Is the City Getting What it Wanted: Monitoring, Tools, Experiences

Francisco Escobedo

University of Florida- School of Forest Resources and Conservation

fescobed@ufl.edu

Is the city getting what it wanted – Urban forest monitoring tools

- What data are being collected and how often
  - Biophysical: Urban tree canopy cover, Environmental benefits data, Tree inventory data
  - Socioeconomic: Social surveys & Economic analyses
- What are these results telling you – or not- about the urban forest

Will focus on the lessons learned based on experience using these tools and methods

Learning objectives

- Discuss tools/methods that are commonly used to monitor the progress of the management plan
- Not only biophysical; but socioeconomic as well
- Considerations and “lesson learned” on using tools and data to monitor urban forest management; importance (value), and success

Biophysical (Trees)

- Inventory/ Ecosystem service tools
  - What are models, Carbon dioxide, “Tradeoffs”
- Urban Tree Canopy Assessment (UTC) Tools
  - Lessons learned on using Remote Sensing and Aerial photo interpretation
  - Actual urban forest growth and mortality

Socioeconomic (People)

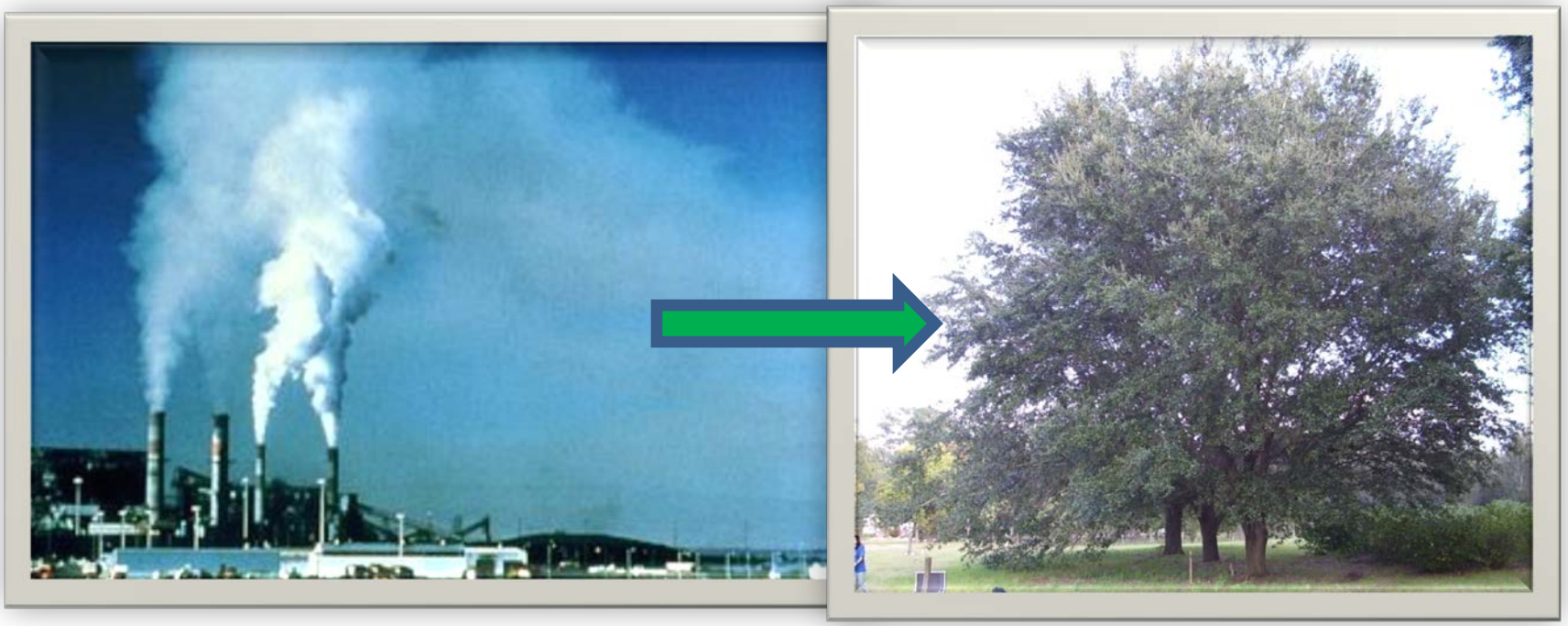
Social and Economic (tools)

- Definition of ecosystem services
- Use of perception surveys; example from the Nature Conservancy
- 2 studies form Florida; Social perception survey and Economic Analysis
- Lessons learned

Biophysical Models- *Simplification of reality*

- Good Eatin', but don't want to know how it's made or go into the kitchen after midnight!!
- Models (*i.e.* tools/software, equations) provide one way to easily understand relationships.
- Depending on your objective or audience- will need to know a little about the tools.. (+/-).

<u>Urban forest offset-</u> CO_2 sequestered through tree planting and stewardship projects that compensate for emissions occurring at another source



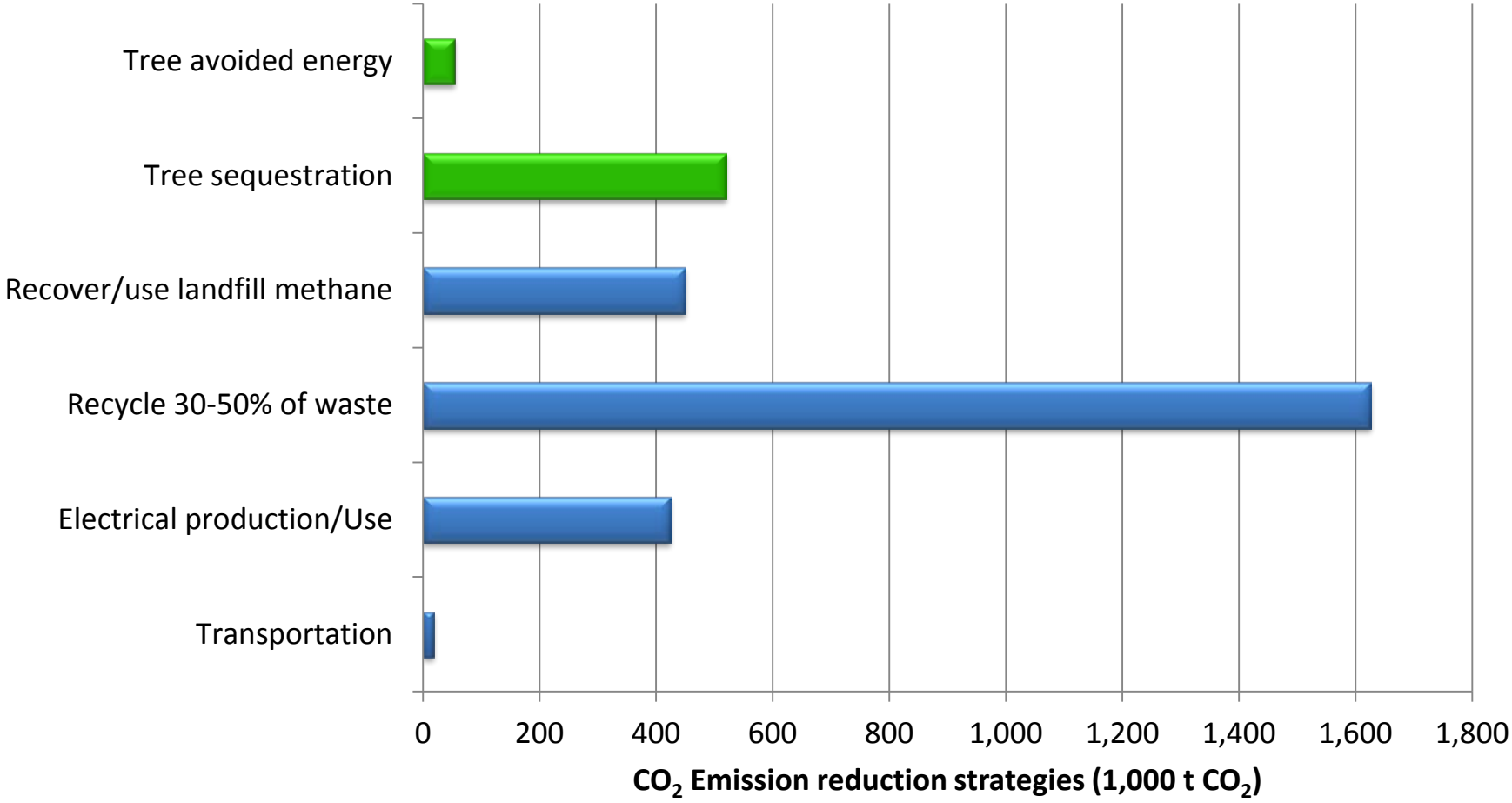
Urban Forestry CO2 offsets

		Gainesville Total CO_2 emissions: 2,097,627 tons		Miami-Dade Total CO_2 emissions: 31,967,000 tons	
Strategies to reduce CO_2 emissions		Emission reduction (tons/ha/yr)	Relative reduction	Emission reduction (tons/ha/yr)	Relative reduction
Urban forests effects	**Tree CO_2 sequestration**	4.5	**2.6%**	3.2	**1.6%**
	CO_2 avoided due to shade and windbreaks	0.65	**0.38%**	0.166	**0.084%**
	CO_2 avoided due to transpiration cooling	0.70	**0.41%**	0.173	**0.087%**

How much CO_2 are trees offsetting (ECO tool)?

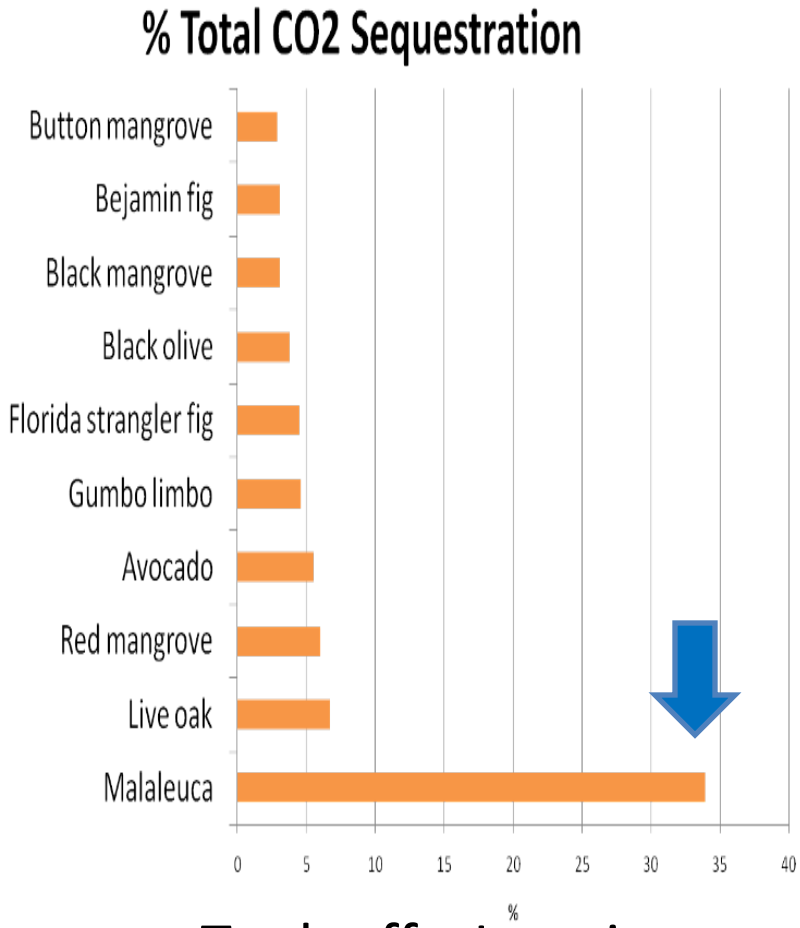
Escobedo et al., 2010. The efficacy of offsetting carbon by subtropical urban forests. Environmental Science and Policy

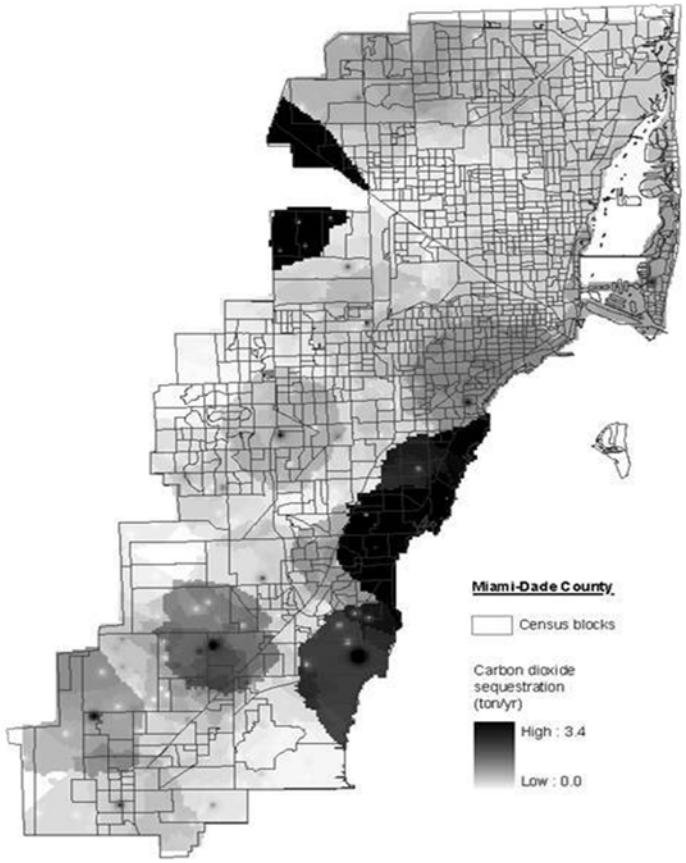
Compare Existing Policies in Miami-Dade



Trees are comparable to other CO_2 reduction strategies

Escobedo et al 2010. Analyzing the efficacy of subtropical urban forests in offsetting carbon emission from cities, Env. Sci & Policy, In Press





Tradeoffs: Invasive trees or ecosystem services?

What objective do you want in the short and long-term

(Escobedo et al., 2010)

Tradeoffs: C Life Cycle of Urban Trees is Unknown

http://www.fs.fed.us/ccrc/topics/urban-forests/

What “trees” are using less water & sequestering more CO_2?

Highly maintained (Planted)

Less maintained (Natural)

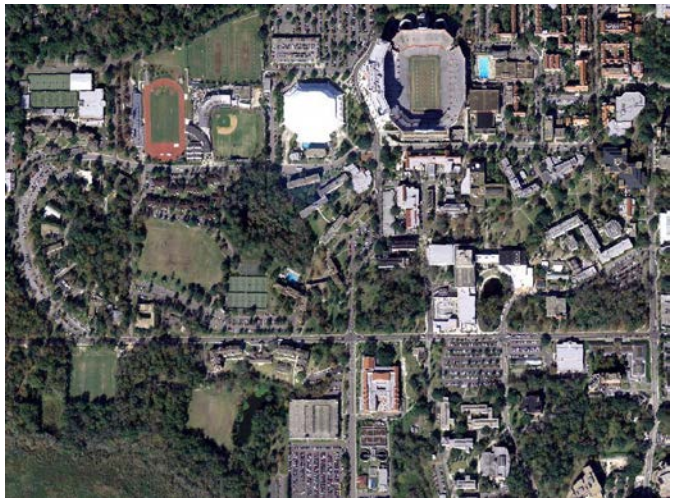
Not all trees are the same

Ecosystem Disservices (Costs)

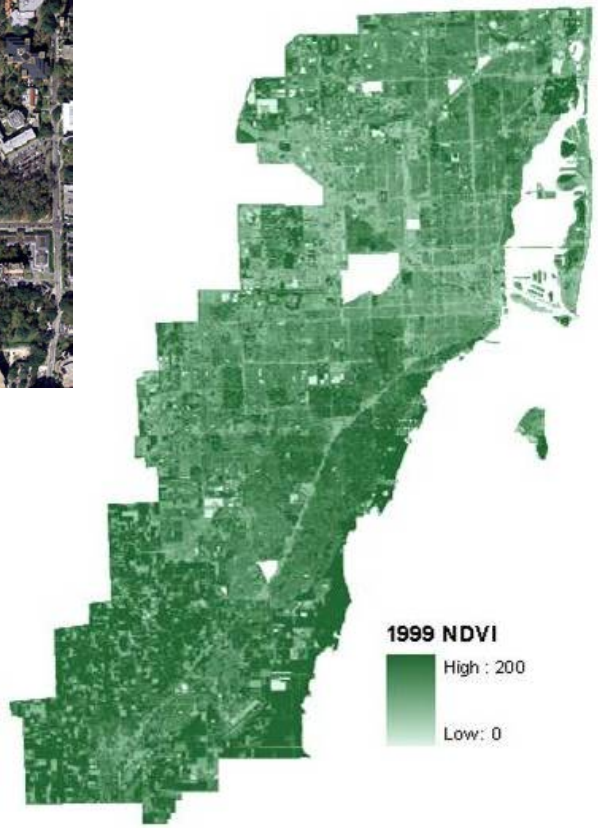
- **Economic costs:** Maintenance, debris/fuel, foregone property value
- **Social nuisances:** Obstructed views, fire hazards, pests, crime
- **Environmental costs:** Pollution from maintenance, water use, invasives, “natural disasters”

3 Methods for Monitoring UTC

Aerial photo



Satellite imagery



Field

Plot 30

Urban Tree Canopy Assessments

- “Tree canopy” varies temporally and spatially!
- Humans better at pattern recognition than computers, especially when viewed or illuminated in various ways.
- Field observations identify attributes that are not spectrally-specific (vertical structure, shading, colors, etc).
  - Validity of RS image; If it agrees with field observations!

Comparison of UTC methods

Photo interpretation (n200) vs Field measurements (n93) (GNV 2007)

Cover type	Photo interpretation points	Field plot estimates
Tree, shrub	59.0	67.0
Building	10.0	9.0

(UFORE)

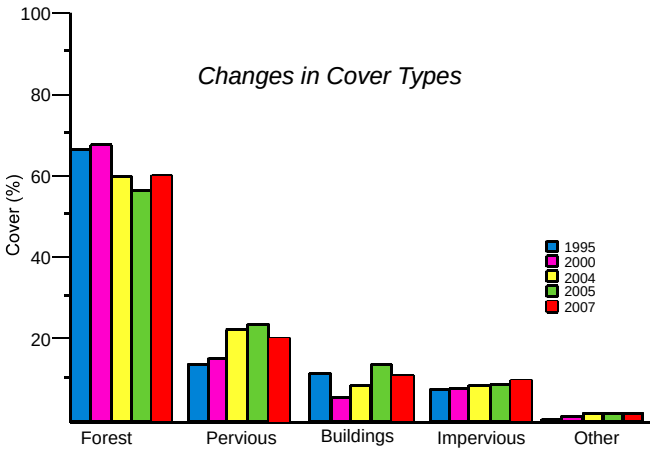
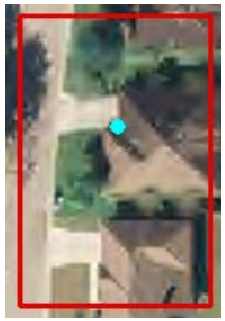


Photo interp. n=1400[c] (MD)



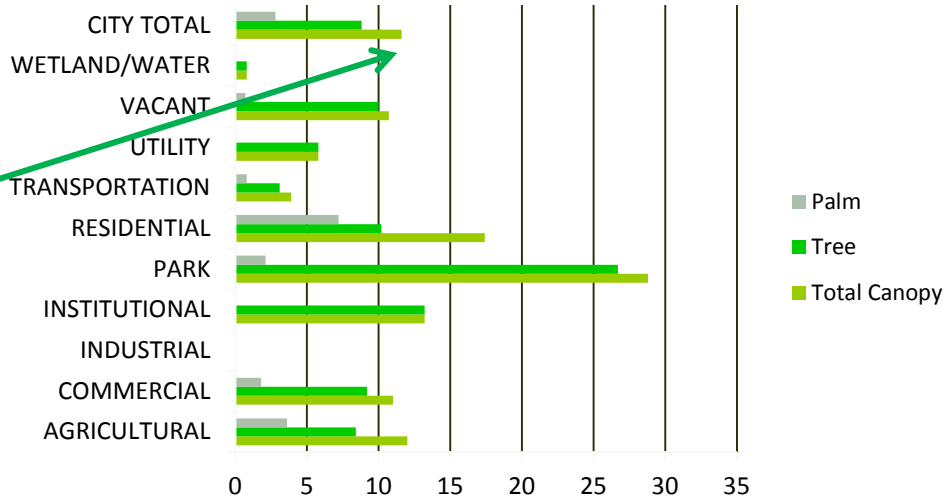
Miami-Dade			
1984		2004	
(%)	SE[a]	(%)	SE[a]
28.5	1.2	16.2	1.0

Digitized plot cover (n-230 MD)

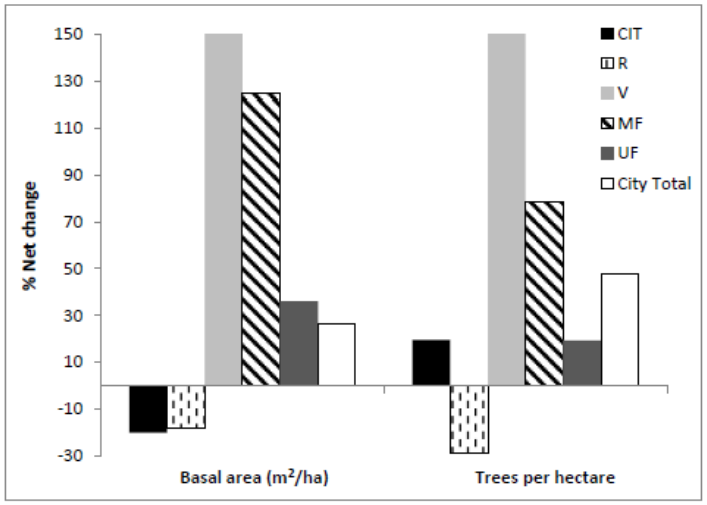
Cover type	Field plots 2007-2008	Ocular estimates 2007[b]	Ocular estimates 2004[b]
Urban forest[c]	15.4%	16.0%	24.0%

[a] Sub-meter resolution
[b] 1-meter resoution
[c] Urban forest is the sum of tree, shrub, and palm cover

UFORE covers- Miami-Dade 2007

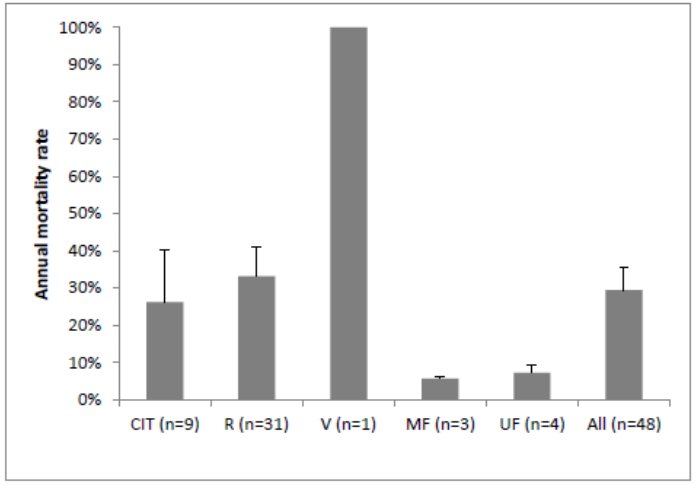


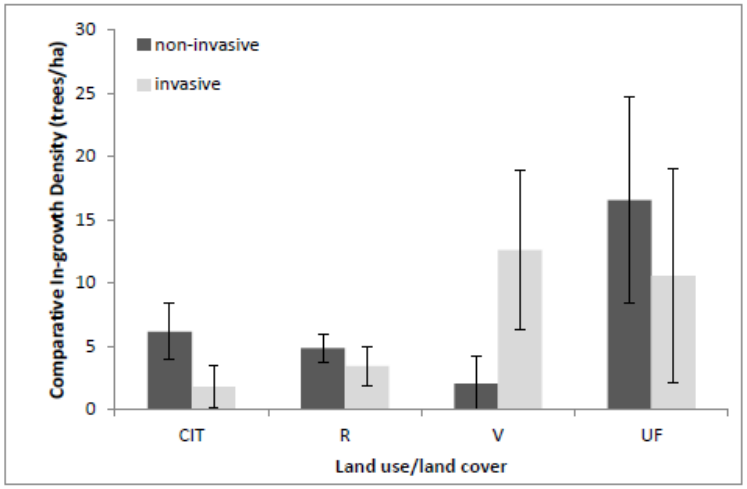
Changes in San Juan Puerto Rico's Urban Forest Structure



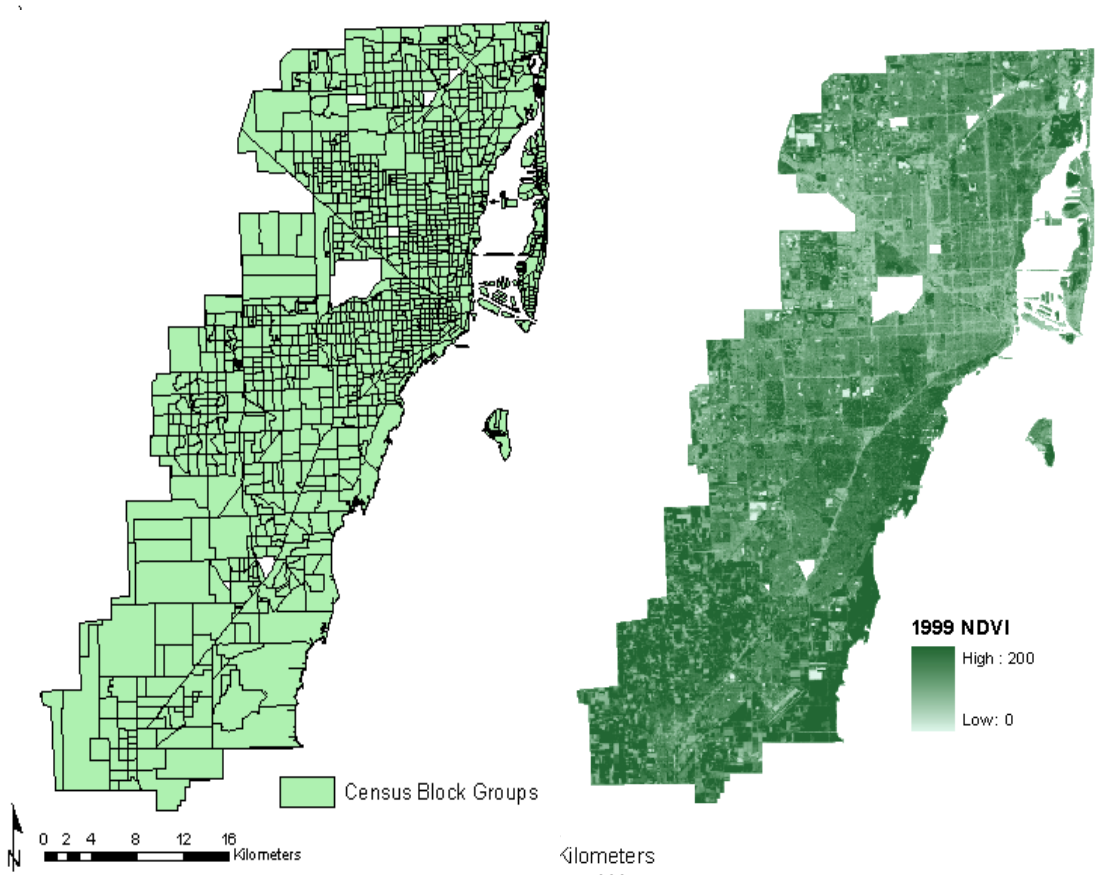
- 94 UFORE Plots
- 2001-2010; No "noticeable" tree cover change

2001	#/ha	2010	#/ha
Avicennia germinans *	25.66	*Rhizophora mangle* *	63.77
Spathodea campanulata ^	25.57	*Spathodea campanulata* ^	38.28
Rhizophora mangle *	18.37	*Laguncularia racemosa* *	29.78
Laguncularia racemosa *	16.99	*Avicennia germinans* *	19.48
Syzygium jambos ^	13.39	*Miconia prasina* (Sw.) DC.	12.87





Tucker et al. In Review. Tree growth and mortality in a subtropical urban forest in San Juan, Puerto Rico, 2001-2010



1999 LANDSAT and 2000 US Census spatial data

People that are:

- Non-white,
- Low income,
- Greater than 45 Years old
- Renters

Have less tree cover

- *Among whites, AA, Hispanics: Tree diversity, leaf area not different, but LAI different*
- *AA: more street trees*
- *Hispanic: trees in better condition*

Flock et al 2011, Environmental Justice Implications of Urban Tree Cover in Miami-Dade County, Florida. ENVIRONMENTAL JUSTICE, 4(2)

UTC varies across Miami-Dade County's different neighborhoods?

Socioeconomic Models- *Simplification of reality*

- Trees living beings, humans place values on trees, difficult to assign $ benefit/costs
  - Depends on who you ask
- Models (*i.e.* tools/software, equations) provide one way to easily assign “benefits and services” of trees
  - Depends on the method you use
- Available tools (models) can be used to help “value” urban forest benefits and lessen costs
  - **Not all benefits and models are the same to all people!**

Ecosystem Services Definitions

- "Capacity of an **ecosystem** to ….satisfy **human needs** directly and indirectly.." (De Groot et al., 1992)
- "…the benefits **people** obtain from **ecosystems**" (MEA, 2003)
- "Flows from an **ecosystem** that are of relatively immediate benefit to **humans** and occur naturally….those that exist without humans *(Brown et al. 2007)*

Ecological processes from natural and semi-natural ecosystems that are of relative worth to humans (Urban forest definition)

The Nature Conservancy: Key Findings From Recent National Opinion Research on "Ecosystem Services"

- *March 2010, 802 telephone interviews with registered voters nationwide.*
  - *Sampling error of +/- 3.5%;*
- *Democratic polling firm of Fairbank, Maslin, Maullin, Metz & Associates (FM3) and the Republican polling firm of Public Opinion Strategies (POS)*

http://www.conservationgateway.org/Files/Pages/key-findings-recent-natio.aspx

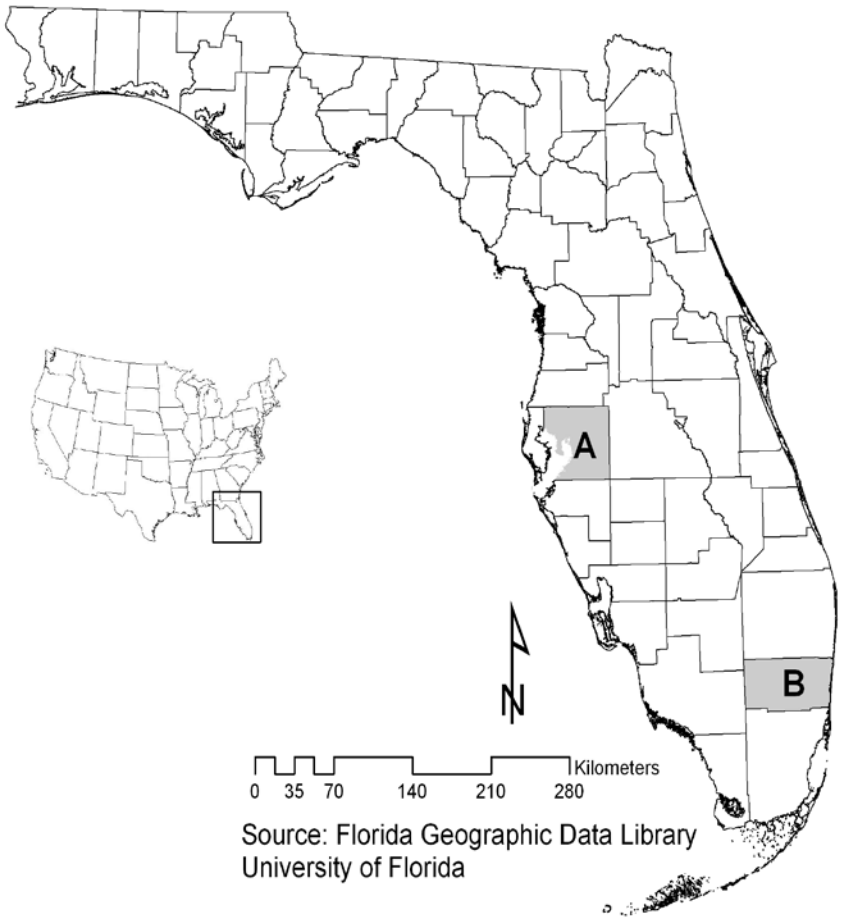
Calculating Nature's Benefits

- *"…majority of voters embrace calculating the benefits nature provides ..and ..acknowledging it as part of decisions about how .. resources are ..used"*
- *Voters are even more supportive of measuring the value of nature <u>in terms other than dollars</u>*
  - *additional clean air or water, number of people who benefit from nature, number of jobs created*

Voters value a wide variety of specific benefits that nature provides

- Particularly high priority on benefits for public health and safety
- Rated “very important” by at least four in five voters nationwide
  - water quality, air quality, production of crops for food, production of medicines, and protection against floods and hurricanes

What do community leaders think of the benefits and costs of urban forests?



- 1,219 mail surveys to HOA leaders
- 22% response in Broward (A); 27% Response Hillsborough (B)
- 5-point Likert scale to assess level of importance to benefits and costs
- ANOVA in each county compared responses of favoring "increasing urban forests"
- A binomial logit regression model assessed probability of respondent favoring increase in urban forests:

$$P(y = 1|x) = \frac{e^{(\beta 0 + \beta_1 x_1 + \beta_2 x_2 \ldots)}}{1 + e^{(\beta 0 + \beta_1 x_1 + \beta_2 x_2 \ldots)}}$$

Wyman, M., F., Escobedo, T. Stein, M. Orfanedes, R. Northrop 2012. Community leader perceptions towards coastal urban forests and hurricanes in Florida. Southern Journal of Applied Forestry, 36:152-158.

What do community leaders think of the benefits and costs of urban forests?

Broward County	Hillsborough County	National Survey[1]
Benefits of Urban Trees		
1. Shade	1. Shade	1. Provide shading and cooling of buildings
2. Aesthetics/beauty	2. Aesthetics/beauty	2. People feel calmer
3. Increased property values	3. Increased property values	3. Reduce smog and dust
4. Create a unique community character	4. Create a unique community character	4. Reduce noise
Costs of Urban Trees		
1. Hurricane damage from trees	1. Hurricane damage from trees	1. Allergies
2. Tree damage to sidewalks, roads, driveways, and foundations	2. Falling branches and trees on power lines	2. Block signage
3. Falling branches and trees on power lines	3. Tree damage to sidewalks, roads, driveways, and foundations	3. Cause cracks in the sidewalk
4. Falling branches and trees on property and cars	4. Block signage	4. Damage to power lines

From: [1]Lohr, V.I., C.H. Pearson-Mims, J. Tarnal, and D.A. Dillman. 2004.

Wyman, M., F., Escobedo, T. Stein, M. Orfanedes, R. Northrop 2012. Community leader perceptions towards coastal urban forests and hurricanes in Florida. Southern Journal of Applied Forestry, 36:152-158.

Who favors urban forests in Broward and Hillsborough County, Florida?

	Broward County				**Hillsborough County**			
Coefficient	Estimate	Std. Error	z value	p value	Estimate	Std. Error	z value	p value
(Intercept)	1.098	0.2885	3.806	0.0001	0.0765	6.0903	0.013	0.99
Tree Cover	0.2961	0.3064	0.878	0.3799	-0.1628	0.1775	-0.917	0.359
Ownership	0.0191	0.2623	0.073	0.942	1.29	73.3079	0.018	0.986
Gender	-0.1761	0.3019	-0.583	0.5598	-0.1219	0.1885	-0.647	0.5179
Age*¥	-0.5606	0.32	-1.752	**0.0798**	0.4275	0.2094	2.042	**0.0411**
Yrs in Florida	0.4467	0.3098	1.442	0.1494	-0.1509	0.1905	-0.249	0.8034
Education*	0.5665	0.325	1.743	**0.0813**	0.0474	0.1905	0.249	0.8034
Income	-0.3862	0.3514	-1.099	0.2718	-0.1416	0.201	-0.704	0.4812

Broward: * $p \leq 0.1$, *pseudo* $R^2 = 0.145$
Hillsborough: ¥ $p \leq 0.05$, *pseudo* $R^2 = 0.077$

Some Results

- 54% from Hillsborough and 64% from Broward favor increase in urban forests
- Hurricane damage from urban forests leading concern in Broward (significantly higher) and Hillsborough
- No significant difference in the benefit rankings between respondents who favor / don't favor increases in urban forests
- *Tree canopy cover - no significant influence on urban forest favorability in either Broward or Hillsborough*

Most studies use tree/veg cover in temperate areas and real estate prices

- Subtropics have different growth rates, hurricanes, demographics, real estate markets, etc

- Used city/site-specific measured forest <u>structure</u> and adjusted <u>property value</u> data in an OLS hedonic *explanatory* model:
  - Assessed property value [y] adjusted for community-specific median property prices

How do Floridians *economically* value different urban forest structure attributes?

7 attributes selected based on the literature and previous experiences

Variable (units)	Definition (n)	Mean
Difference from median price (2008/ 2009 USD)	Assessed value difference from local median home sales in cities of: Miami-Dade, Gainesville, Pensacola, and Orlando (193)	-38791.2
Residential area (ft2)	Area of residential structure on parcel (193)	2182.90
Number of bathrooms (#)	Number of bathrooms in residential structure on parcel (193)	2.14
Percent maintained grass (% Grass in 0.04 ha plot)	Percent of plot that is maintained grass/turf (193)	35.81
Number of trees (No. Trees)	Number of trees or palms with a DBH> 2.5 cm in 0.04 ha plot (193)	5.61
Percent shrub (% Shrub 0.04 ha plot)	Percent of plot that is woody plants > 30 cm in height and < 2.5 cm in DBH (192)	7.94
Tree Leaf Area Index (LAI)	Total sum of 1-sided leaf area of an individual tree crown/ surface ground area (193)	1.9
City (Dummy variable #)	Dummy 2= Miami-Dade, Dummy 3= Orlando	

Urban forest structure effects on property value (preliminary)

Significant:

- % grass,

#Trees, LAI

Effects on Value:

- # Trees= +
- Tree LAI= +
- Shrubs=+/-
- *Grass= -*

Variable	Parameter Estimate	Standard Error	t Value	Pr >|t|
Intercept	-161892	21624	-7.49	<.0001
Square Feet	31.8052	2.41052	13.19	<.0001
No. Bathrooms	39194	7320.968	5.35	<.0001
% Grass	**-538.938**	226.7679	-2.38	0.0185
No. Trees	**2286.67**	1006.824	2.27	0.0243
% Shrub	**-482.795**	556.1479	-0.87	0.3865
Tree LAI	**8567.16**	4394.892	1.95	0.0528
Citydum2 (Miami)	-43591	15896	-2.74	0.0067
Citydum3 (Orlando)	-71523	19269	-3.71	0.0003

Heteroskedasticity (LOESS curve analysis) and spatial autocorrelation (Moran's I = 0.043 and p=0.09) revealed no serious problems

What do “Floridians Value”?

- Value shade, aesthetics, and property price increases provided by trees
  - …*Do not value* damage (hurricane) from urban forests
- No mention by community leaders of biogeochemical or hydrological cycles
  - Depends on who you ask; HOA president, resident, manager, politician?
- 54% from Hillsborough and 64% from Broward favor increase in urban forests
  - Context!
- Tree canopy cover - no significant influence; but #s and LAI were significant

Quantifying “what you want” is complex

- Context
  - ✓Environmental
  - ✓Social/economic
- Scale
  - ✓Tree vs Ecosystem
- Ecosystem functions can yield multiple services
  - ✓Good/bad
- Costs rarely considered
  - ✓Other relevant ecosystem services overlooked

Take Home Message

Conclusions