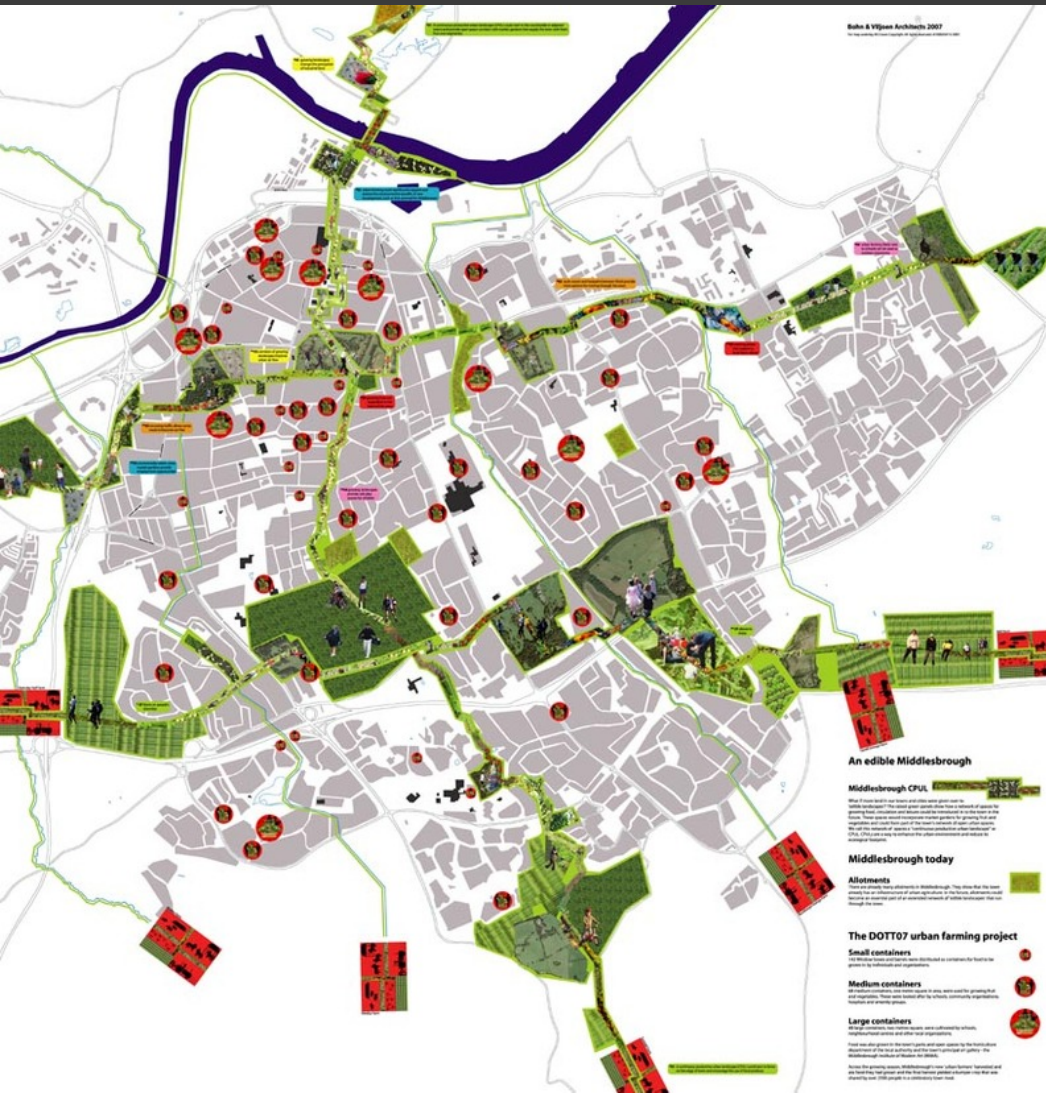


Tree crops can be tied to urban tree canopy and greenway efforts

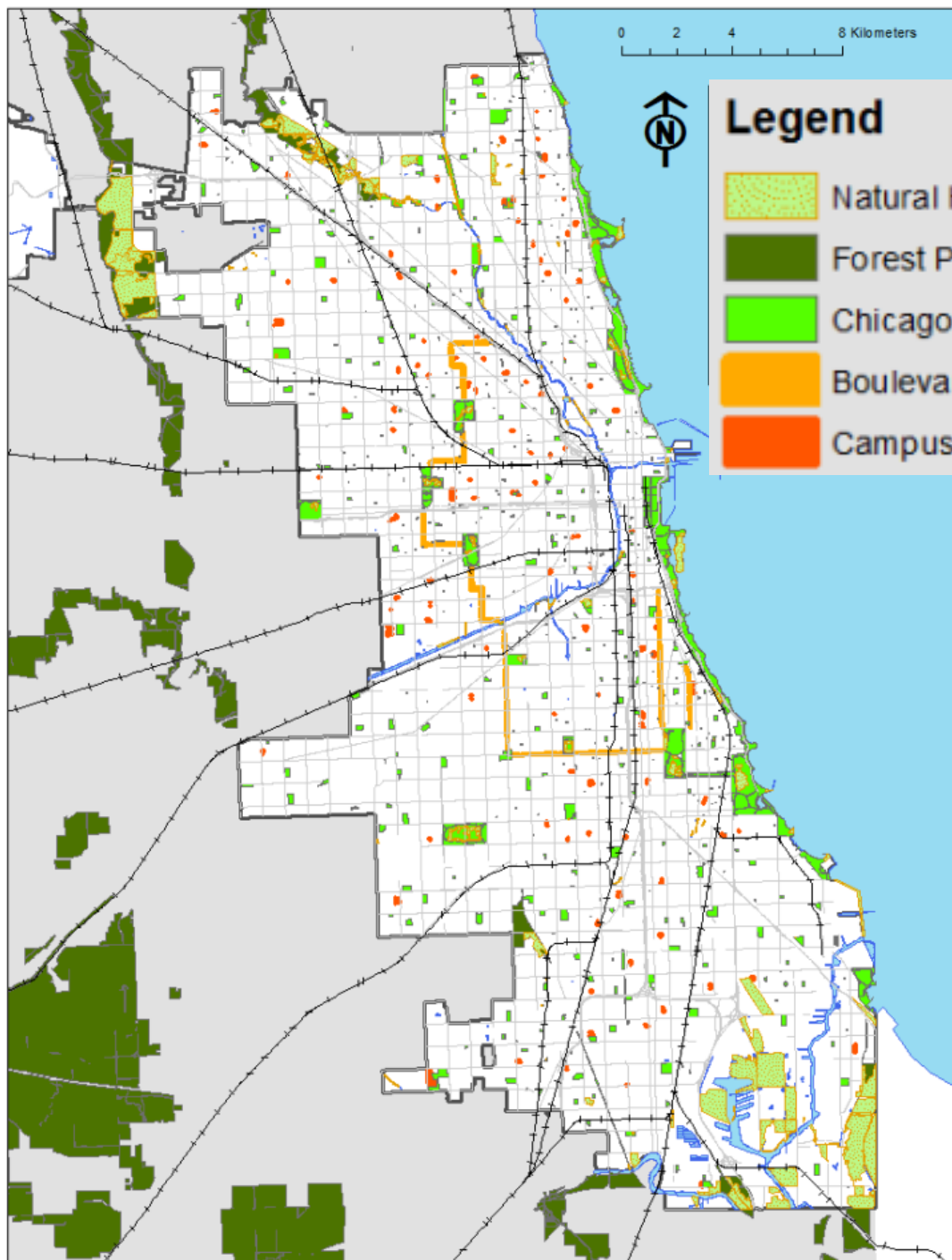
- CPULs: Continuous Productive Urban Landscapes
 - Connected agricultural spaces in the city that incorporate leisure and recreation
 - Incorporate city farms, market gardens, allotments, community gardens, etc.
 - Producing food where one wants to eat it, and consuming food where it was grown



Tree crops can be tied to urban tree canopy and greenway efforts




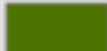



CARROT CITY
CREATING PLACES FOR URBAN AGRICULTURE
Mark Gorgolewski, June Komisar, and Joe Nasr



0 2 4 8 Kilometers



Legend

-  Natural Habitats
-  Forest Preserve
-  Chicago Parks
-  Boulevards
-  Campus Parks

Maps of public fruit trees can be used for gleaning (fallingfruit.org)

falling fruit – Map the urban harvest!

Map About Data Activity + Add source Login Sign up

Address 61801 Zoom to me Filter Edible type Labels Link Embed

Tree inventories [?] Download

1124 of 16567 visible

Info Reviews (0)

Black walnut *Juglans nigra*

This grove is full of black walnut trees. Be warned - they have a tough green flesh outside of an incredibly tough shell. The juice from the green flesh will stain EVERYTHING it touches a deep brown (useful as a dye?). I recommend: collect the green balls from the ground when they drop off the tree in fall. Put them on a stretch of pavement and drive over them a bunch to crush the green flesh (it won't break the shells, don't worry). Wear gloves, gather the shells, hose them off, and let dry in the sun. Then they need to cure for a while. Then eventually you can crack them, using a vise, and enjoy the interesting flavor in cookies! It's a lot of work, but you can't really buy black walnuts because they are such a pain in the rump to get the nut out of them!

Map data ©2015 Google Terms of Use Report a map error

Edible landscaping alternatives can be integrated into public spaces

- Shade trees producing fruits and nuts
 - Persimmon, walnut, Chinese chestnut, pecan, others
- Selected low-maintenance orchard trees
 - American plum, pear, cider apple, cherry
- Understory plantings
 - Pawpaw, Amelanchier sp, elderberry, aronia
- Shrubs for hedges
 - Currants, blueberry, hazelnut, brambles
- Ground-covers
 - Strawberry, lingonberry, winterberry

Dedicated community orchards can be added to public parks



Trees and shrubs can provide benefits for cultivated crops too

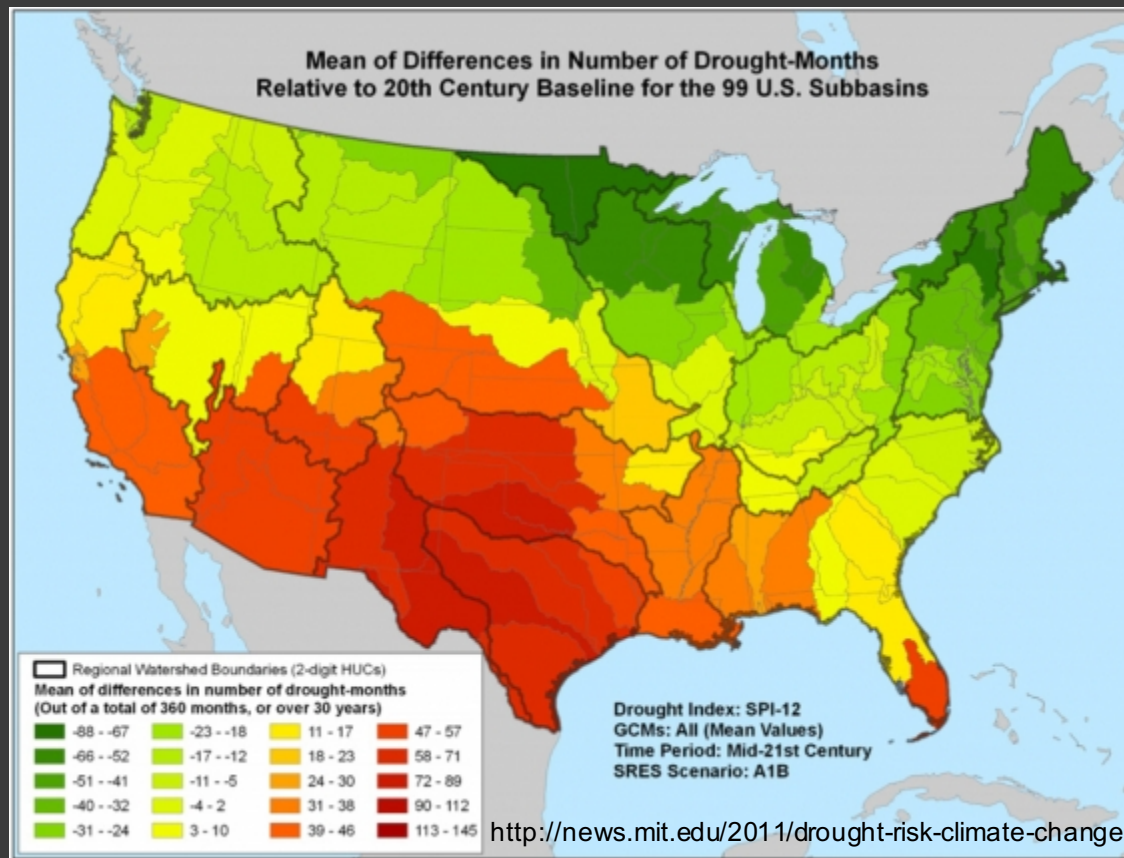
Buffers provide a wide range of functions to support healthy sites

- Microclimate
- Filtering runoff
- Filtering air
- Productivity
- Visual quality



Tree and shrub species can be selected for future conditions

- Consider species that are native and adapted to local conditions and future climate variability



Nut trees provide shade, store carbon, and supply starch and oil



American Hazelnut

- High oil nut
- Dense vegetation
- Ornamental



Chinese chestnut

- High starch nut
- Valuable crop
- Heavy producer



Pecan

- Native to Midwest
- Few pest problems
- Allows dappled light

Fruit trees improve scenic beauty and provide fresh healthy food



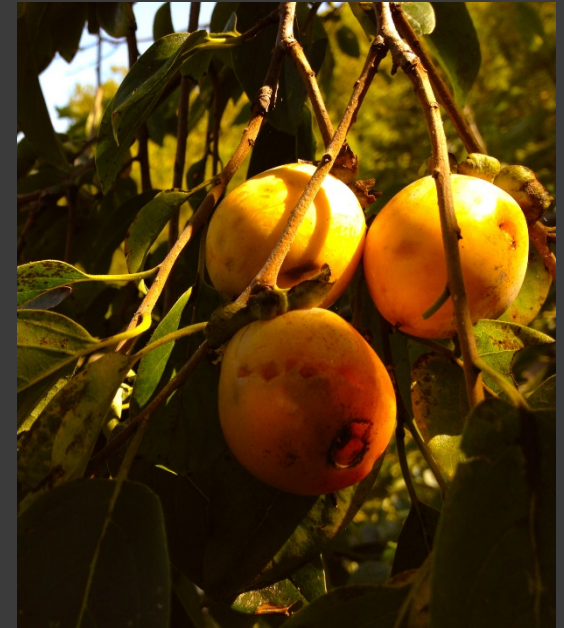
Cider apple

- Heavy production
- Showy flowers
- Low maintenance



Common pawpaw

- Native to Midwest
- Fruit eaten fresh
- High value crop



American persimmon

- Rich flavor
- High vitamin C
- Native to Midwest

Shrubs with small fruits support wildlife and human consumption



Aronia berry

- High antioxidants
- Few pests
- Ornamental



Juneberry

- Fruit eaten fresh
- Ornamental
- Many species



Elderberry

- High antioxidants
- Nitrogen cycling
- Vigorous growth

Tree crops contribute to climate change mitigation and adaptation

MITIGATION

- Sequester **carbon** in biomass and soil
- Provide favorable **microclimate** to reduce urban heat island and related energy use
- Require **fewer inputs** of energy-intensive materials such as synthetic fertilizers

ADAPTATION

- **Tolerate disturbance**, like drought and flooding
- Contribute to conservation of **biodiversity**
- Protect **resources** including water and soil

MLAD lab website:

www.multifunctionallandscape.com

Facebook: “Agroforestry for Food”

Support for this project was provided by:

USDA Hatch Act funds (project no. ILLU-802-383)

Illinois Nutrient Research & Education Council (NREC)

UIUC Institute for Sustainability, Energy and Environment

