Estimating forest carbon storage in the city

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Key players in this work

Dr. Clara Pregitzer, Deputy Director of Conservation Science, NAC (led all the science presented)

Ms. Chloe Hanna, (Special Assistant to the NYS Parks Commissioner)

Ms. Sarah Charlop-Powers, Executive Director, Co-Founder Natural Areas Conservancy

Dr. Rich Hallett, Research Ecologist, USFS

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To estimate forest carbon stocks confidently, and to guide management that increases carbon, you must first accurately characterize your forest

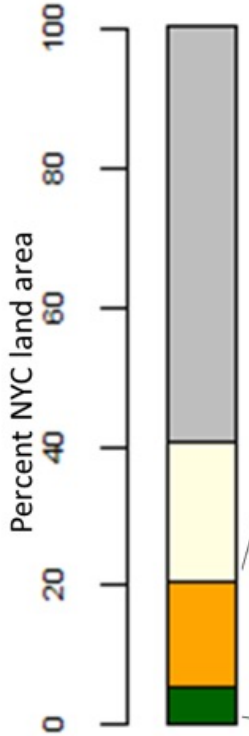
Inaccurate characterization leads to incorrect carbon estimates and opens the door to management that degrades carbon stores and the forest in general

NYC

Rendering of Manhattan 1492 looking North
Credit: Eric Sanderson

Manhattan

Urban forest (vs. canopy) is very patchily distributed



Developed
Non-forested greenspace
Tree canopy:other
Tree canopy:natural area

Tree canopy:other: Open grown trees planted or growing in close proximity to buildings, in rights of way, residential areas or in landscaped parkland.

Tree canopy:natural area: Trees growing in forest stands which often occur in areas such as remnant parkland, vacant lots, privately owned woodlands

Pregitzer et al. (2019) *Environmental Research Letters*

What constitutes urban forest? (the most influential decision you will make for shaping your understanding of this resource)

Thanks to Jen Shin for this and related graphics

How you define urban forest matters because:

- ✓ It dictates how you measure urban forest
- ✓ Those measurements shape your knowledge of the resource you are working with
- ✓ That knowledge – and the **overemphasis of the importance** of big data in decision making – shapes policy and management for the urban forest

(*Spoiler alert*: Defining the urban forest as all the green canopy in a city has threatened effective management in NYC and led to major underestimates of the number of trees in NYC, their native status, and how much C is stored: *The big data paradox*)

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Estimating carbon storage in urban forests of New York City

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The outsized importance of natural area forests for carbon (C)

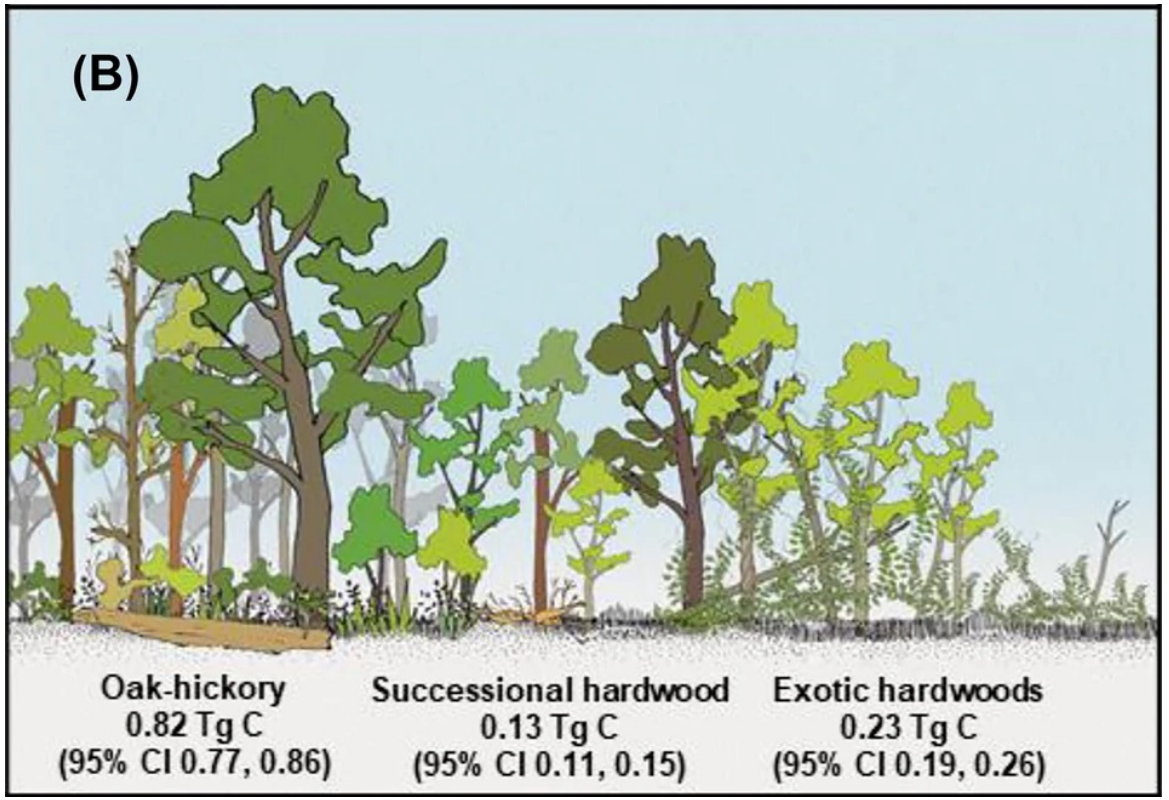
- Prior estimates of "urban forest" stocks in NYC are 1.2 Tg C (Nowak et al. 2018)
- The mean estimate from our work – for just natural area forests – is 1.5-times greater at 1.84 Tg!!!

Note: 1.84 Tg C = 1.84 million metric tonnes (Mt) C

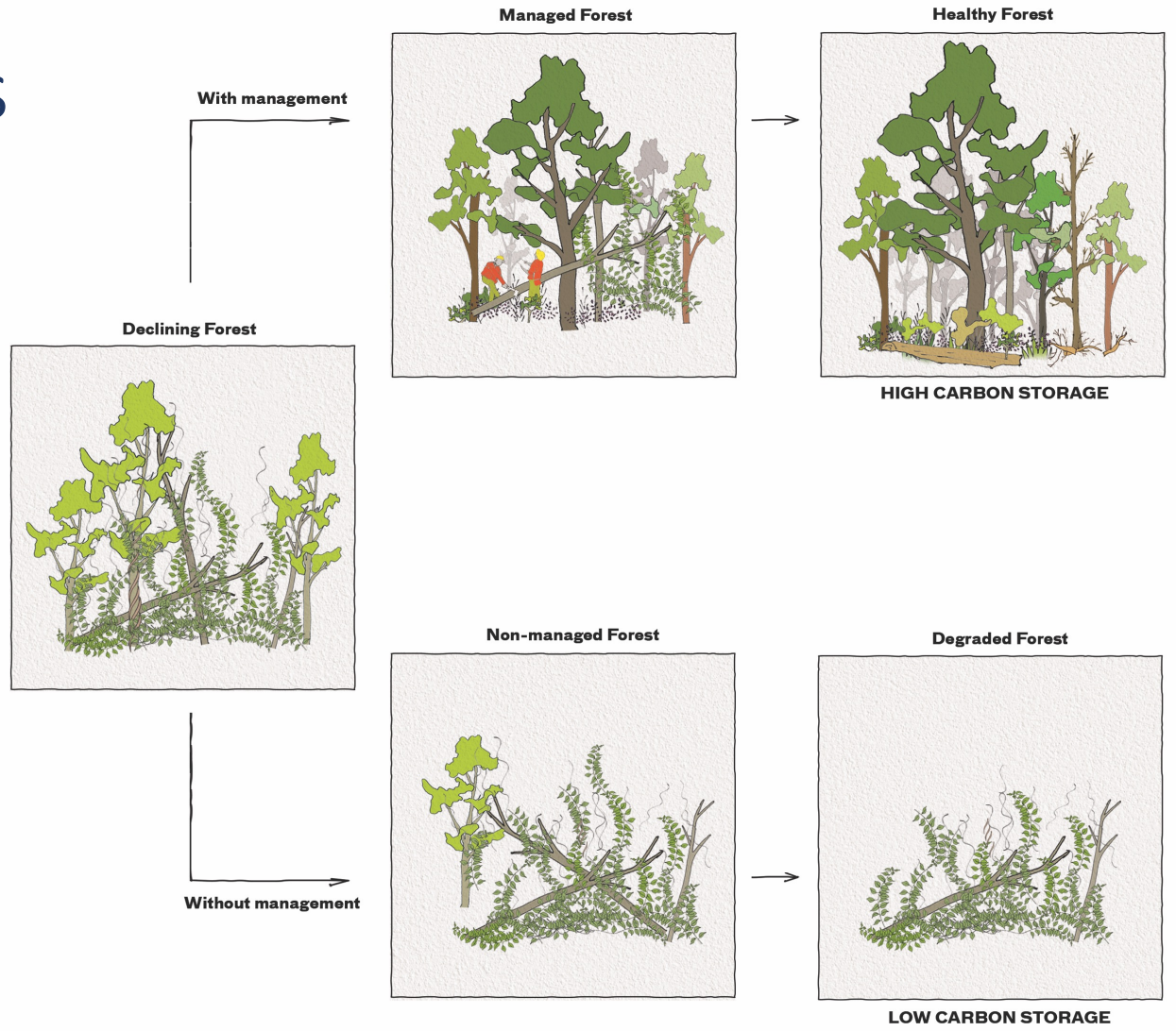
To capture just 1 tonne C (~2,204 pounds C), 183 trees must grow for a year…and you release 1 tonne driving ~9,167 miles

The outsized importance of natural area forest

- The combination of standing forest biomass and area occupied, meant that native oak-hickory forest is the predominant forest C stock in NYC
- Our estimated annual C stock change in natural area forests offsets emissions from the ~13,000 taxis in NYC >2.5-times



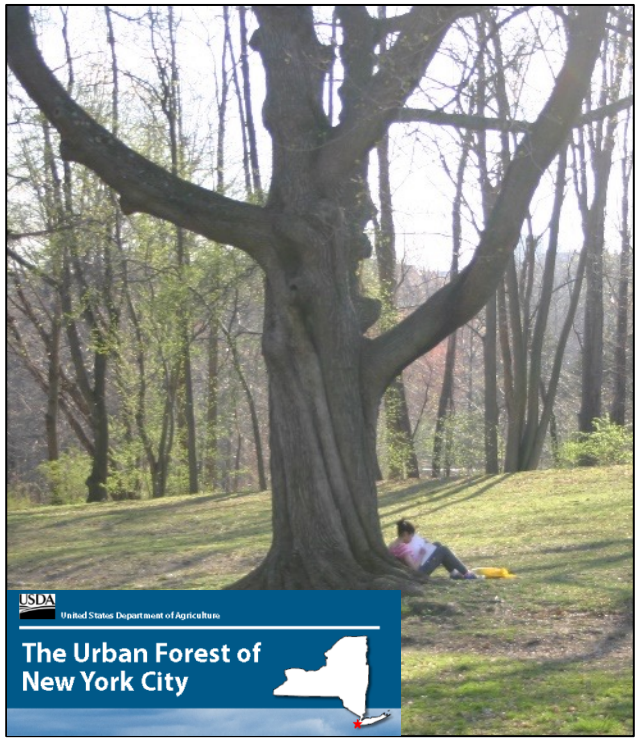
Urban natural area forests need management



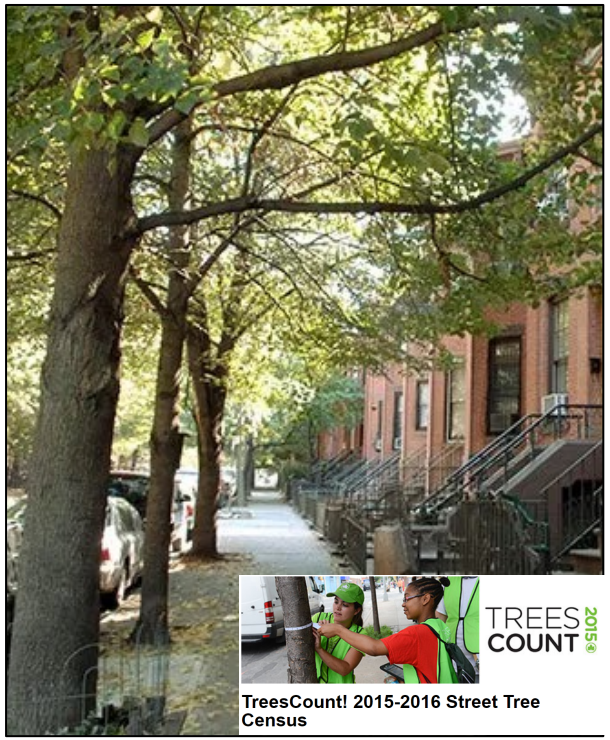
- But whether you get support to manage native-dominated urban forest depends on how you define urban forest
- The most common definition is that urban canopy = urban forest
- This definition leads to measurements which characterize urban forest as co-dominated by non-natives
- Which undermines management goals for native forest

Forest assessments define and measure the urban forest in different ways: with contrasting results

Entire urban forest assessment (i-Tree)



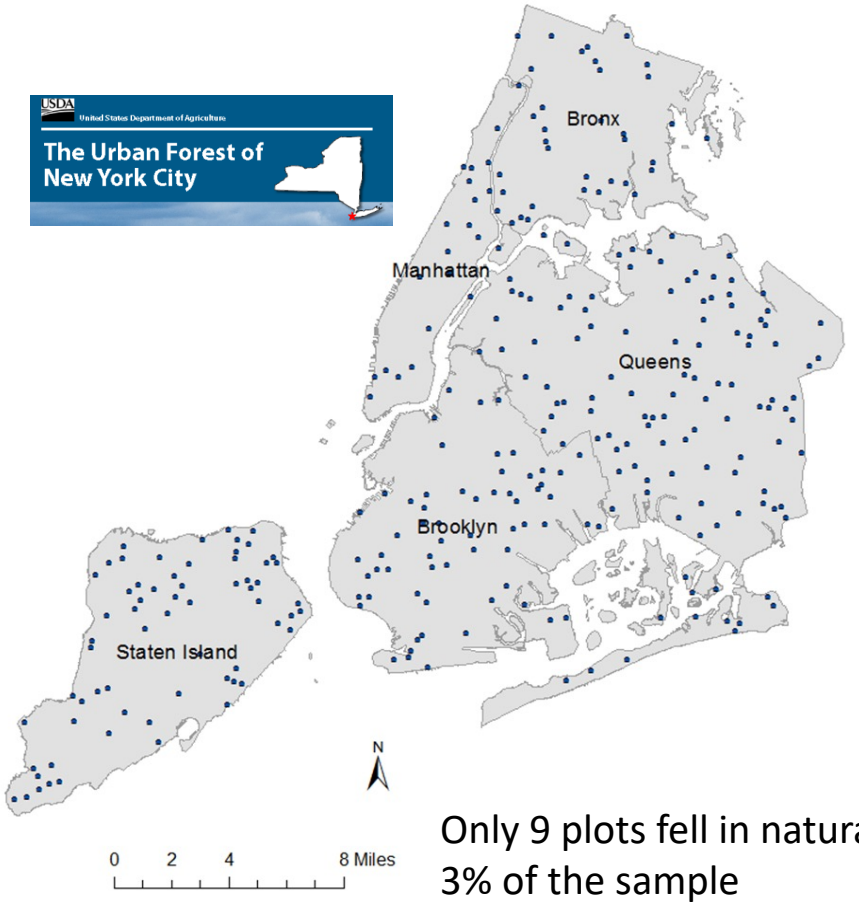
Street tree census



TreesCount! 2015-2016 Street Tree Census

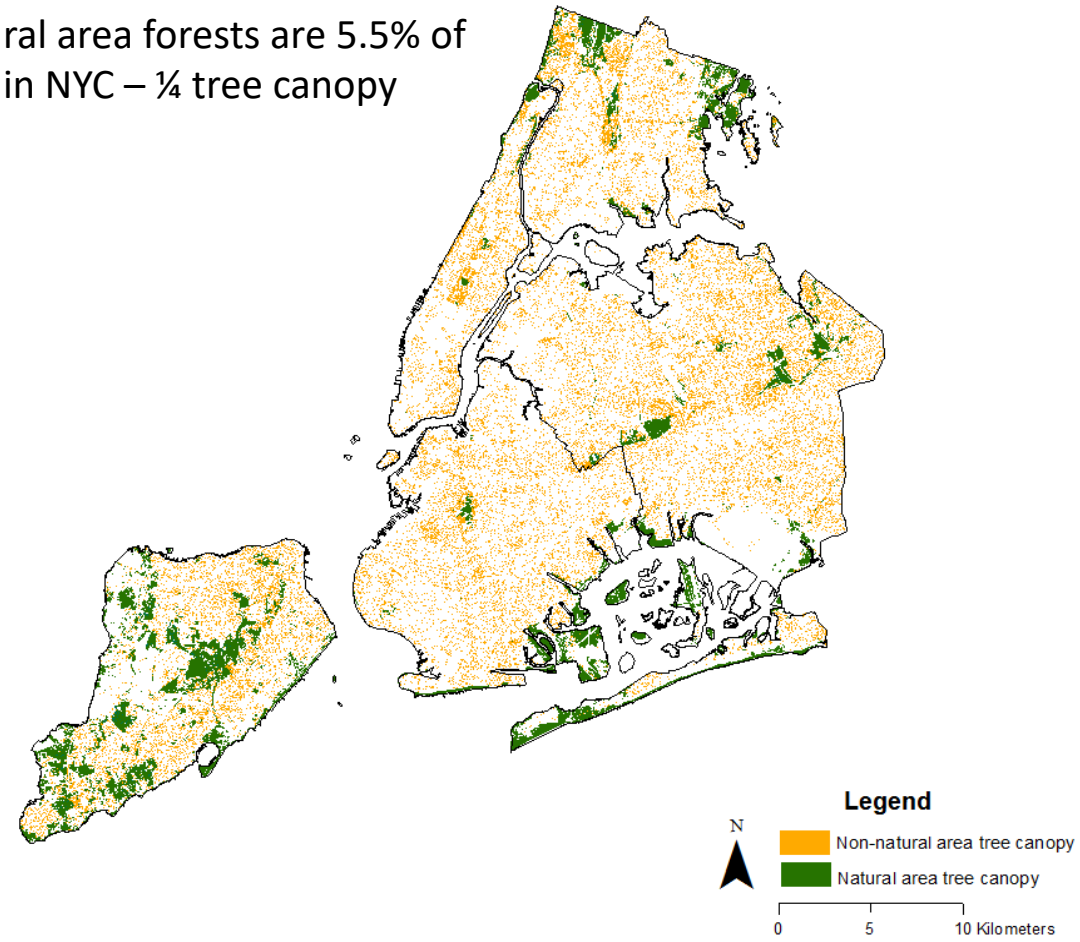
Natural areas forest assessment

Your understanding (and hence policy and management) of urban forest may be dependent on how you sample



Only 9 plots fell in natural areas, 3% of the sample

Natural area forests are 5.5% of land in NYC – ¼ tree canopy

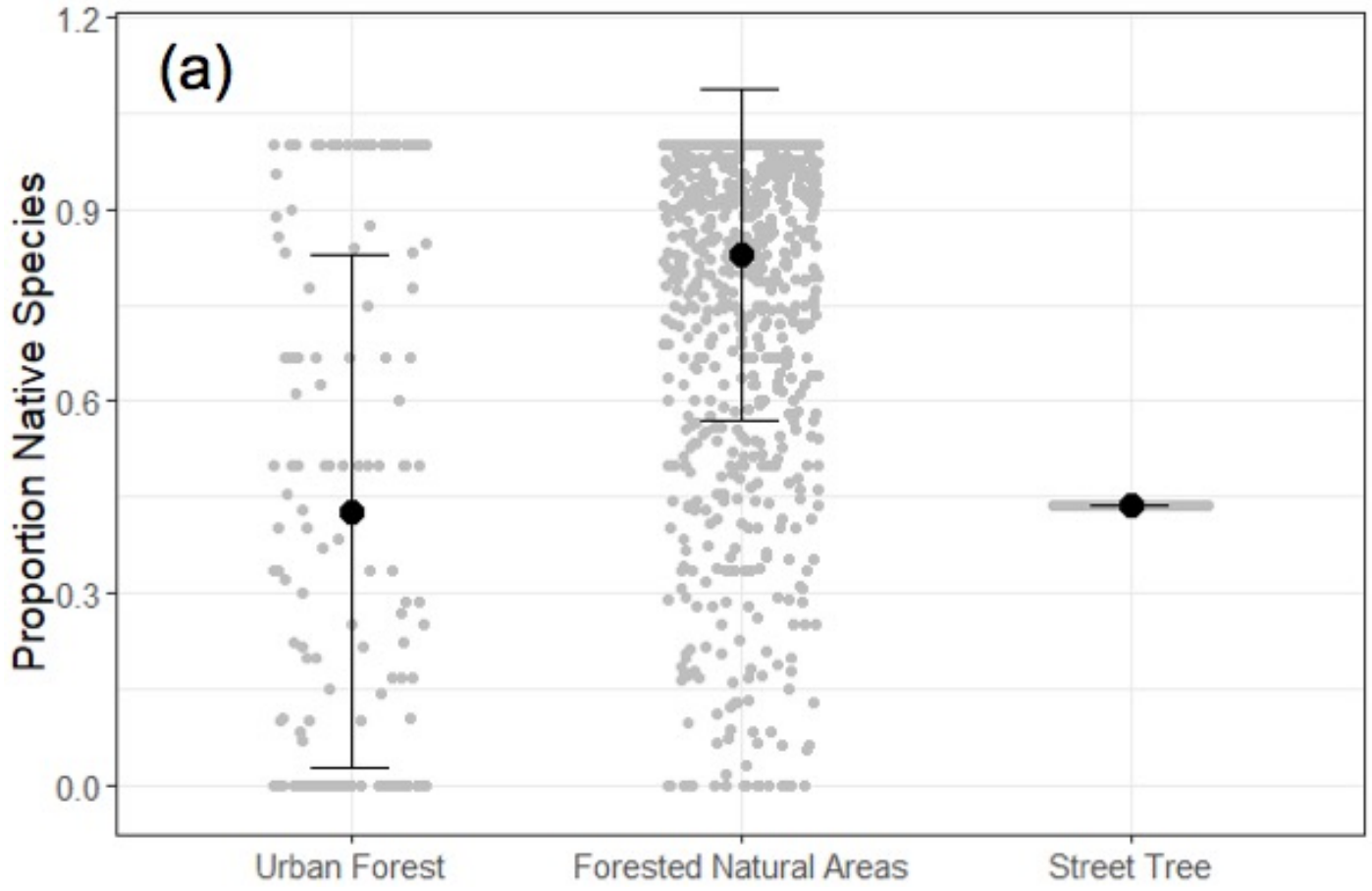


The most common tree species in urban forests are distinct from urban canopy assessments

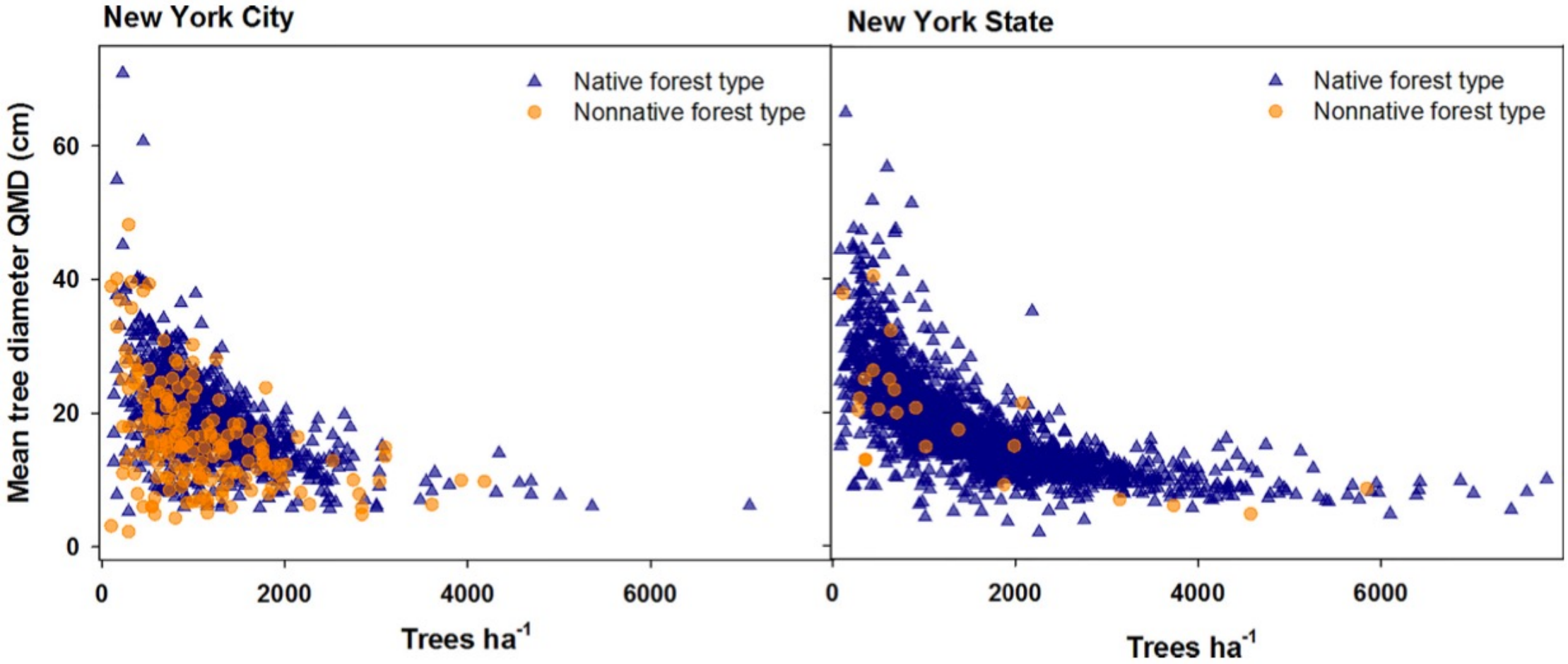
Table 1. The five most dominant tree species (by proportion of basal area) for each assessment type in New York City. Live trees were used for calculations of basal area and number of trees in each assessment. All assessments were conducted between 2013 and 2015. The citywide urban forest data were field collected across the entire urban canopy ($n = 296$, Nowak *et al* 2018a), the natural areas assessment ($n = 1124$, Pregitzer *et al* 2019) was field collected in municipally-owned forested natural areas, and the street tree census was field collected as a full census of publicly-owned street trees ($n = 652,173$ live trees measured by NYC Parks).

Species	Native status	Percent basal area in assessment	Percent number of trees in assessment
Urban forest			
Norway Maple *(Acer platanoides)*	Non-native	12.3%	5.3%
Pin oak *(Quercus palustris)*	Native	9.5%	1.3%
London planetree *(Platanus hybrida)*	Non-native	6.2%	1.2%
White oak *(Quercus alba)*	Native	5.5%	3.7%
Black oak *(Quercus velutina)*	Native	3.8%	0.7%
Forested natural areas			
Red oak *(Quercus rubra)*	Native	20.4%	4.4%
Sweetgum (*Liquidambar styraciflua)*	Native	16.5%	10.1%
Black cherry *(Prunus serotina)*	Native	6.0%	8.5%
Red maple *(Acer rubrum)*	Native	5.7%	7.0%
Tulip-tree *(Liriodendron tulipifera)*	Native	5.6%	1.9%
Street trees			
London planetree *(Platanus x acerifolia)*	Non-native	34.5%	13.3%
Pin oak *(Quercus palustris)*	Native	14.9%	8.2%
Honey locust *(Gleditsia triacanthos var.)*	Non-native	6.1%	9.9%
Norway maple *(Acer platanoides)*	Non-native	6.0%	5.2%
Silver maple *(Acer saccharinum)*	Native	4.8%	1.9%

Urban forests are native dominated and not co-dominated by non-natives



Urban forests in NYC are similar in structure to rural forests in NY State



Ecological Applications, 0(0), 2018, pp. 1–11

A city-scale assessment reveals that native forest types and overstory species dominate New York City forests

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Environmental Research Letters

LETTER

Defining and assessing urban forests to inform management and policy

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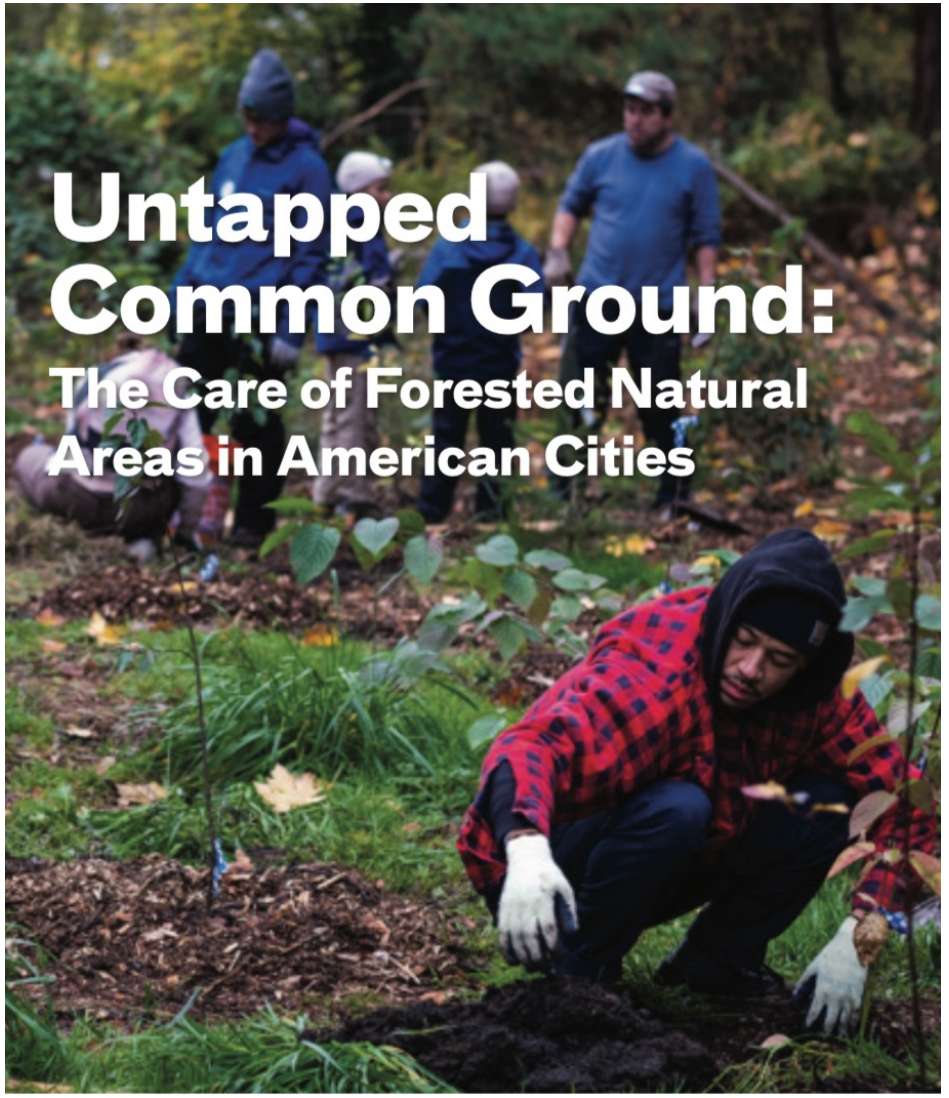
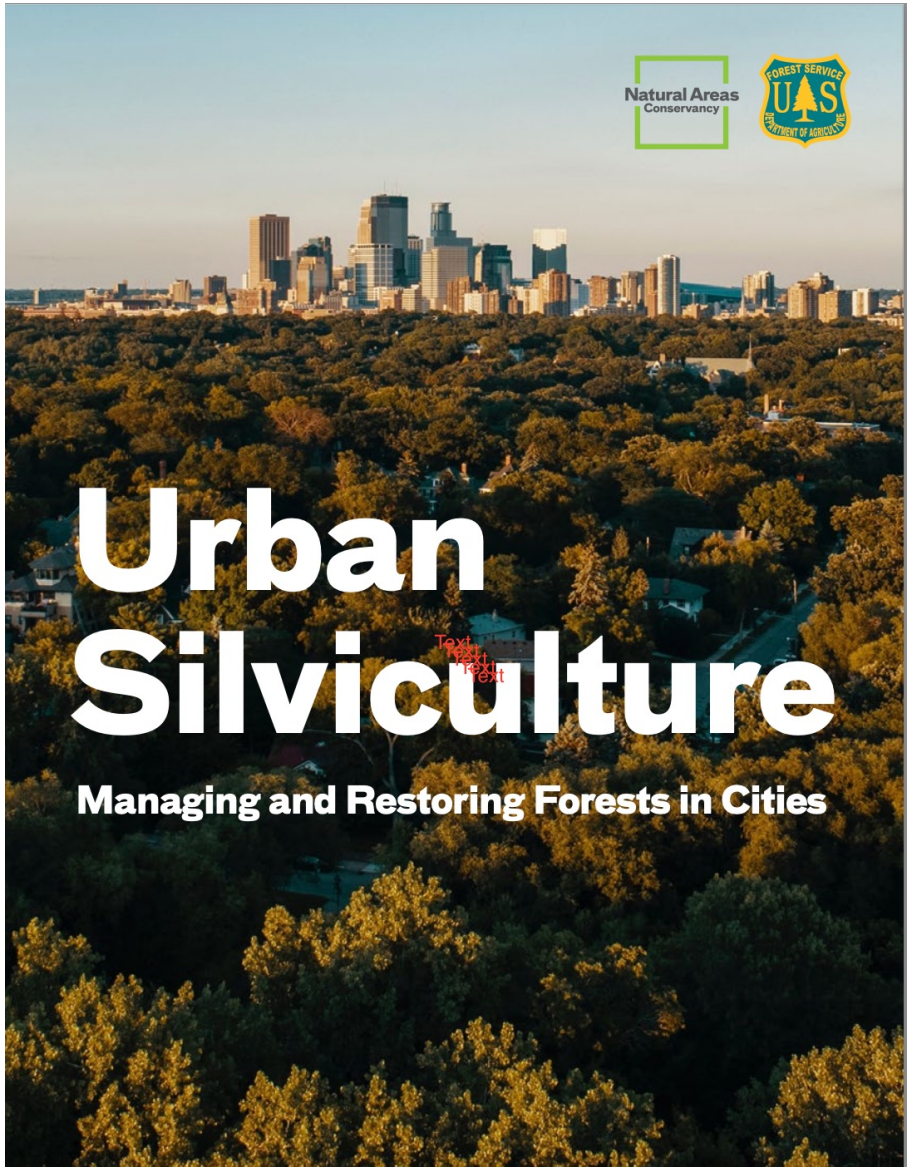
Keywords: urban forest, urban assessment, urban greenspace, urban tree canopy, i-Tree, urban forest structure, urban forest composition

You set policy and target management for the resource you "believe" you have (and your belief is based on how you measure; be aware of the *big data paradox*)





Accurate characterization of your forest resource opens the door to silvicultural (and not just arboricultural) management in urban forests

The importance of defining urban forest to recognize diverse management needs

- To estimate forest carbon stocks confidently, and to guide management that increases carbon, you must first accurately characterize your forest

- Accurate characterization leads to robust carbon estimates and opens the door to management that sustains and builds carbon stores and forest resilience