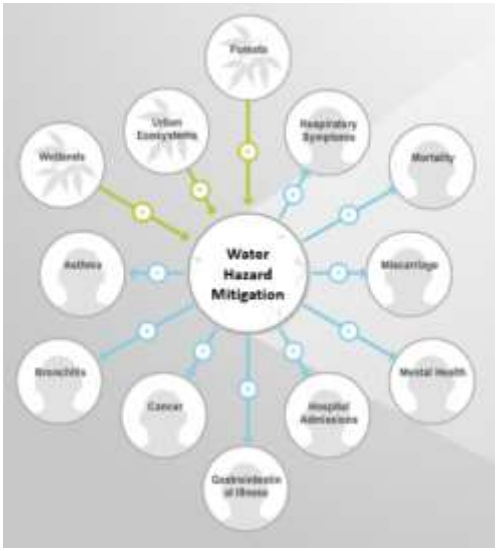
Fine-Scale Environmental Indicators of Well-Being for Urban Communities



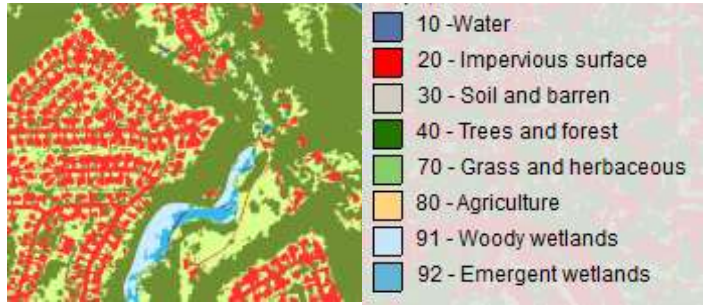
Part of the ACES 2016 Session:
"Evidence-Based Approaches for Linking Ecosystem Services and Human Health"

Laura Jackson, Ph.D.
U.S. Environmental Protection Agency
Office of Research and Development
December 6, 2016

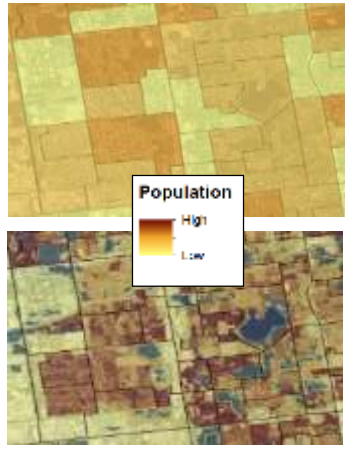
EnviroAtlas: www.epa.gov/enviroatlas

An online decision support tool for viewing, analysing, and downloading geospatial data related to ecosystem services

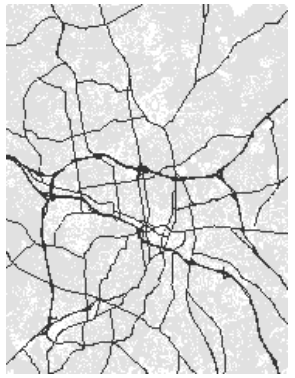
- Maps, data, tools and information about the supply, demand, drivers, and social benefits of ecosystem services
- National & community components
- Population and climate scenarios
- Reference data (e.g., boundaries, land cover, soils, impaired water bodies, wetlands, demographics)
- Analytic and interpretive tools
- Free & open access



One-meter land cover data (communities)

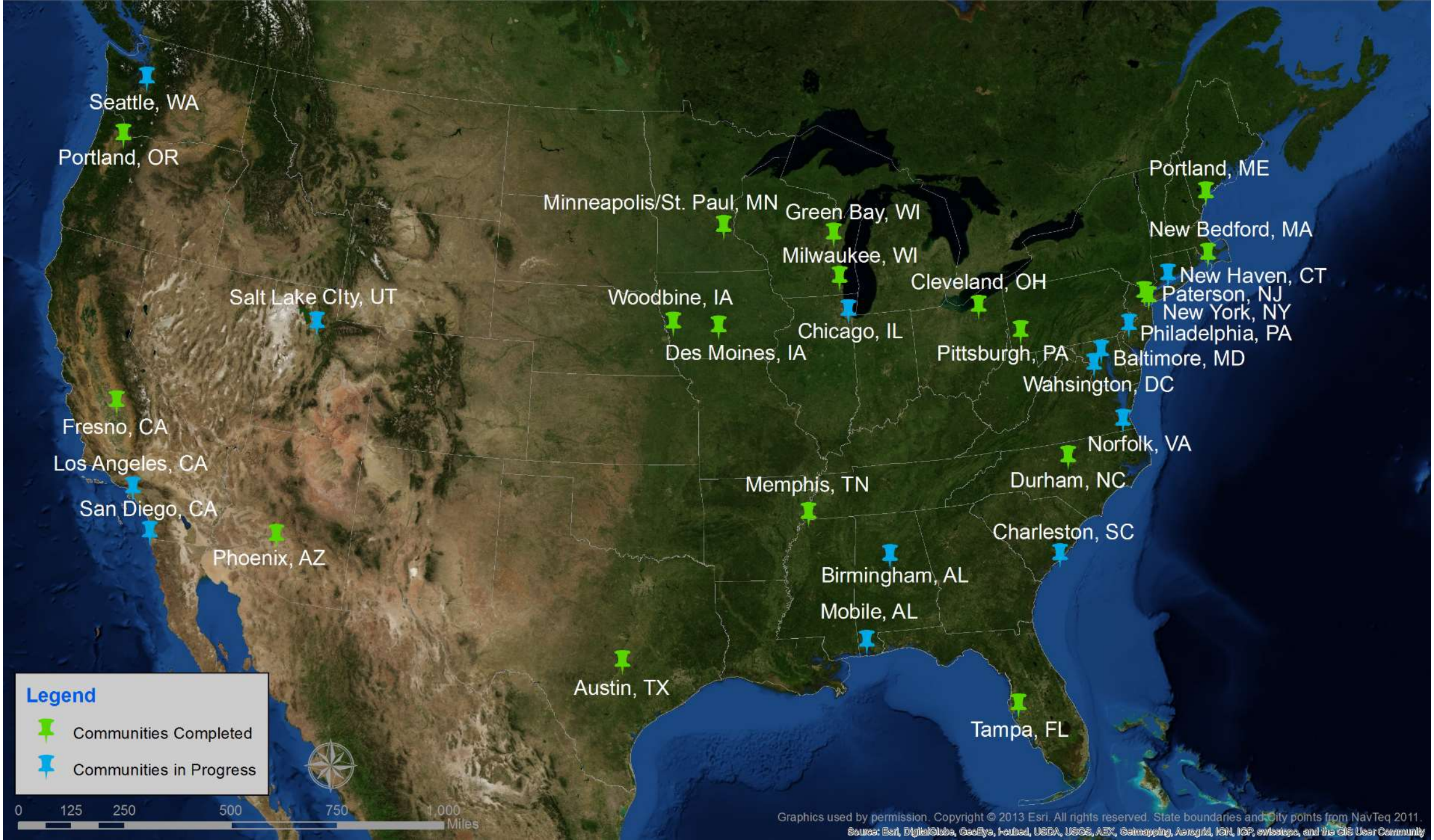


Downscaled pop. data



Built infrastructure

Developed through cooperative effort among multiple Federal agencies, universities, and other organizations


Seattle, WA
Portland, OR
Salt Lake CIty, UT
Fresno, CA
Los Angeles, CA
San Diego, CA
Phoenix, AZ
Austin, TX
Minneapolis/St. Paul, MN
Green Bay, WI
Milwaukee, WI
Woodbine, IA
Des Moines, IA
Chicago, IL
Cleveland, OH
Pittsburgh, PA
Memphis, TN
Birmingham, AL
Mobile, AL
Tampa, FL
Portland, ME
New Bedford, MA
New Haven, CT
Paterson, NJ
New York, NY
Philadelphia, PA
Baltimore, MD
Wahsington, DC
Norfolk, VA
Durham, NC
Charleston, SC
Legend
Communities Completed
Communities in Progress
0 125 250 500 750 1,000
Miles
Graphics used by permission. Copyright © 2013 Esri. All rights reserved. State boundaries and City points from NavTeq 2011.
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Ecosystem Services & Health:
Unrealized Assets = Unintended Consequences

Approach: Demonstrate Multiple Benefits of Green Infrastructure,

- Clean air
- Clean & plentiful water
- Natural hazard mitigation
- Climate stabilization
- Recreation, culture & aesthetics
- Food, fiber & materials
- Biodiversity conservation

…and How They Relate to Human Health & Well-Being

- ***Air and water pollutants removed by neighborhood tree cover***
- ***Homes and schools near busy roadways***
- ***Extreme heat events***
- ***Opportunities for physical exercise, social engagement, outdoor experience, and play***
- ***Distributions of vulnerable populations***

Boiling it down: Hazard Buffering and Health Promotion

Literature Review: The Eco-Health Relationship Browser

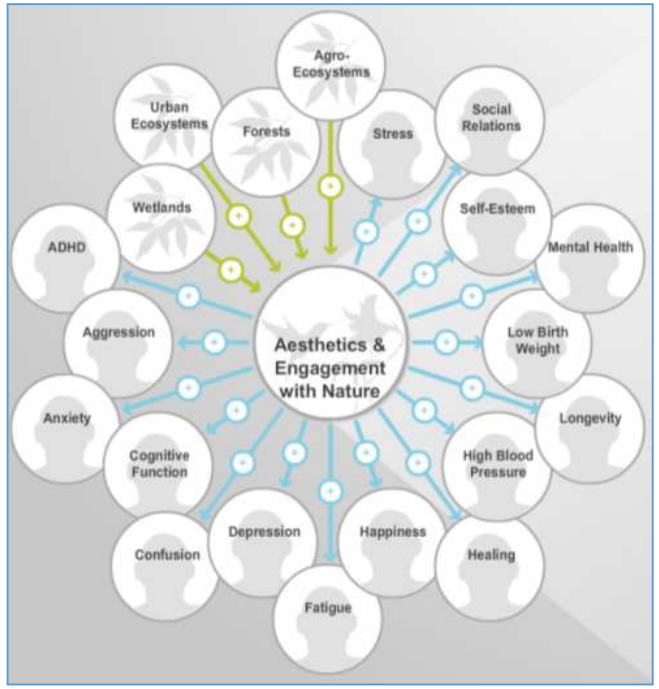
4 ecosystems:

- Forests
- Urban Ecosystems
- Wetlands
- Agro-Ecosystems

6 Ecosystem Services:

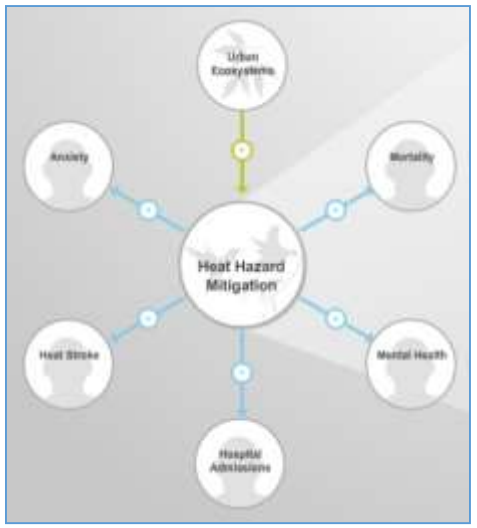
Health promotional services

- Aesthetics & Engagement with Nature
- Recreation & Physical Activity



Buffering services

- Clean Air
- Clean Water
- Heat Hazard Mitigation
- Water Hazard Mitigation



Incl. extensive bibliography (n ~ 300)

30+ health outcomes:

- Asthma
- ADHD
- Cancers
- Cardiovascular diseases
- Heat stroke
- Healing
- Low birth weight
- Obesity
- Social relations
- Stress

… many more

Disparate Methods; Unknown Transferability of Research Findings

"Children who lived in greener neighborhoods were less likely to increase their BMI z-scores over two years compared to those who had less-green neighborhoods (Bell et al. 2008)."

"The odds of hyperactivity/inattention problems were almost 1.5 times higher for children living 500 meters from urban green spaces than those living within 500 meters (Markevych et al. 2014)."

"The probability of five-year survival of senior citizens increased from 66% when participants had very few parks and tree-lined streets near the residence, to 74% when there were plenty of both (Takano et al. 2002)."

"… more cases of worsening asthma in flooded households (48%) than in non-flooded (25%) (Reacher et al. 2004)."

"Greenspace buffers between 100 m and 500 m were associated with birthweights that increased at least 15 g for each interquartile range increase in average greenness (Dadvand et al. 2014)."

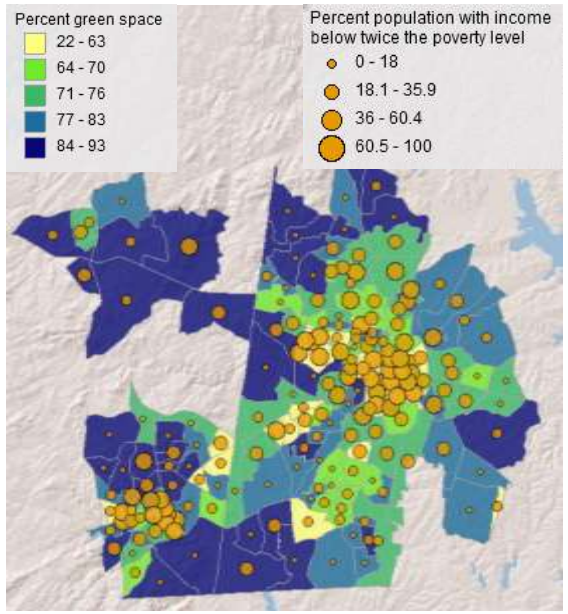
"With strategic tree placement, annual reductions in ambient concentrations of PM 10 may reach 7- 20% (Bealey et al. 2006)."

"A 10 micro-g/m3 rise in PM10 was estimated to represent a 5.8% increase in daily bronchitis hospital admissions (Wordley et al. 1997)."

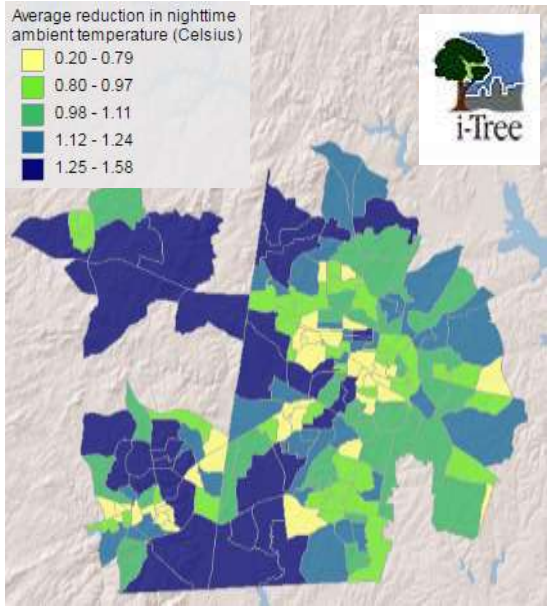
Causality and Mechanisms Are Often Also Unclear

Examples of Community Health and Well-Being Indicators to Assist Decision-Making

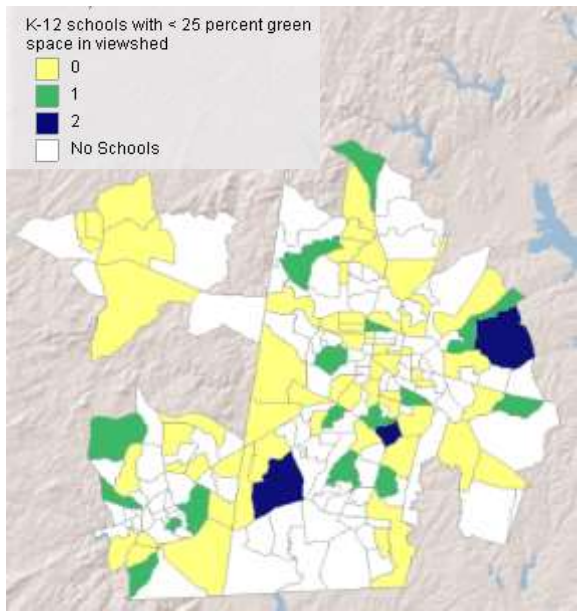
e.g., health interventions, public infrastructure, social equity



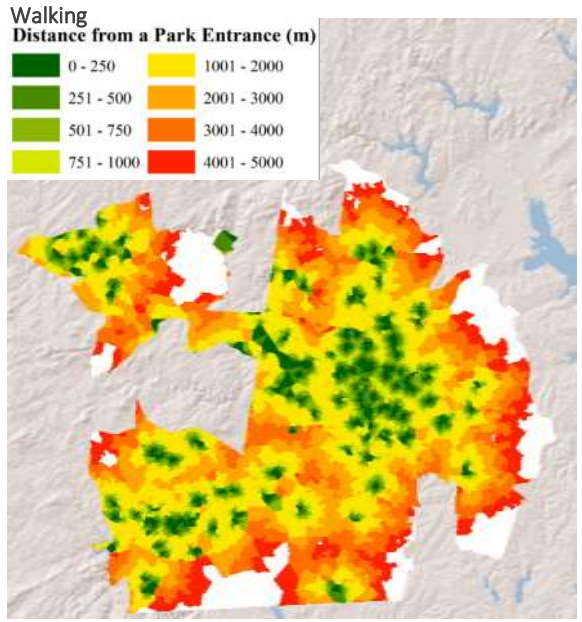
Summaries by census block-group approximate neighborhoods and facilitate population overlays



Modeled hazard mitigation: heat, air pollutants, contaminated runoff



Potential to improve school performance through cognitive restoration & stress reduction



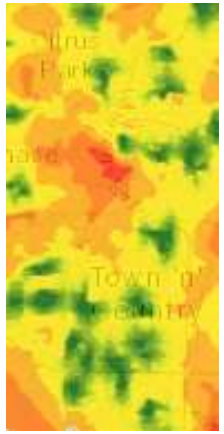
Opportunities for physical activity, engagement with nature, & social interaction

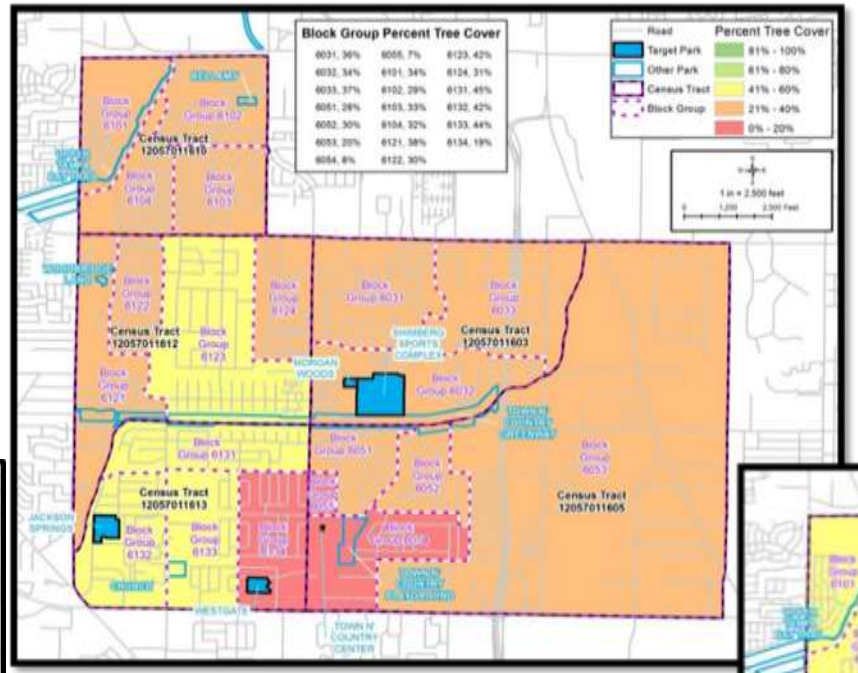
Consistent metrics available across all EnviroAtlas communities

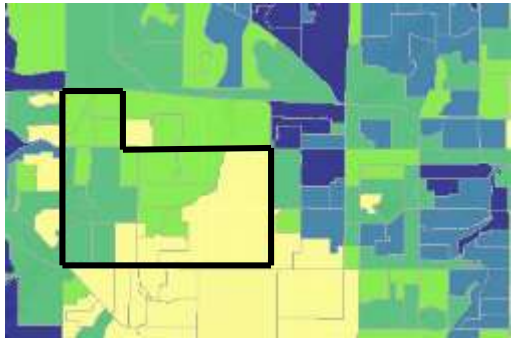
Pictured: Greater Durham, NC

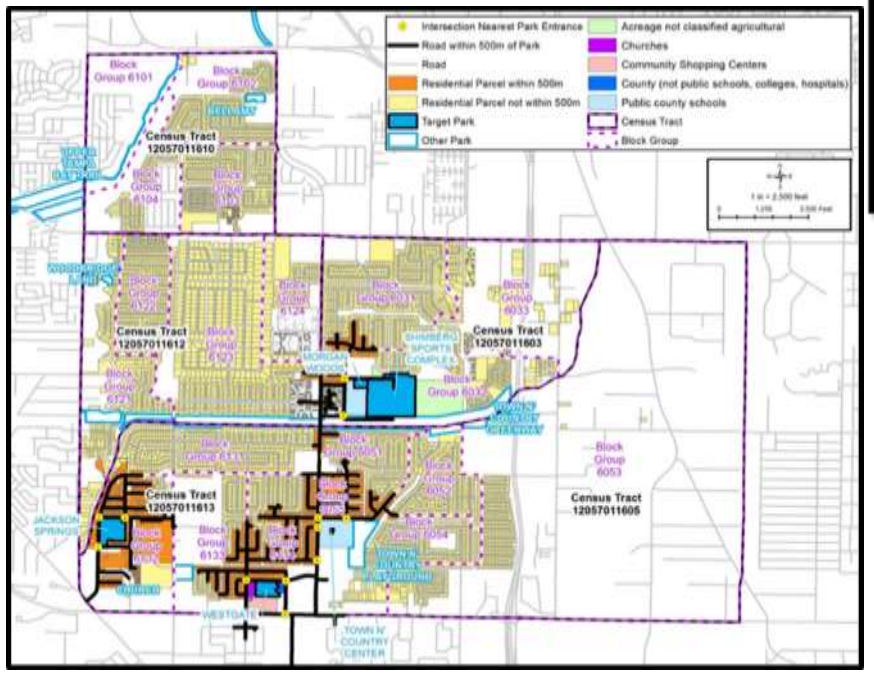
HIA: Should County Permit Local Businesses/Orgs. to Offer Exercise Classes in Public Parks? Access to Green Space & Nature

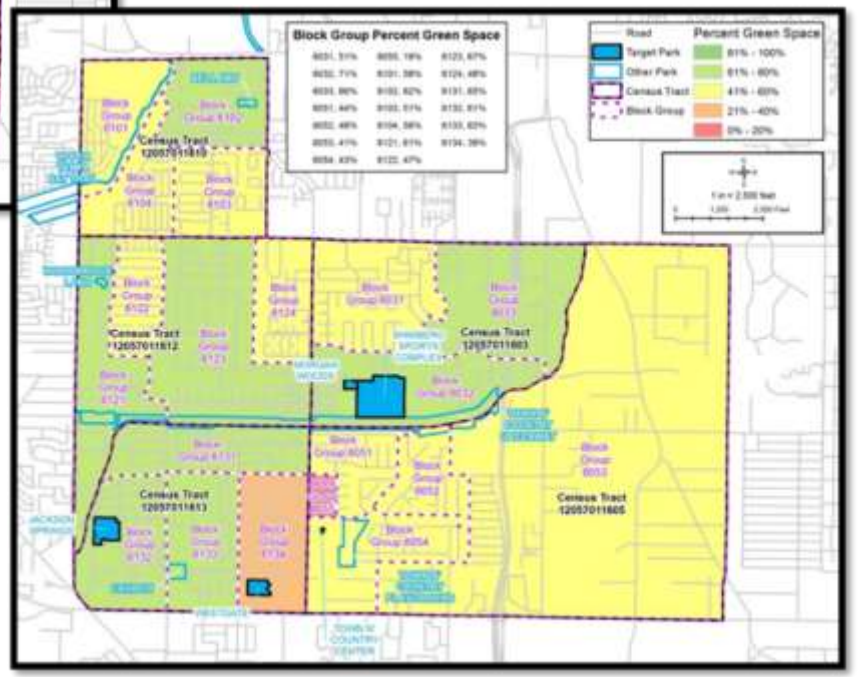
"Of the 28,086 estimated population for the target area, approximately 19.1% of people live within 500 meters walking distance from a target park entrance."





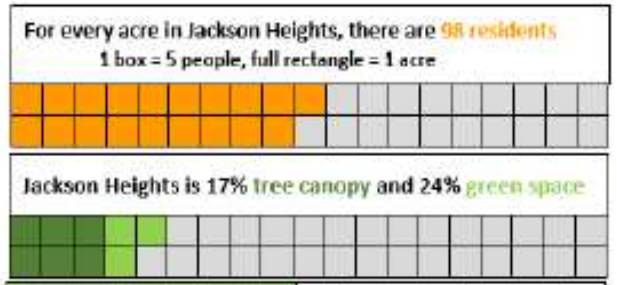




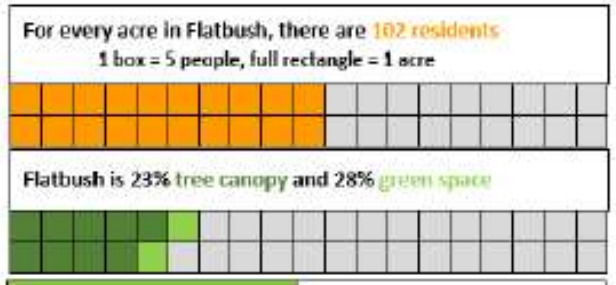


City of New York
Parks & Recreation

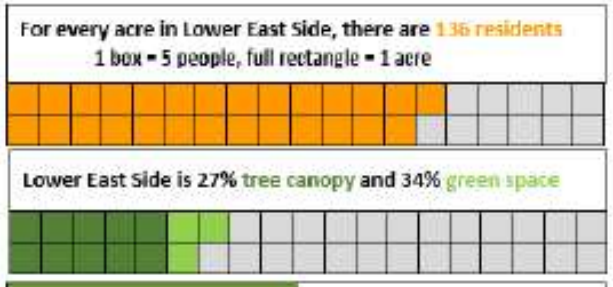
Jackson Heights, Queens – 1101 acres	Flatbush, Brooklyn – 1039 acres	Lower East Side, Manhattan – 536 acres
		



Summer temp reduction	0.70 °F
Runoff avoided (per acre)	1395 gallons
Respiratory health savings (per 10,000 residents)	$1421
Schools with adequate green space (% of total)	50%
Green streets (% of total acreage)	1.4%
Community gardens	0

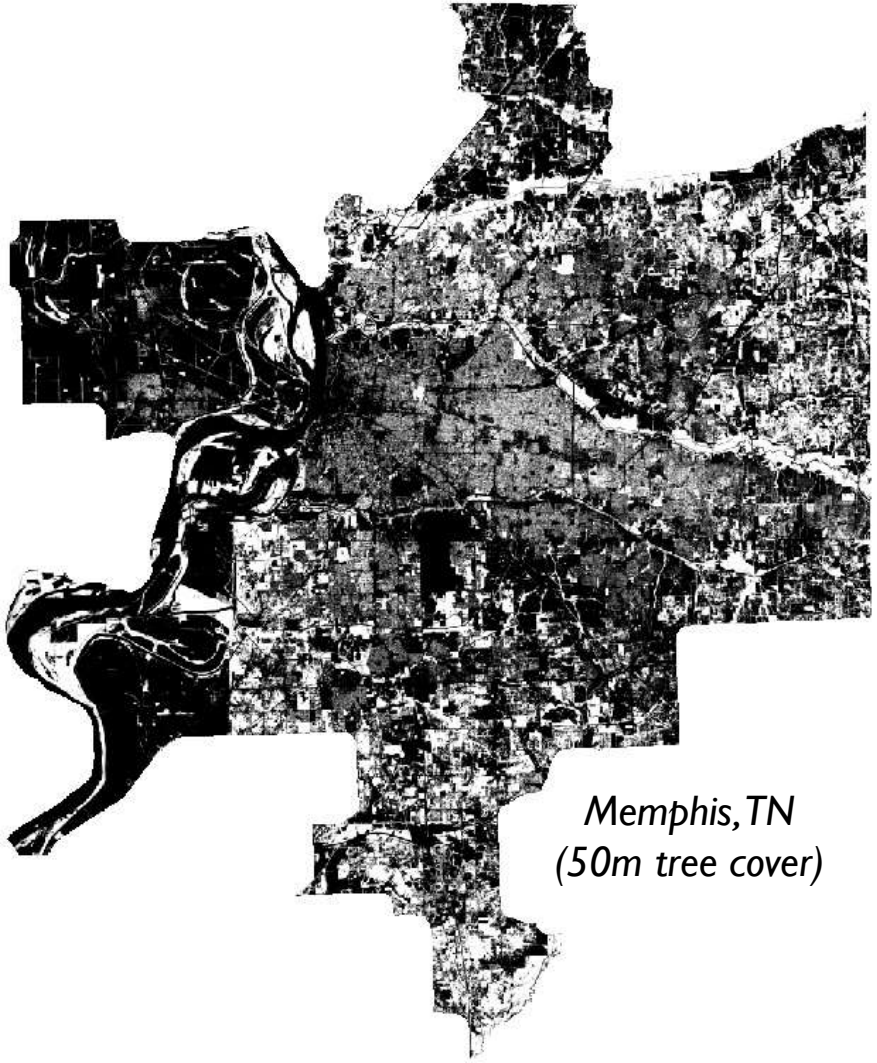


Summer temp reduction	0.82 °F
Runoff avoided (per acre)	1623 gallons
Respiratory health savings (per 10,000 residents)	$3305
Schools with adequate green space (% of total)	33%
Green streets (% of total acreage)	1.2%
Community gardens	1

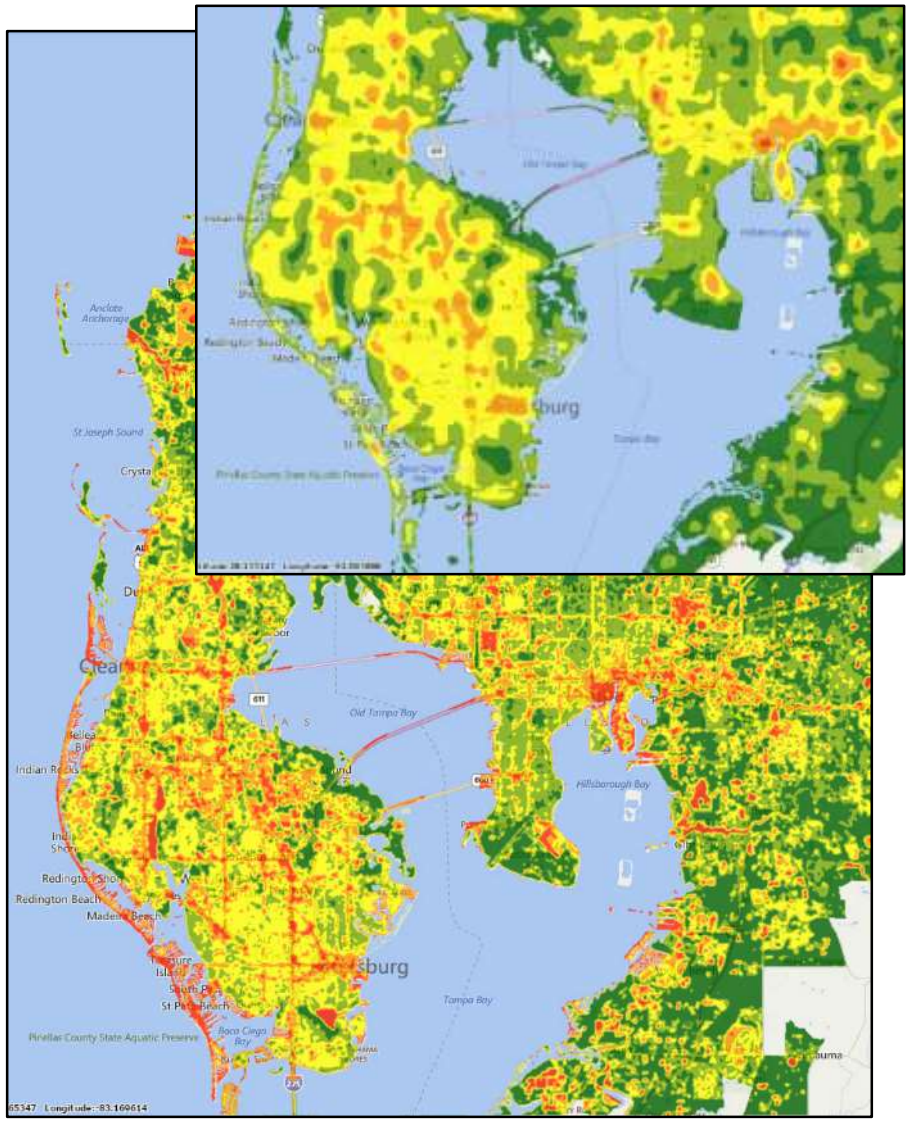


Summer temp reduction	1.01 °F
Runoff avoided (per acre)	1558 gallons
Respiratory health savings (per 10,000 residents)	$4071
Schools with adequate green space (% of total)	79%
Green streets (% of total acreage)	4.9%
Community gardens	29

Multiple Moving-Window Metrics w/1m Landcover Data for Geospatial Matching to Confidential Health Data



Memphis, TN
(50m tree cover)

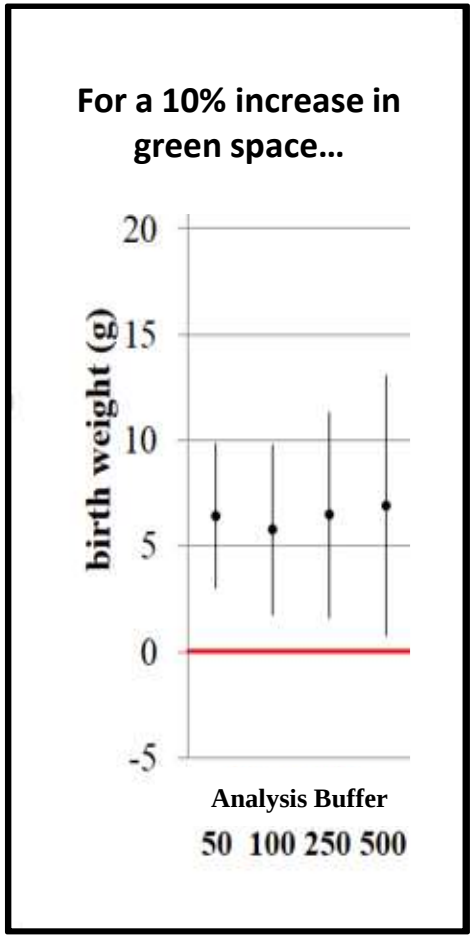


Tampa/St. Petersburg, FL (250m, 1,000m green space)

Residential Buffer Analyses

Durham, NC, EnviroAtlas Pilot Community

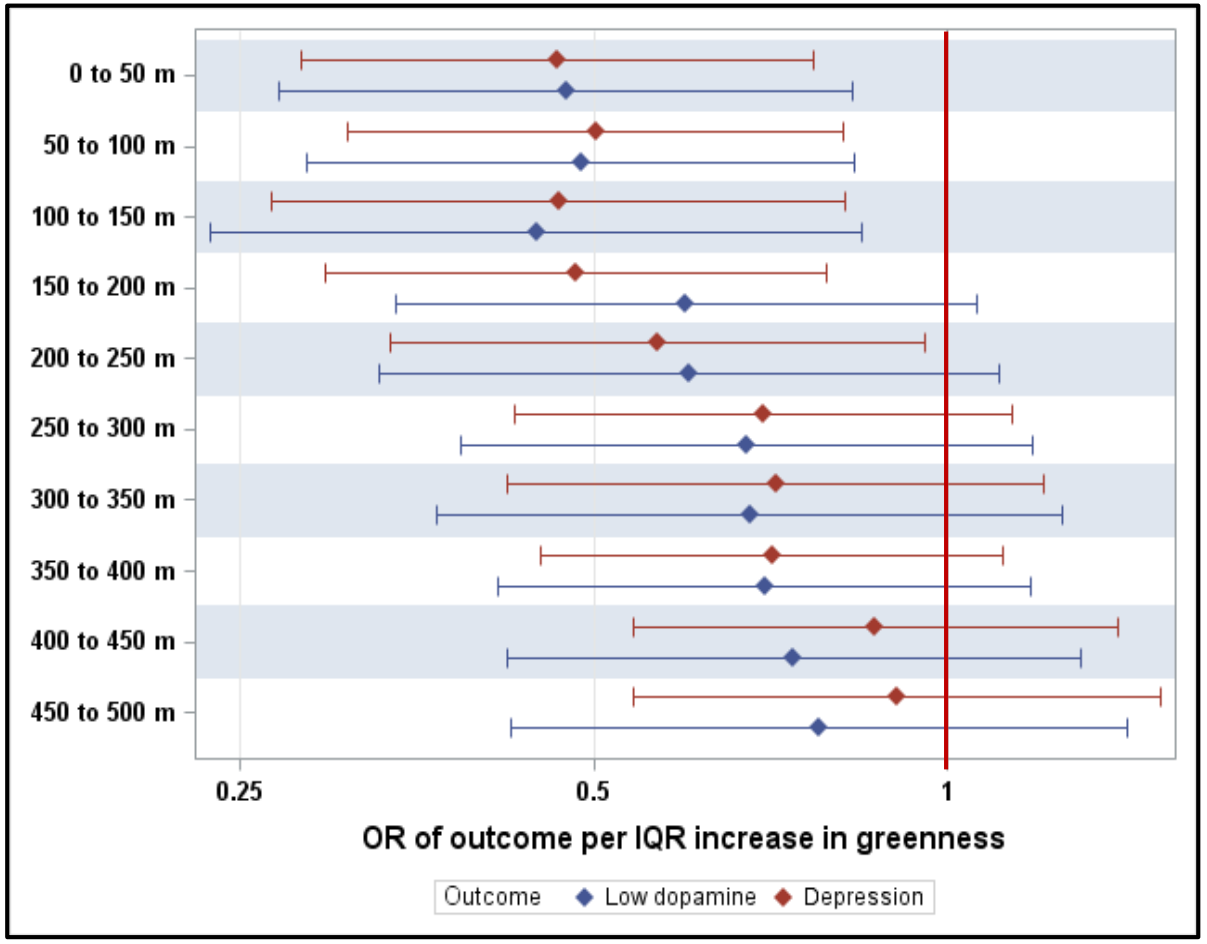
Birth weight



N = 22,893 (2004-2009)

Bush et al. unpublished

Depression

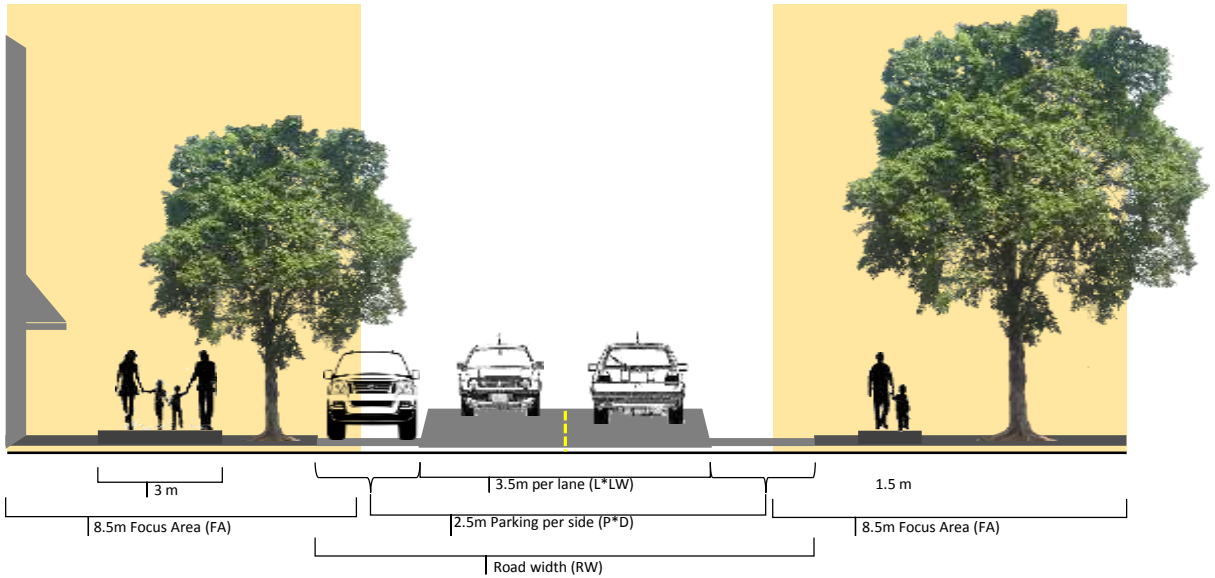


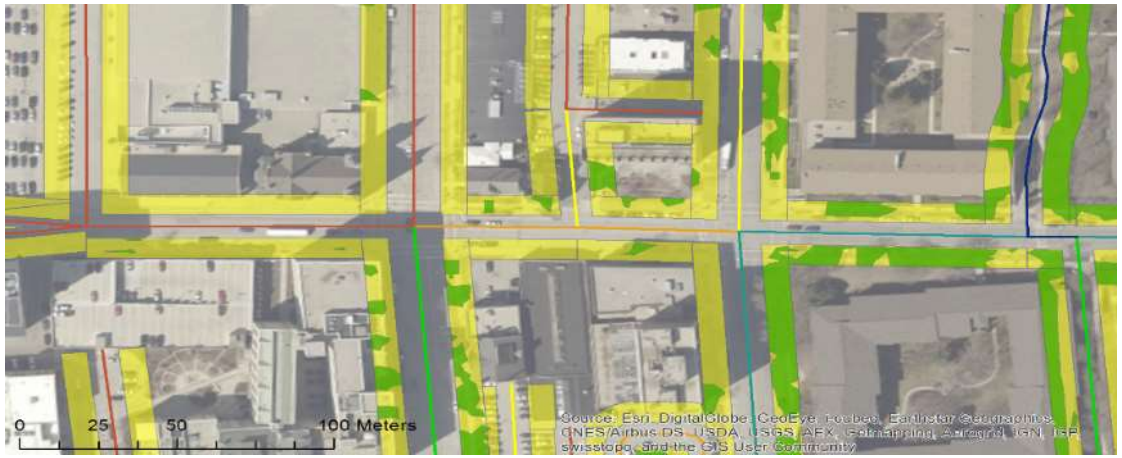
N = 204; (2013)

Egorov et al., in prep.

All regression models controlled for race/ethnicity, age, education and smoker status, plus selected other covariates (e.g., BMI, housing density).

Fine-Scale Green-Space Pattern Metrics: Indicators of Walkability

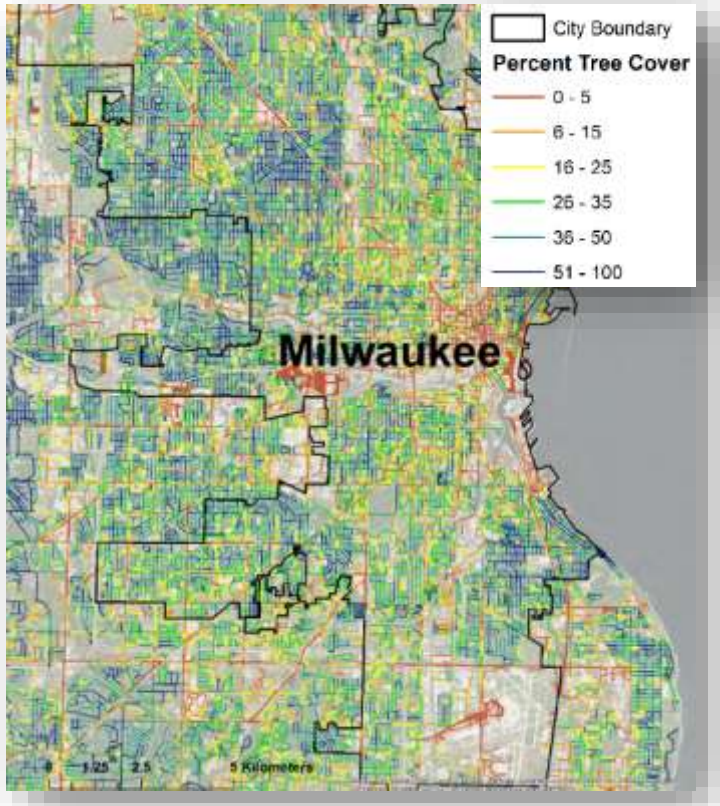




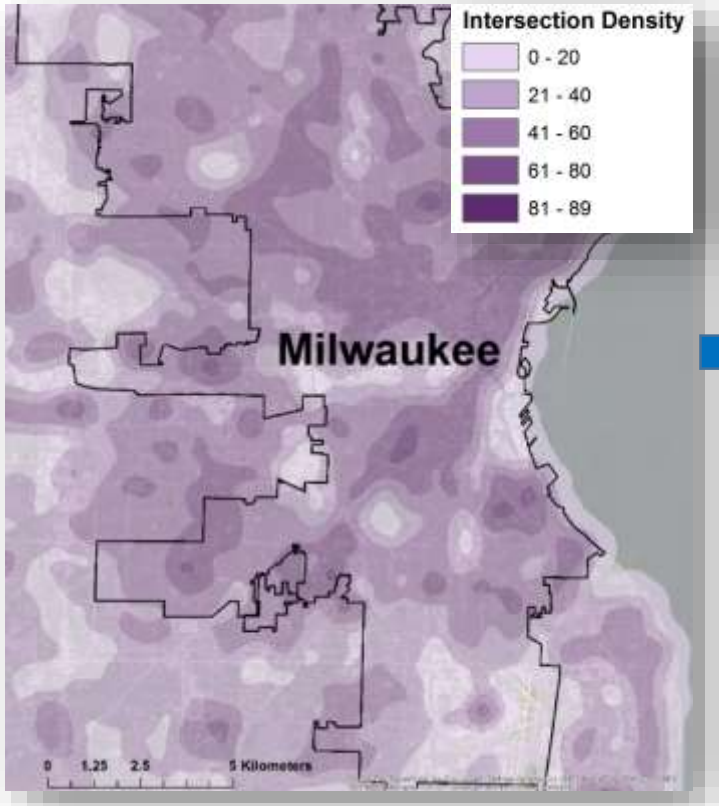
Quantifying tree cover in estimated sidewalk area

Quantifying total green space in pedestrian viewshed

Leah Yngve, former ASPPH fellow with EnviroAtlas



% sidewalk tree cover by city block

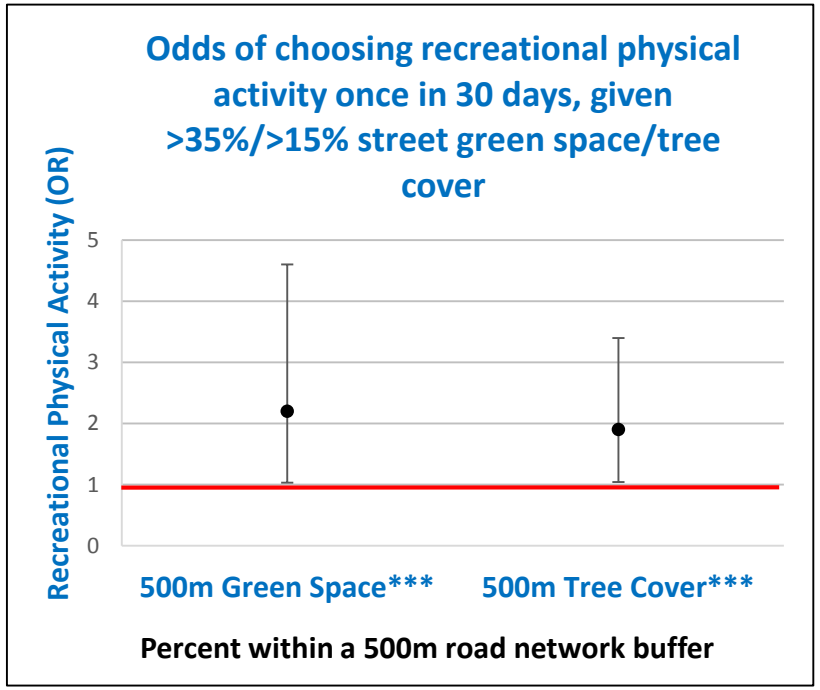


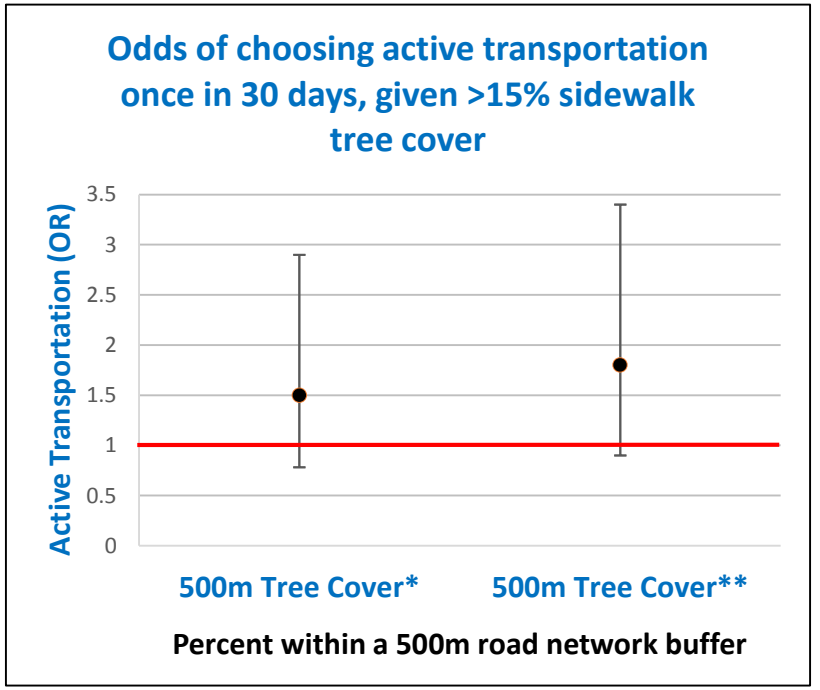
Intersection density w/in 750m

(Google Maps Street Views)

Street-Level Green Space vs. Physical Activity

Survey respondents in Milwaukee and Green Bay, WI
N = 712 (2008-2013)





Significant joint effects:

In neighborhoods with >15% sidewalk tree cover AND high intersection density (>25/km^2), OR = 2.07 (95% CI: 1.04-4.12).

In neighborhoods with >15% sidewalk tree cover AND perceived proximity to a store, OR = 3.51 (95% CI: 1.64-7.51).

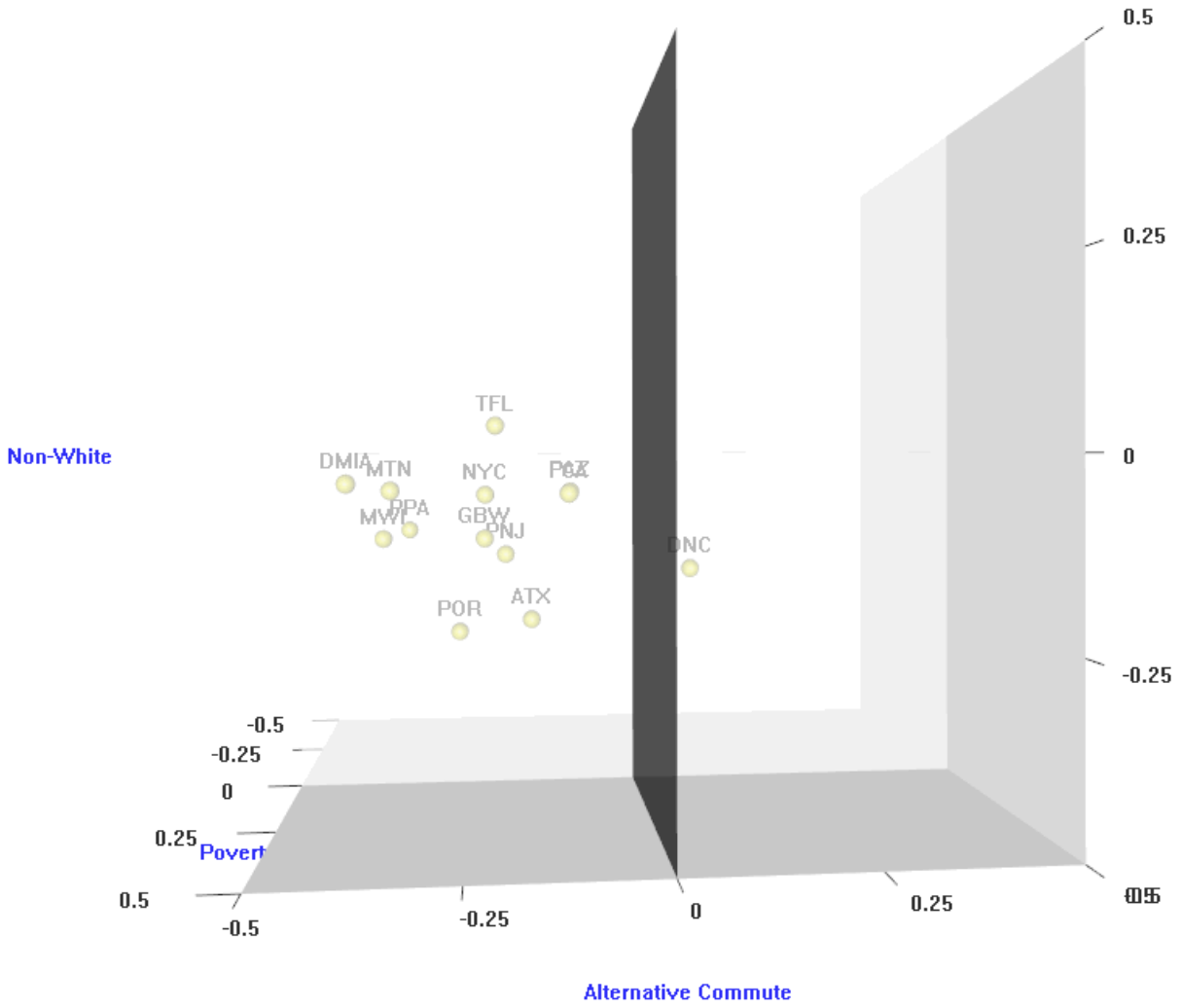
**** adjusted for education, race/ethnicity, age, season, city, intersection density, walking distance to nearest park entrance, and economic hardship index*

*** adjusted for job status, residential status, city, and economic hardship index (EHI)*
** adjusted for above, plus intersection density and perceived proximity to a store*

Yngve et al. Landscape & Urban Planning (in prep.)

Yngve, Malecki, Beyer, Jackson, Journal of Transport & Health (submitted)

Green space along Walkable Roads vs. Metrics of Disadvantage

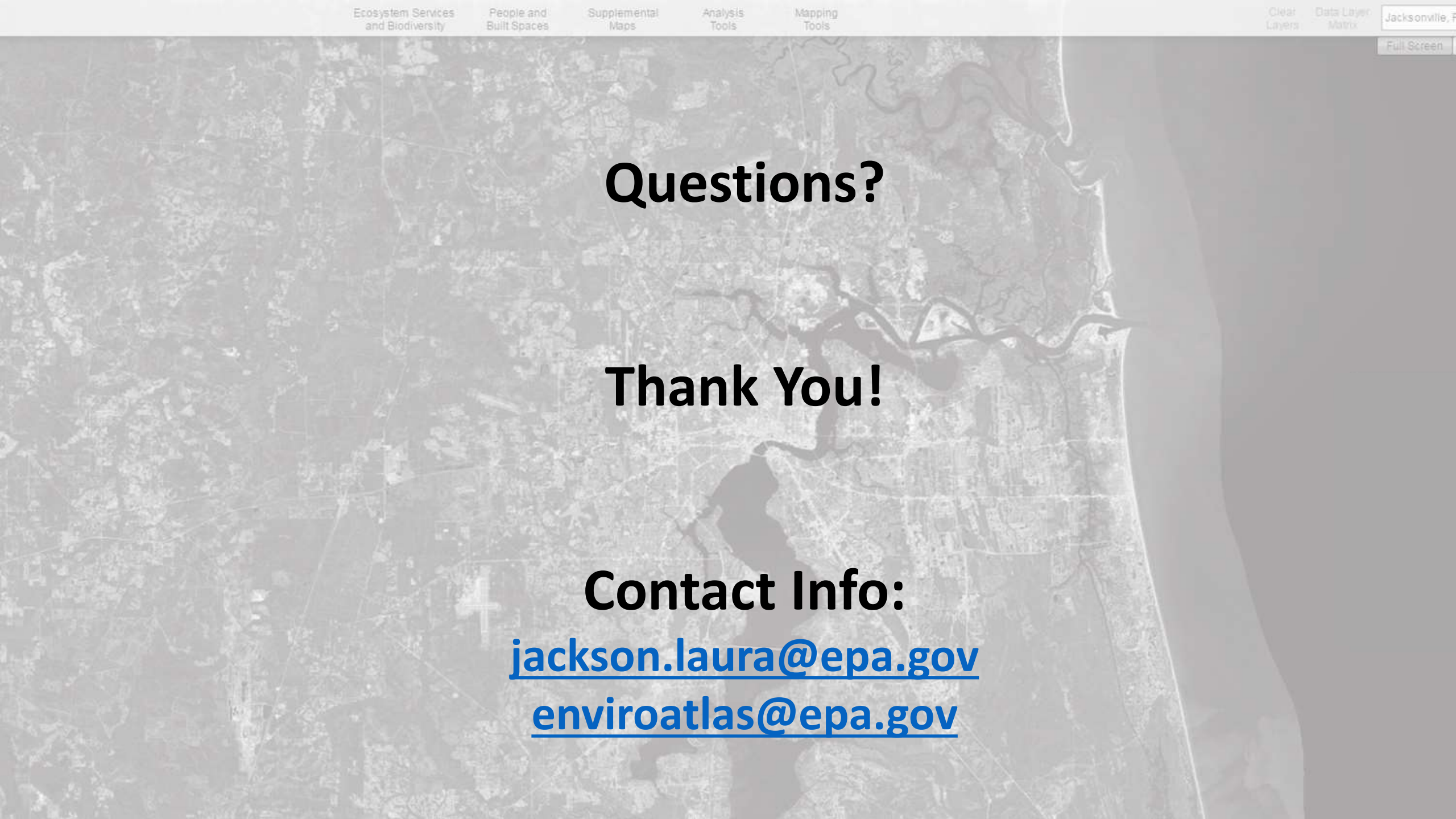


ATX – Austin, TX
DMIA – Des Moines, IA
DNC – Durham, NC
FCA – Fresno, CA
GBW – Green Bay, WI
MTN – Memphis, TN
NBMA – New Bedford, MA
NYC – New York, NY
PAZ – Phoenix, AZ
PME – Portland, ME
PNJ – Paterson, NJ
POR – Portland, OR
PPA – Pittsburgh, PA
TFL – Tampa, FL

In New Bedford, MA, and Portland, ME, a 10% increase in alternative transportation is associated with ~15-20% decrease in green space, respectively *(not shown; Yngve et al., in prep.)*.

Additional Health Issues Under Analysis or Planned

- Body mass index
- Children's blood lead levels
- Autism rates
- Rates of ADHD-related behavior
- Unexplained sudden death
- Life expectancy



Questions?

Thank You!

Contact Info:

jackson.laura@epa.gov
enviroatlas@epa.gov