The power of GEDI: Investigate the efficacy of spaceborne Lidar to model biodiversity and characterize habitat heterogeneity at the continental and global scales

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Background

- Vegetation's three-dimensional (3-D) structure is a key predictor of biodiversity.
- Vegetation vertical structure, often difficult to observe by optical remote sensing instruments, is a critical but rarely examined component of habitat heterogeneity
- Most previous studies are limited to relatively small spatial extents or focused only on canopy height-related metrics
- The availability of GEDI data provides an opportunity to evaluate the importance of habitat vertical structure on biodiversity at broad scales.

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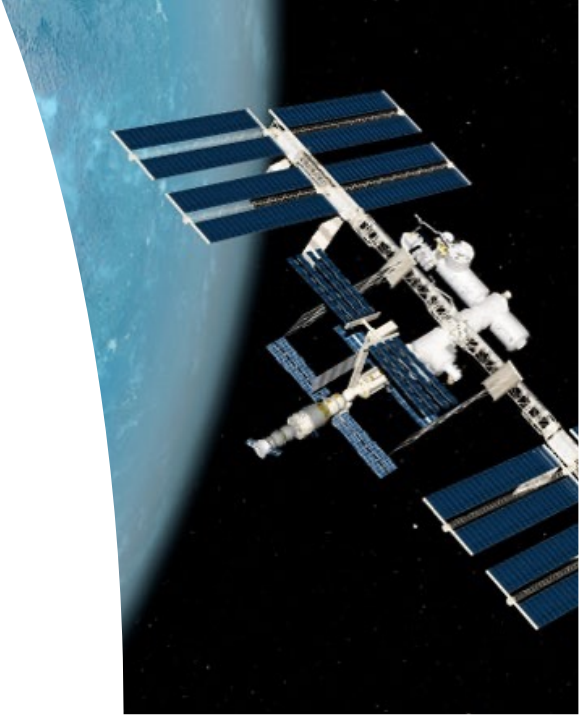
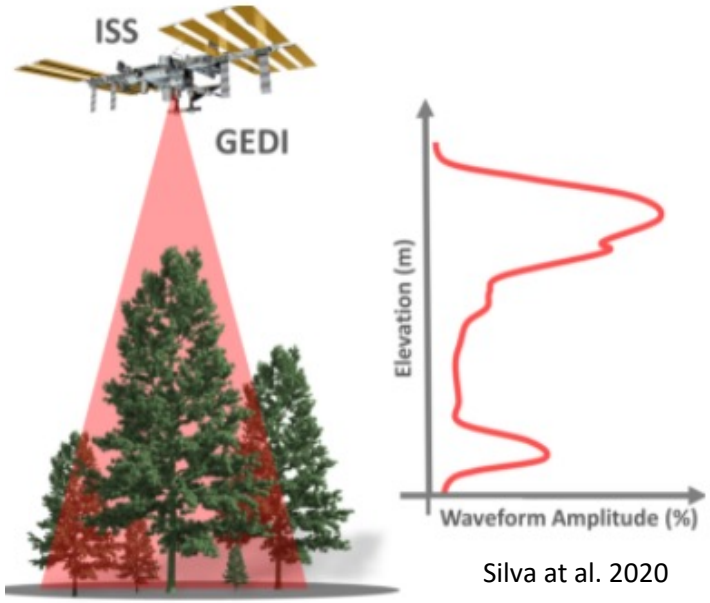




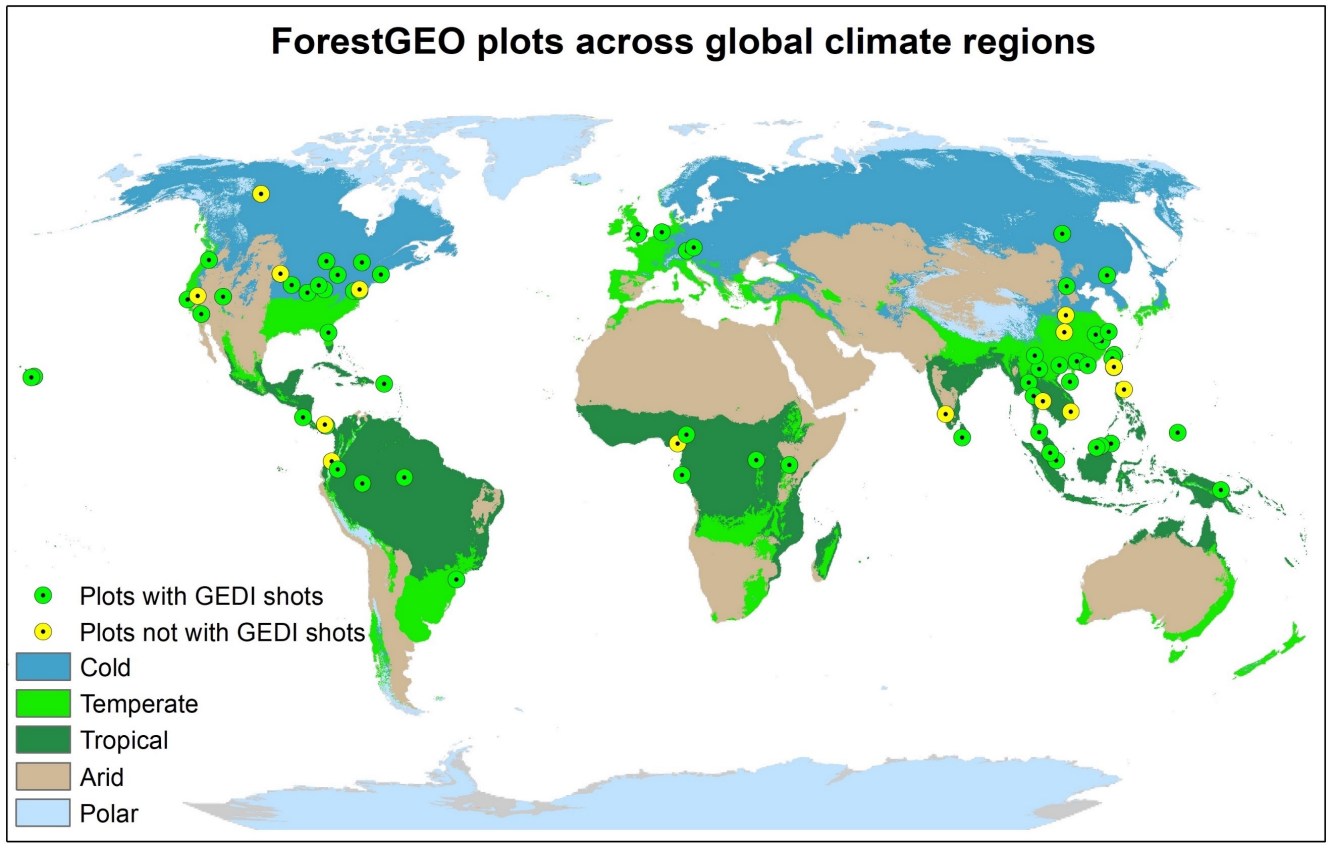
Silva at al. 2020

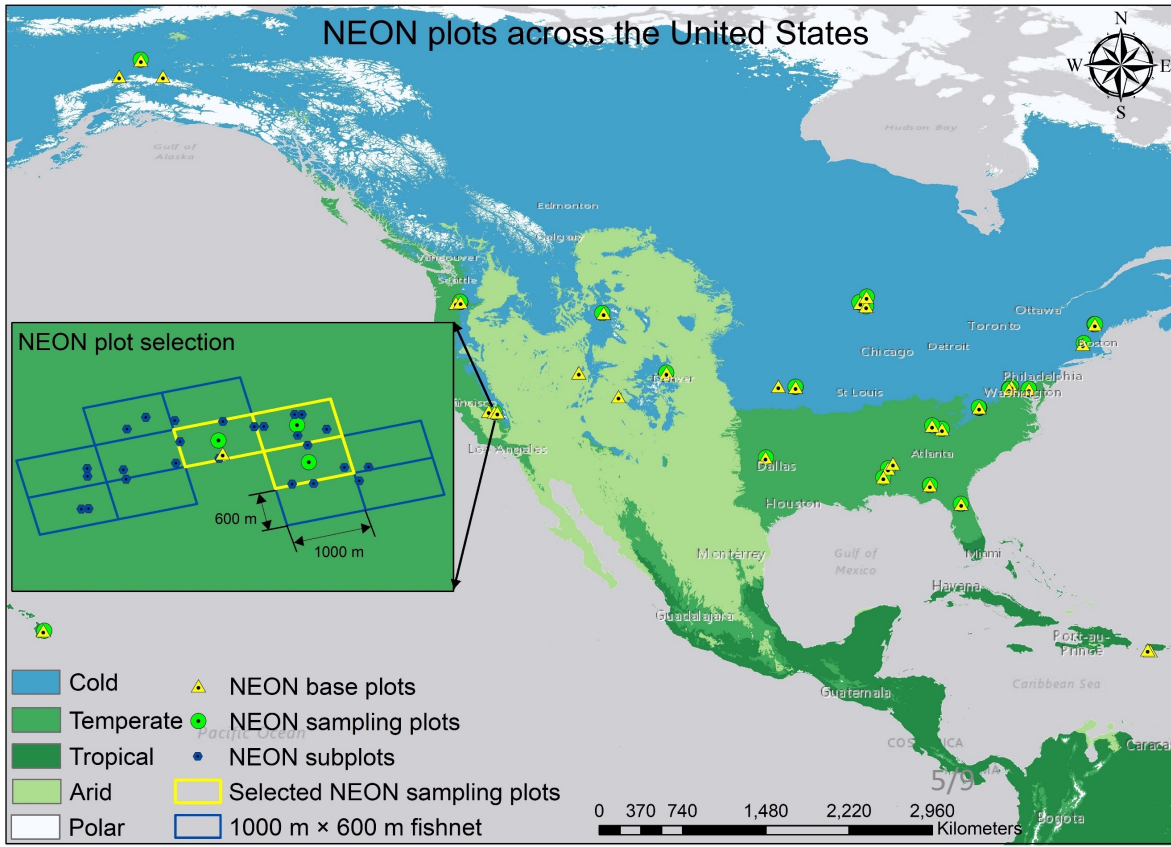
Research Questions:

- ***1. What are the efficacies of GEDI derived 3-D vegetation metrics in explaining biodiversity distribution at continental scale?***
- ***2. How does GEDI derived 3-D vegetation metrics facilitate better conservation planning and practices?***

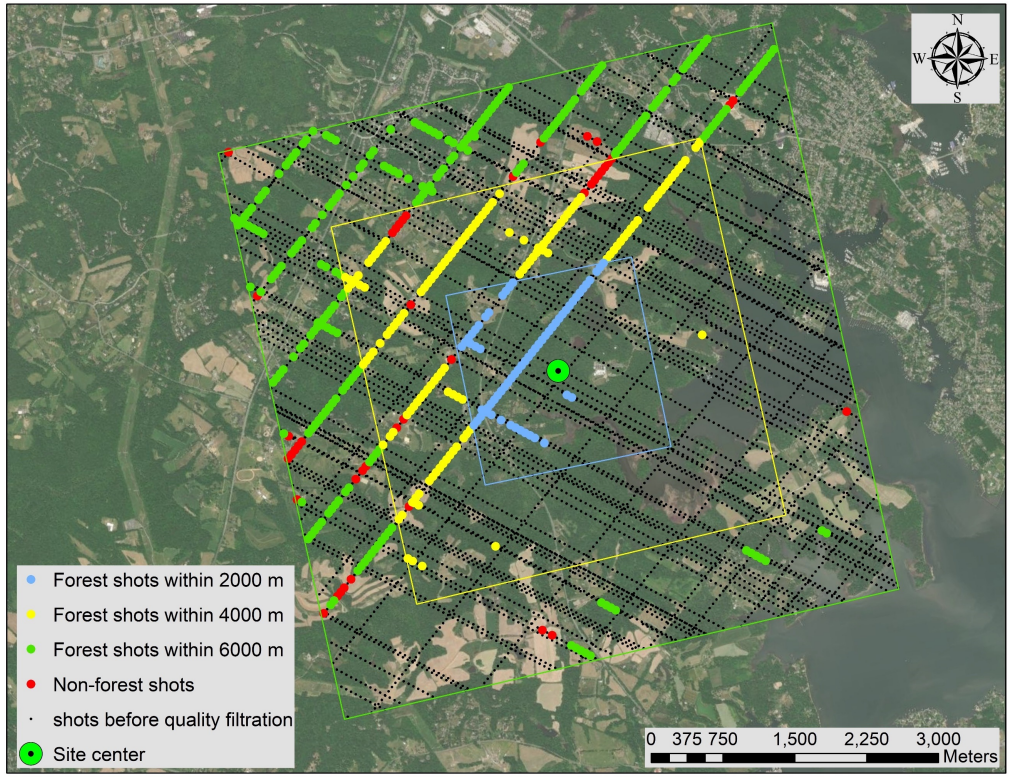
Modeling Global Forest Tree Biodiversity

- The Forest Global Earth Observatory (ForestGEO, n = 74)
- National Ecological Observatory Network (NEON, n = 51)

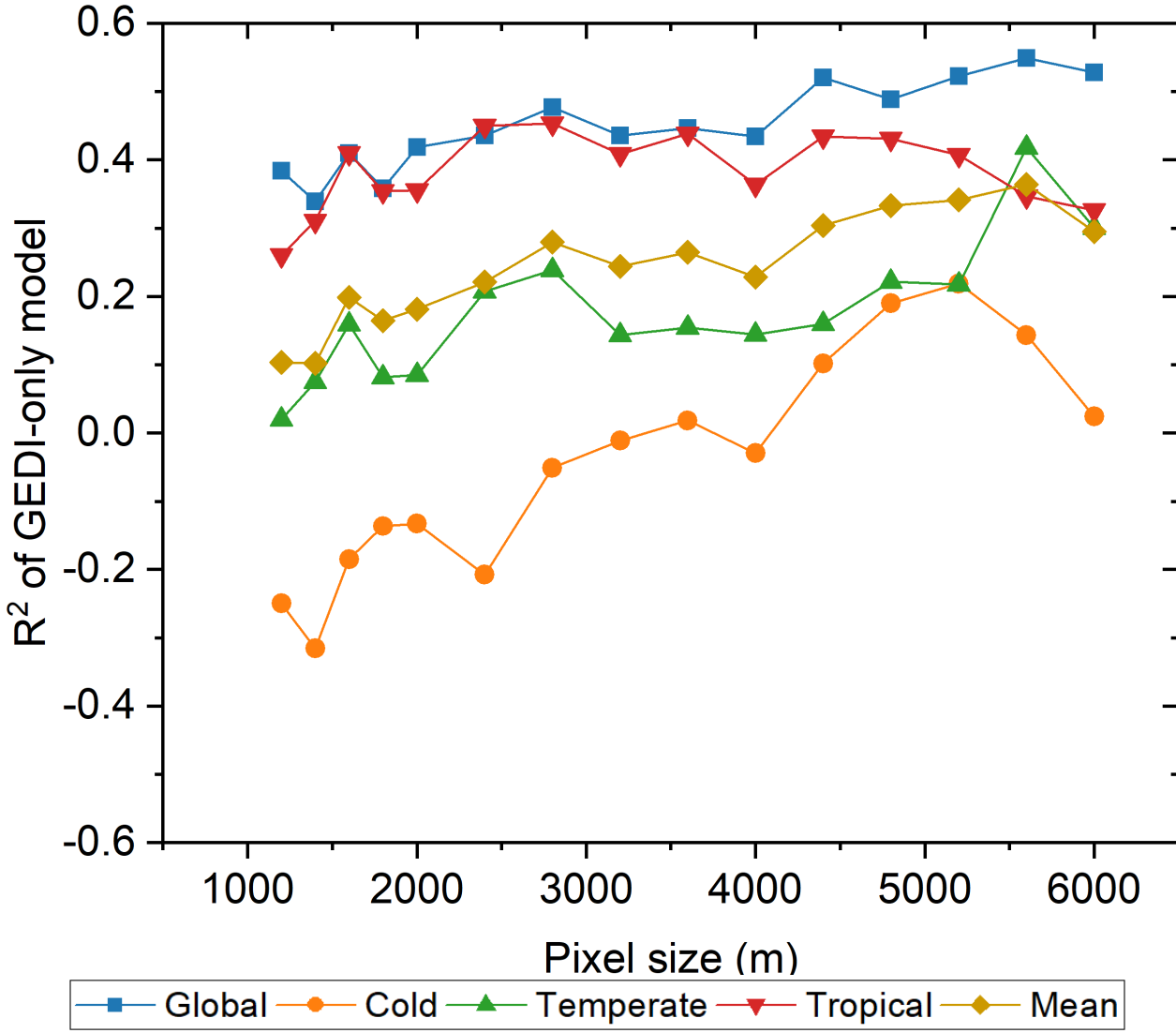




- Tested 15 buffer sizes ranging between 1200 m – 6000 m



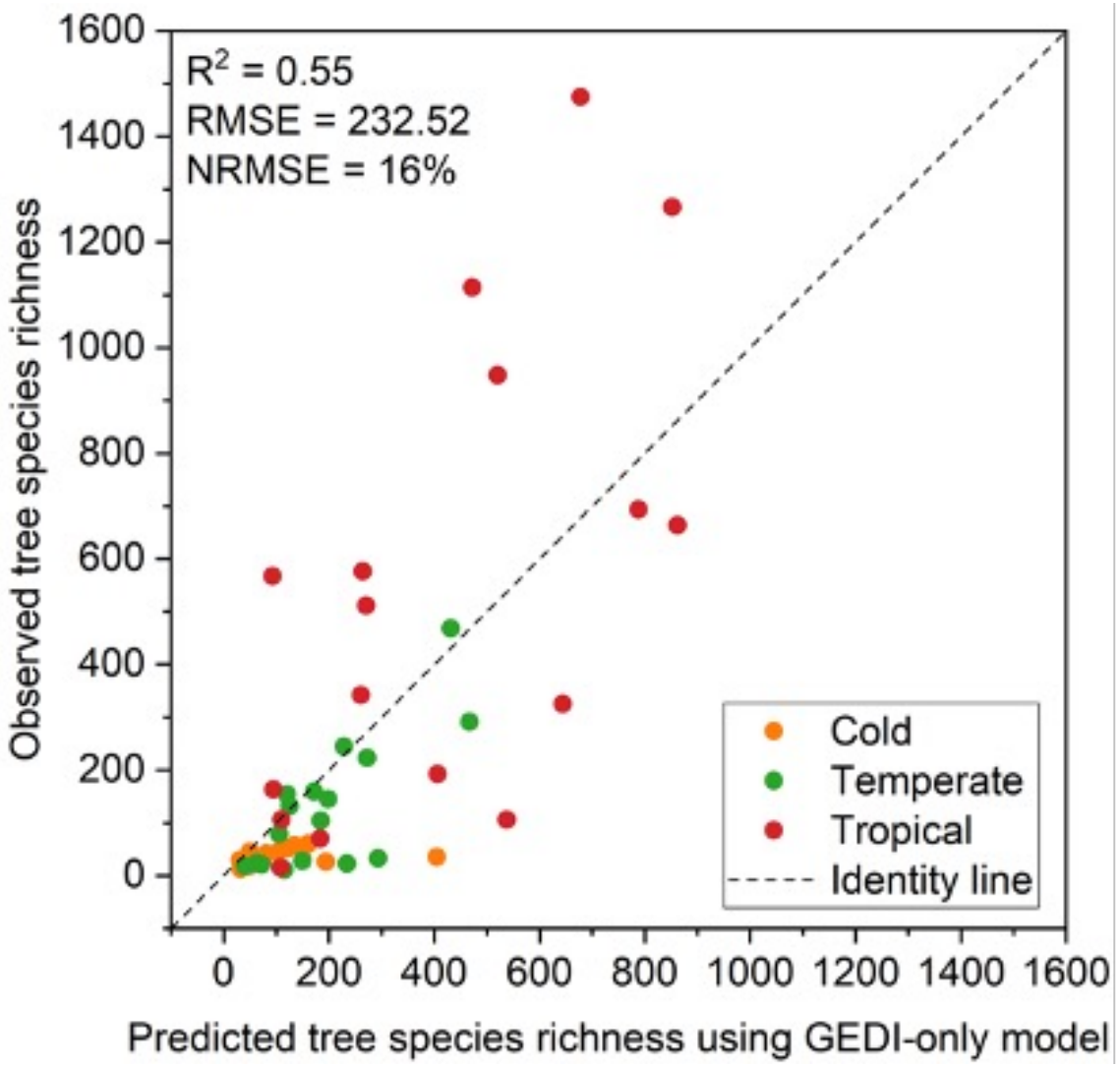
GEDI tree richness models



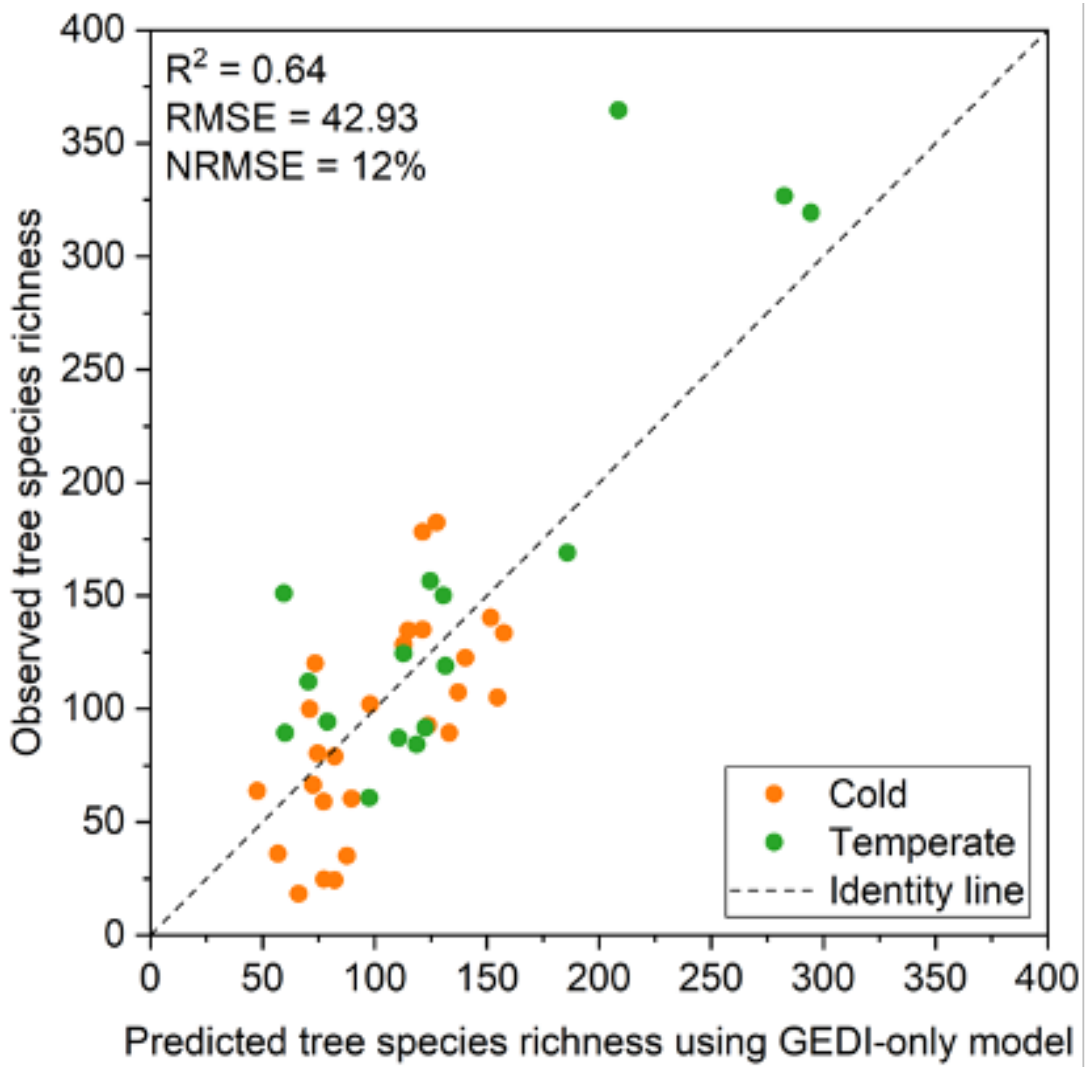
- Optimal buffer size at 5600m
- On average global models perform better than stratified models in individual climate zones
- Temperate climate models perform better than the rest of climate zones

Jin Xu, Volker C. Radeloff, Melissa Songer, Kjirsten Coleman, Qiongyu Huang **Modeling Worldwide Tree Biodiversity Using Canopy Structure Metrics from Global Ecosystem Dynamics Investigation (GEDI) data** (under revision)

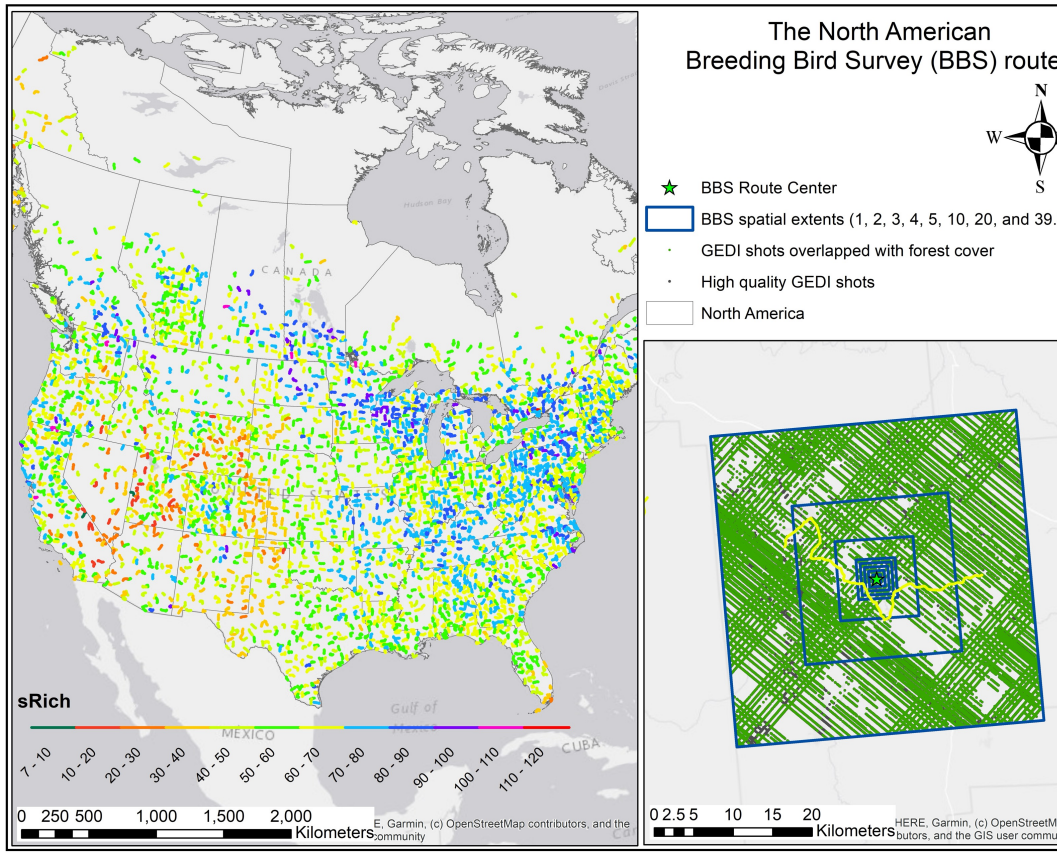
ForestGEO Global Plots



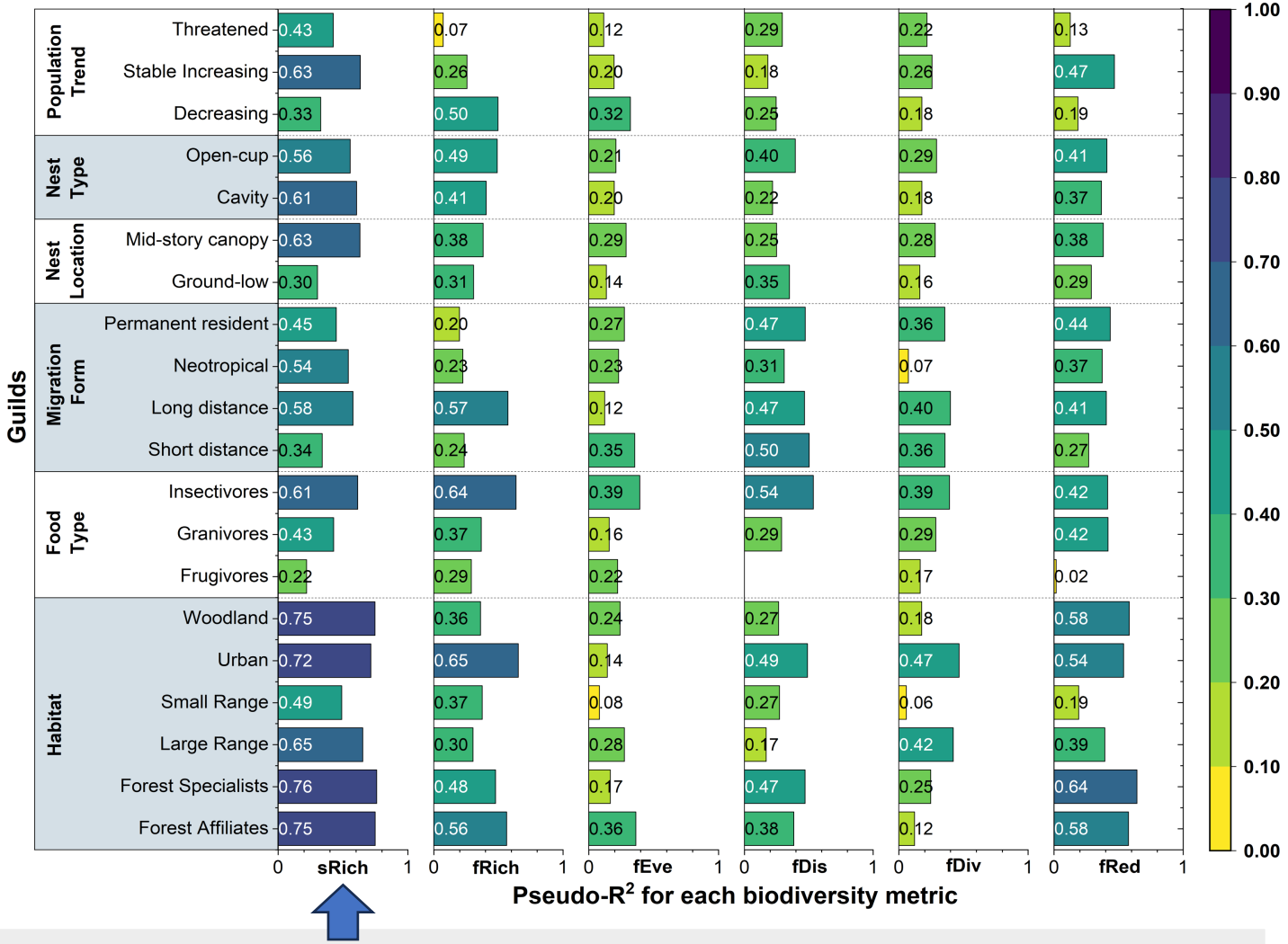
NEON Forest Plots in the U.S.



Modeling North American breeding bird biodiversity

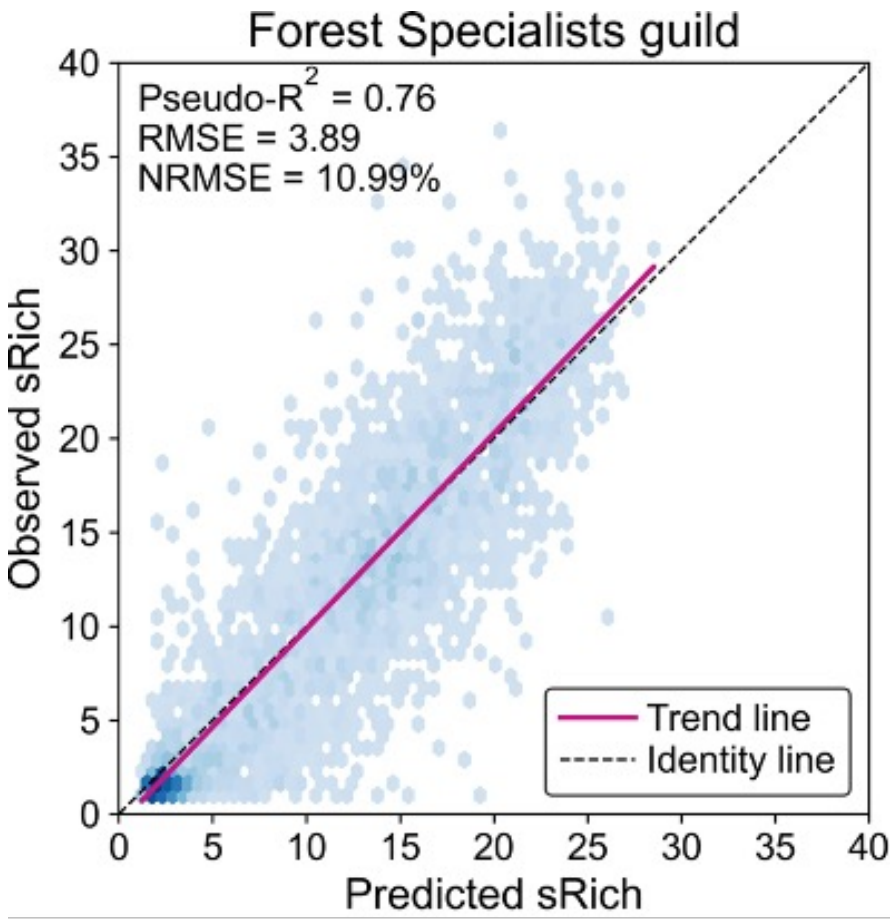


Model results for one species richness index (sRich) and five functional diversity indices: functional richness (fRich), evenness (fEve), dispersion (fDis), divergence (fDiv), and redundancy (fRed).

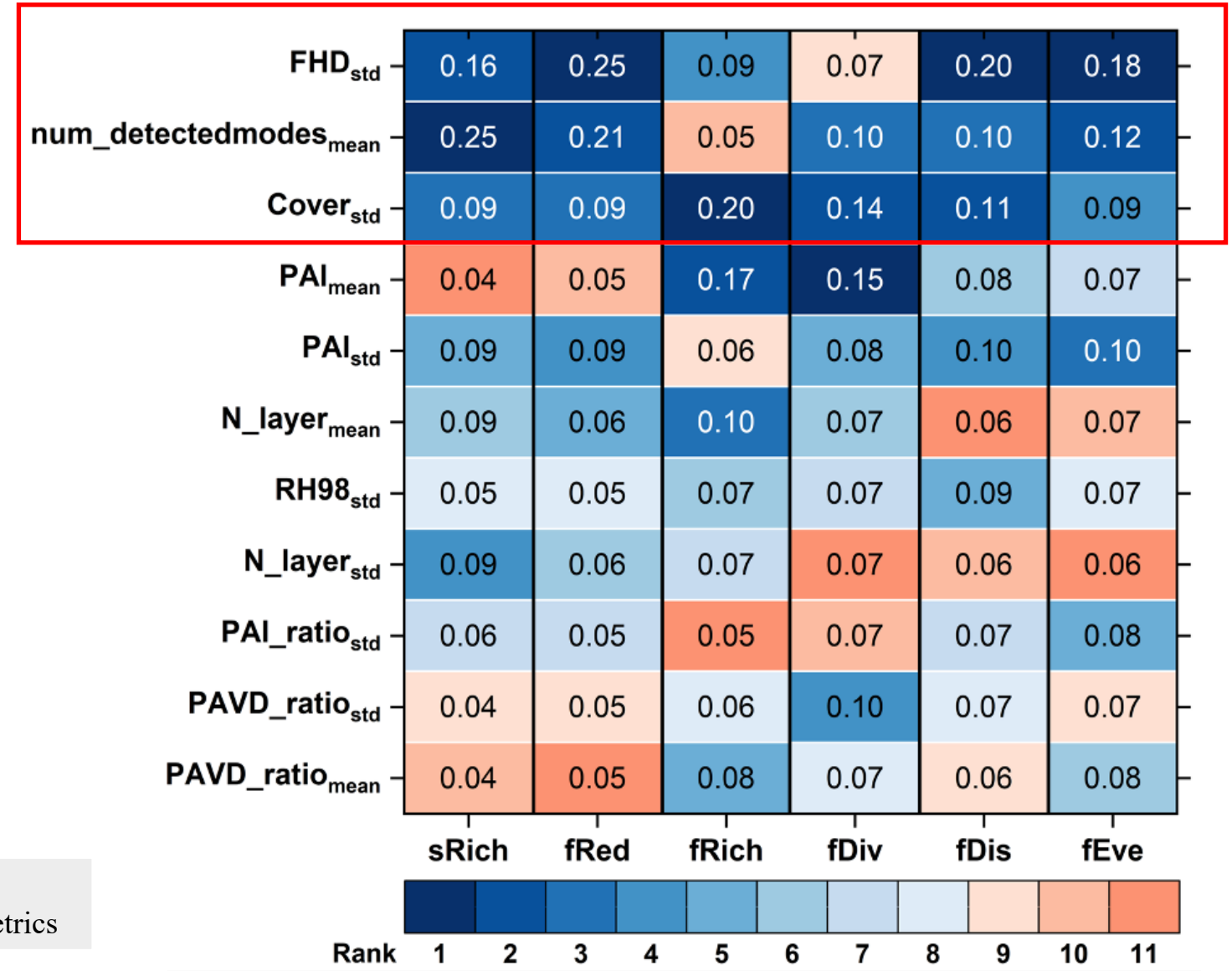


Pseudo-R^2 for the spatial extent of 39.2 km across 20 guilds, i.e., the full length of the BBS route.

Xu J., Farwell L., Radeloff VC., Luther D., Songer M., Cooper WJ., & Huang, Q. (2024). Avian Diversity Across Guilds in North America versus Vegetation Structure as Measured by the Global Ecosystem Dynamics Investigation (GEDI). (Under revision)

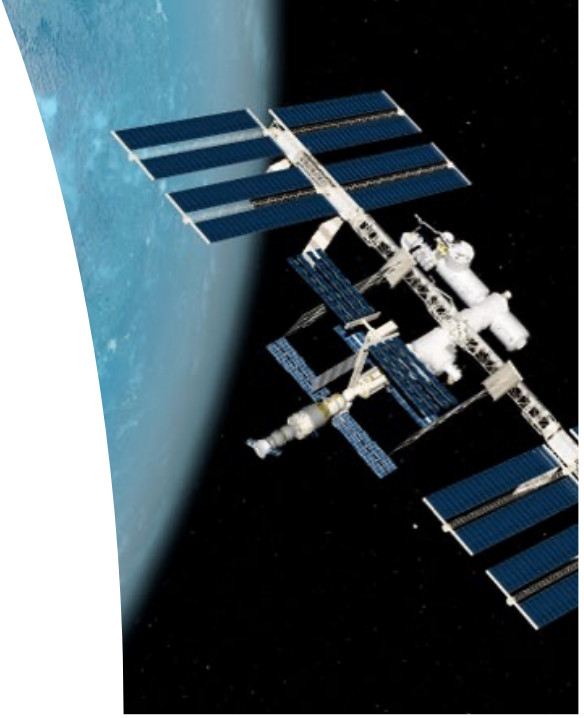


Forest specialist guild, urban guild, and insectivore guilds produced the best model to predict individual biodiversity metrics



Feature importance for the best-performing guild and each diversity index. The number indicates the contribution to the overall model performance for each feature.

Xu J., Farwell L., Radeloff VC., Luther D., Songer M., Cooper WJ., & Huang, Q. (2024). Avian Diversity Across Guilds in North America versus Vegetation Structure as Measured by the Global Ecosystem Dynamics Investigation (GEDI). (Under revision)



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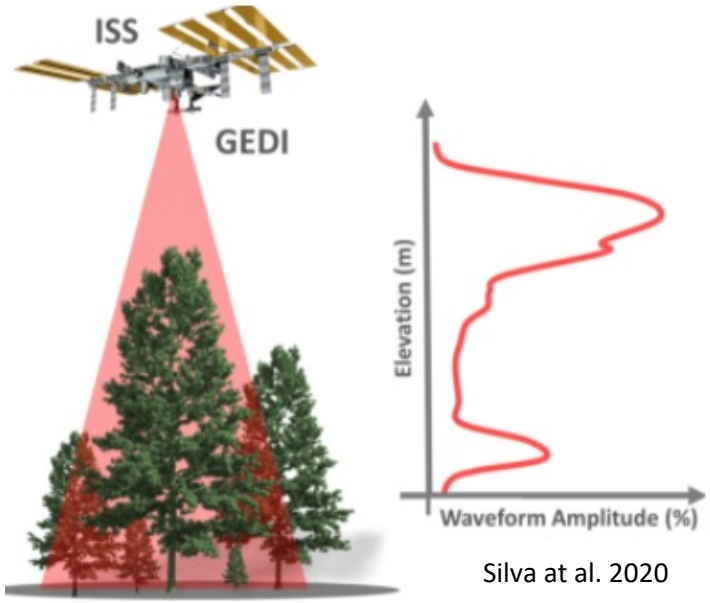

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Conservation Biology

PRACTICE AND POLICY | Open Access

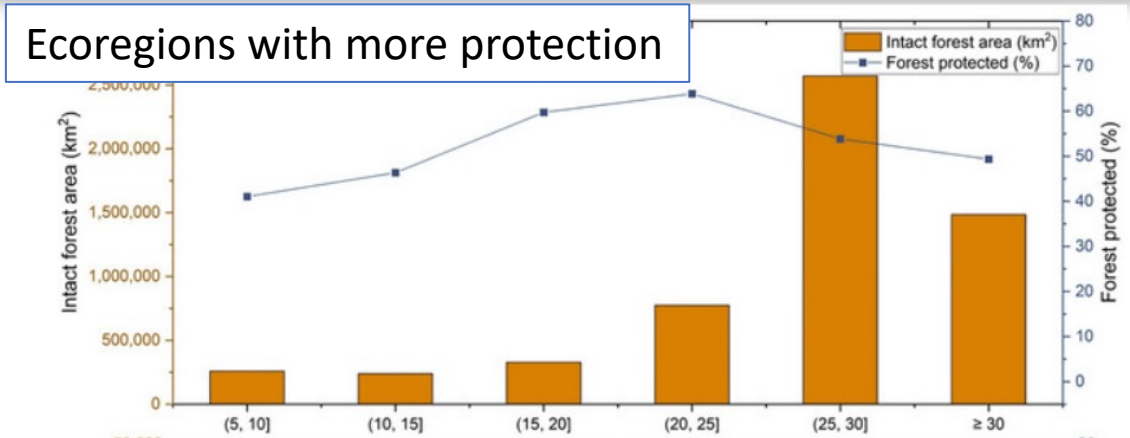
Prioritizing global tall forests toward the 30 × 30 goals

Qiongyu Huang, Jin Xu, Jesse Pan Wong, Volker C. Radeloff, Melissa Songer

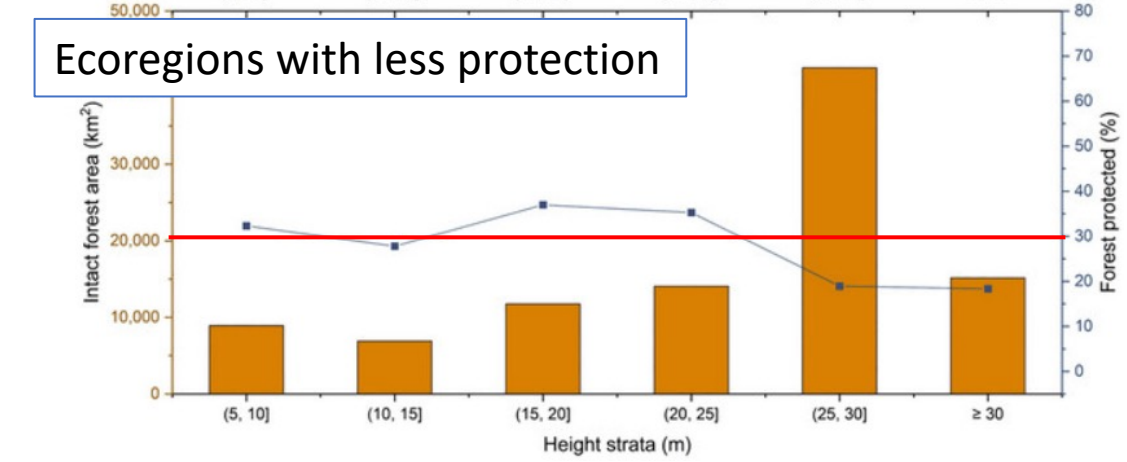
First published: 28 June 2023 | https://doi-org.smithsonian.idm.oclc.org/10.1111/cobi.14135 |

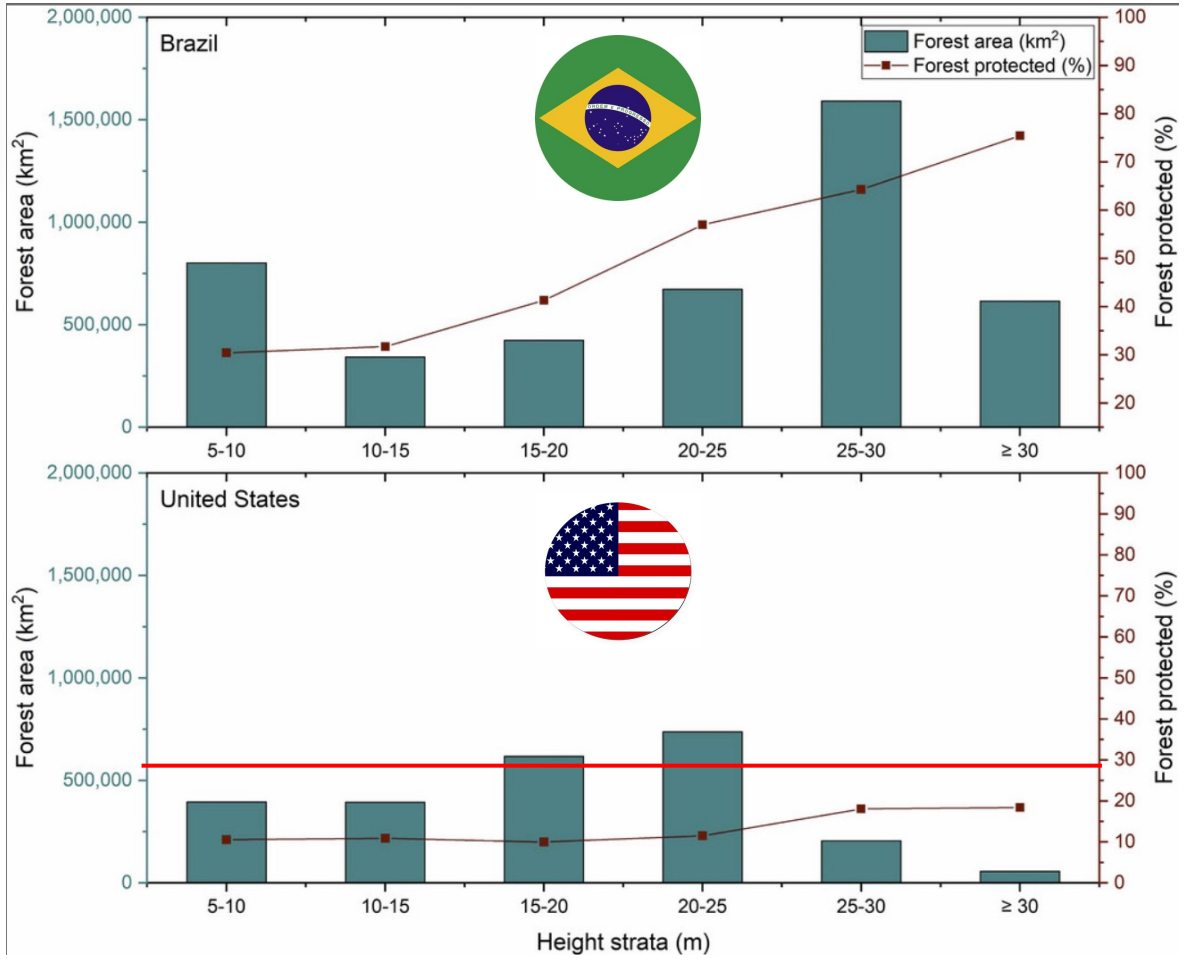
Facilitate better conservation planning and practices

Ecoregions with more protection



Ecoregions with less protection





- **Newly funded project**: A Remote-Sensing-Based Bird Friendly Certification System for Sustainable Agroforestry
- A web-based application to utilize multisensory remote sensing data including GEDI to evaluate bird habitat quality in coffee growing landscapes in Colombia, Peru, and Panama
- Facilitate habitat conservation by making Bird-Friendly Certification process more accessible

RUSTIC POLYCUTLTURE:
Very tall natural forest trees with coffee inserted under the natural canopy.

TRADITIONAL POLYCUTLTURE:
A very diverse system of planted shade trees, some of which may be quite tall (>15-20 meters).

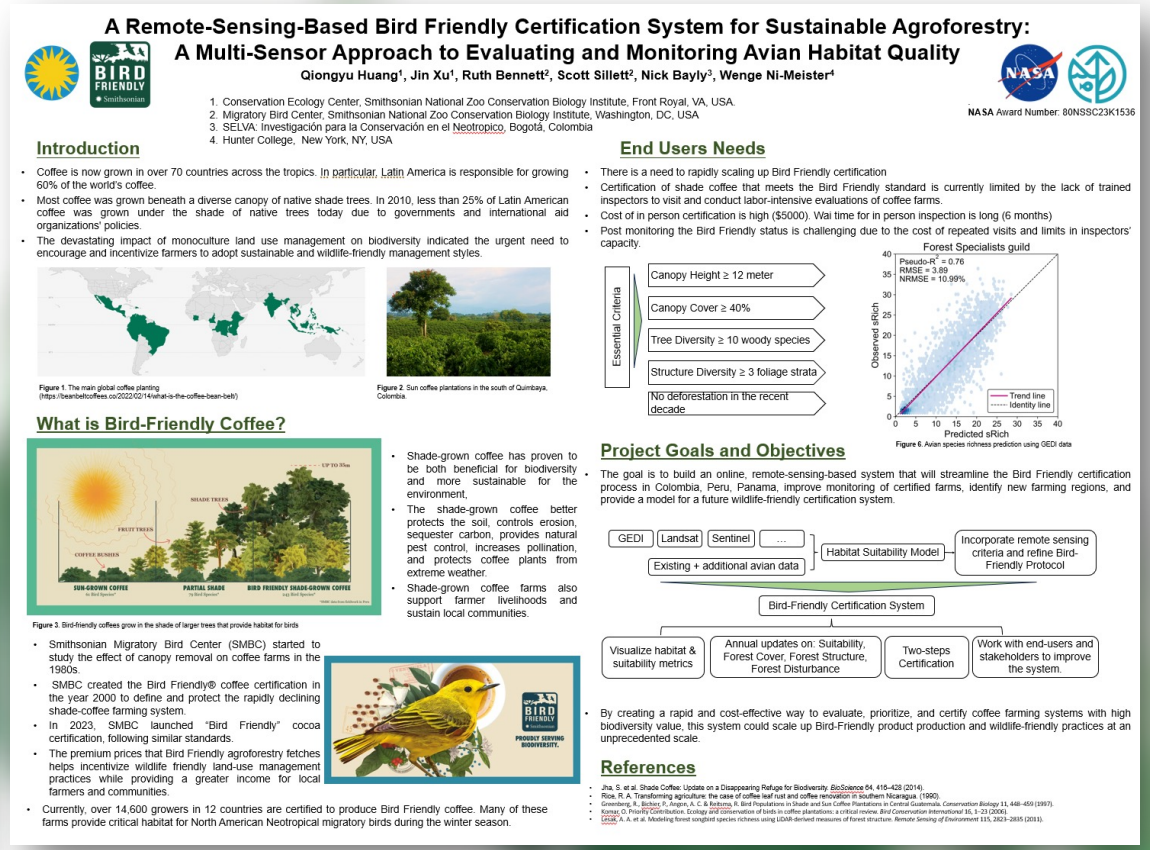
COMMERCIAL POLYCULTURE
The planted shade here is less diverse, but may meet the Bird Friendly standards.

SHADED MONOCULTURE
Only one or two planted species of shade make up this category, and the trees are kept rather short (<10m usually).

MONOCULTURE
Coffee only.

Funded by NASA Ecological Application program 80NSSC23K1536

- Poster presentation | Tuesday May 7th 5:00 PM



A Remote-Sensing-Based Bird Friendly Certification System for Sustainable Agroforestry: A Multi-Sensor Approach to Evaluating and Monitoring Avian Habitat Quality

Qiongyu Huang[1], Jin Xu[1], Ruth Bennett[2], Scott Sillett[2], Nick Bayly[3], Wenge Ni-Meister[4]

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2. Migratory Bird Center, Smithsonian National Zoo Conservation Biology Institute, Washington, DC, USA
3. SELVA: Investigación para la Conservación en el Neotropico, Bogotá, Colombia
4. Hunter College, New York, NY, USA

NASA Award Number: 80NSSC23K1536

Introduction

- Coffee is now grown in over 70 countries across the tropics. In particular, Latin America is responsible for growing 60% of the world's coffee.
- Most coffee was grown beneath a diverse canopy of native shade trees. In 2010, less than 25% of Latin American coffee was grown under the shade of native trees today due to governments and international aid organizations' policies.
- The devastating impact of monoculture land use management on biodiversity indicated the urgent need to encourage and incentivize farmers to adopt sustainable and wildlife-friendly management styles.

Figure 1. The main global coffee planting (https://beanbeltcoffees.co/2022/02/14/what-is-the-coffee-bean-belt/)

Figure 2. Sun coffee plantations in the south of Quimbaya, Colombia.

What is Bird-Friendly Coffee?

Figure 3. Bird-friendly coffees grow in the shade of larger trees that provide habitat for birds

- Shade-grown coffee has proven to be both beneficial for biodiversity and more sustainable for the environment,
- The shade-grown coffee better protects the soil, controls erosion, sequester carbon, provides natural pest control, increases pollination, and protects coffee plants from extreme weather.
- Shade-grown coffee farms also support farmer livelihoods and sustain local communities.
- Smithsonian Migratory Bird Center (SMBC) started to study the effect of canopy removal on coffee farms in the 1990s.
- SMBC created the Bird Friendly® coffee certification in the year 2000 to define and protect the rapidly declining shade-coffee farming system.
- In 2023, SMBC launched "Bird Friendly" cocoa certification, following similar standards.
- The premium prices that Bird Friendly agroforestry fetches helps incentivize wildlife friendly land-use management practices while providing a greater income for local farmers and communities.
- Currently, over 14,600 growers in 12 countries are certified to produce Bird Friendly coffee. Many of these farms provide critical habitat for North American Neotropical migratory birds during the winter season.

End Users Needs

- There is a need to rapidly scaling up Bird Friendly certification
- Certification of shade coffee that meets the Bird Friendly standard is currently limited by the lack of trained inspectors to visit and conduct labor-intensive evaluations of coffee farms.
- Cost of in person certification is high ($5000). Wai time for in person inspection is long (6 months)
- Post monitoring the Bird Friendly status is challenging due to the cost of repeated visits and limits in inspectors' capacity.

Essential Criteria:
- Canopy Height ≥ 12 meter
- Canopy Cover ≥ 40%
- Tree Diversity ≥ 10 woody species
- Structure Diversity ≥ 3 foliage strata
- No deforestation in the recent decade

Figure 6. Avian species richness prediction using GEDI data

Project Goals and Objectives

- The goal is to build an online, remote-sensing-based system that will streamline the Bird Friendly certification process in Colombia, Peru, Panama, improve monitoring of certified farms, identify new farming regions, and provide a model for a future wildlife-friendly certification system.

- By creating a rapid and cost-effective way to evaluate, prioritize, and certify coffee farming systems with high biodiversity value, this system could scale up Bird-Friendly product production and wildlife-friendly practices at an unprecedented scale.

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Thank You!

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