

Characterizing Carbon Stocks in Mangroves of the Zambezi River Delta



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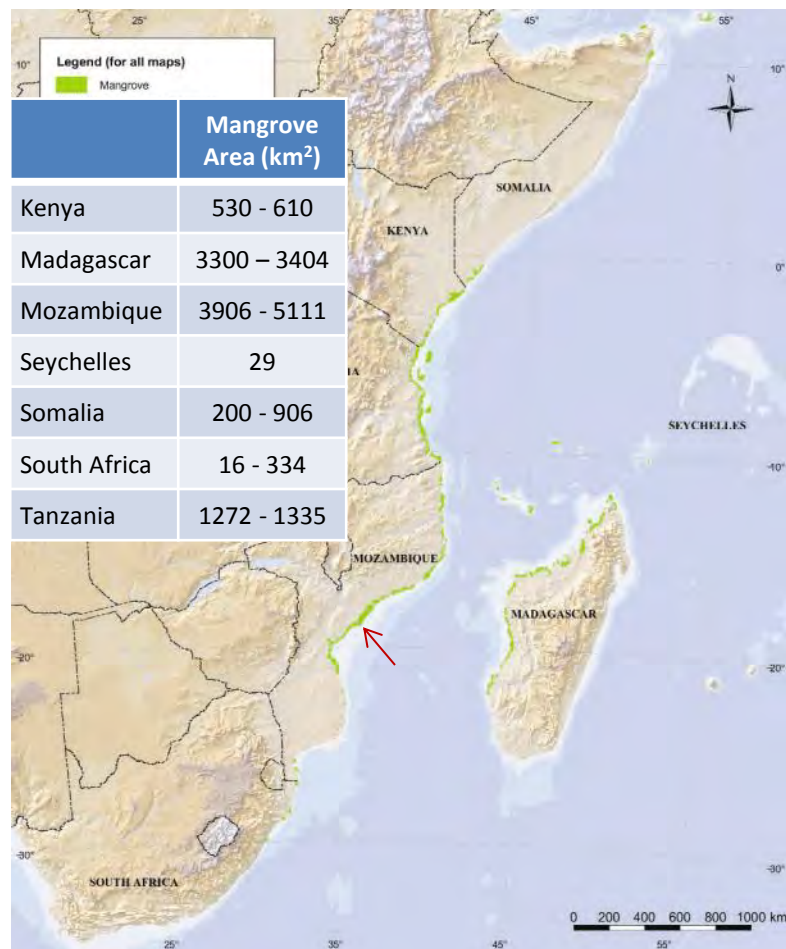
Collaborators

- **Denise Nicolau, Rito Mabunda, WWF - Mozambique**
- **Salomão Bandeira, Celia Macamo, Univ. Eduardo Mondlane**
- **Wenw Tang, Univ. North Carolina – Charlotte**
- **Temilola Fatoyinbo, Mark Simard, National Aeronautics & Space Administration**
- **Chandra Giri, US Geological Survey**
- **Joaquím Macuacua, National Directorate of Land and Forests, Mozambique**
- **Jason Ko, Stan Zaubach US Forest Service**
- **Italvino Cunat, Outfitter**



Mangroves in East Africa

- East Africa contains approximately 23% of the mangroves on the continent.
- Loss and degradation of the resource is a wide-spread concern; supporting information is weak.
- Very little research or operational inventories to characterize the forest carbon pools.
- Mangroves are typically in remote areas, with few remote sensing tools or data available.



(from Taylor 2003)

Our Objective

- Inventory of carbon pools within the mangrove forest on the Zambezi River Delta, Mozambique
 - Baseline study to facilitate inclusion of mangroves in Mozambique's National REDD Strategy,
 - Test protocols for inventory and monitoring purposes,
 - Establish plots that may be used for monitoring.

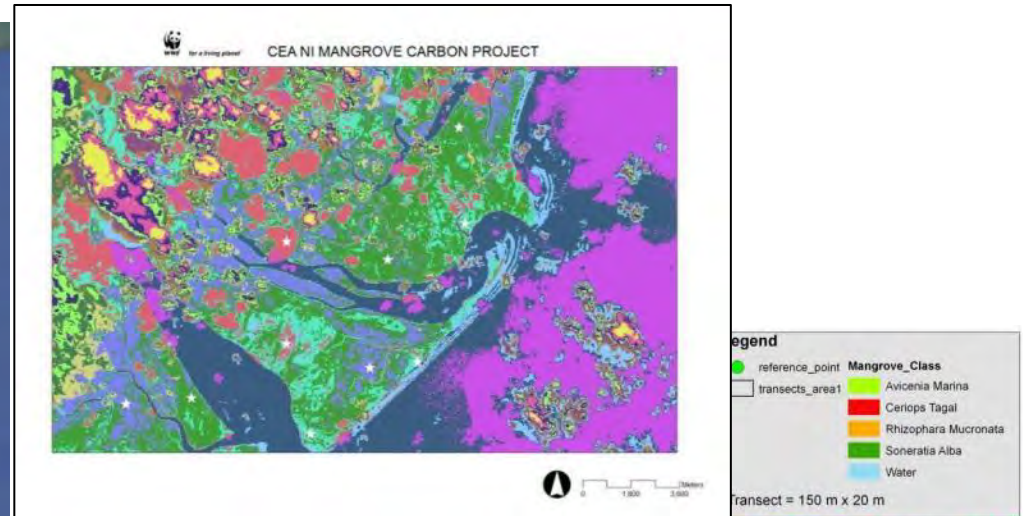


Zambezi River Delta – Inventory of Mangrove Carbon Pools

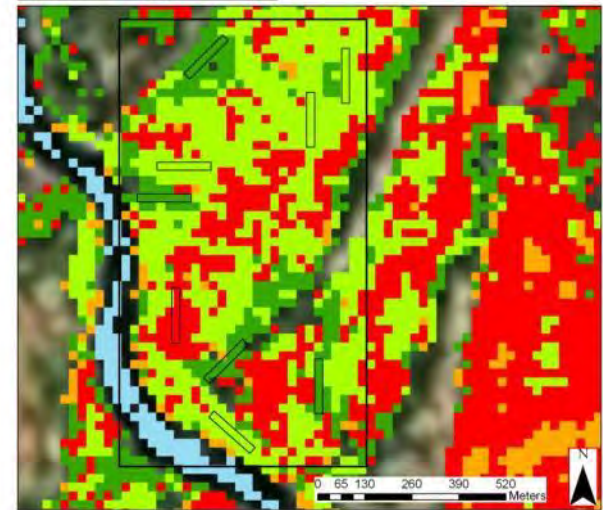
The challenge – how to inventory a large tract (~ 302 km²) efficiently, accurately, and safely?

Image © 2014 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Google earth



One approach: Use remote sensing to identify mangrove types as a basis for a stratified sampling design.



Mangrove cover types did not correspond well with actual species composition – highly heterogeneous stands.

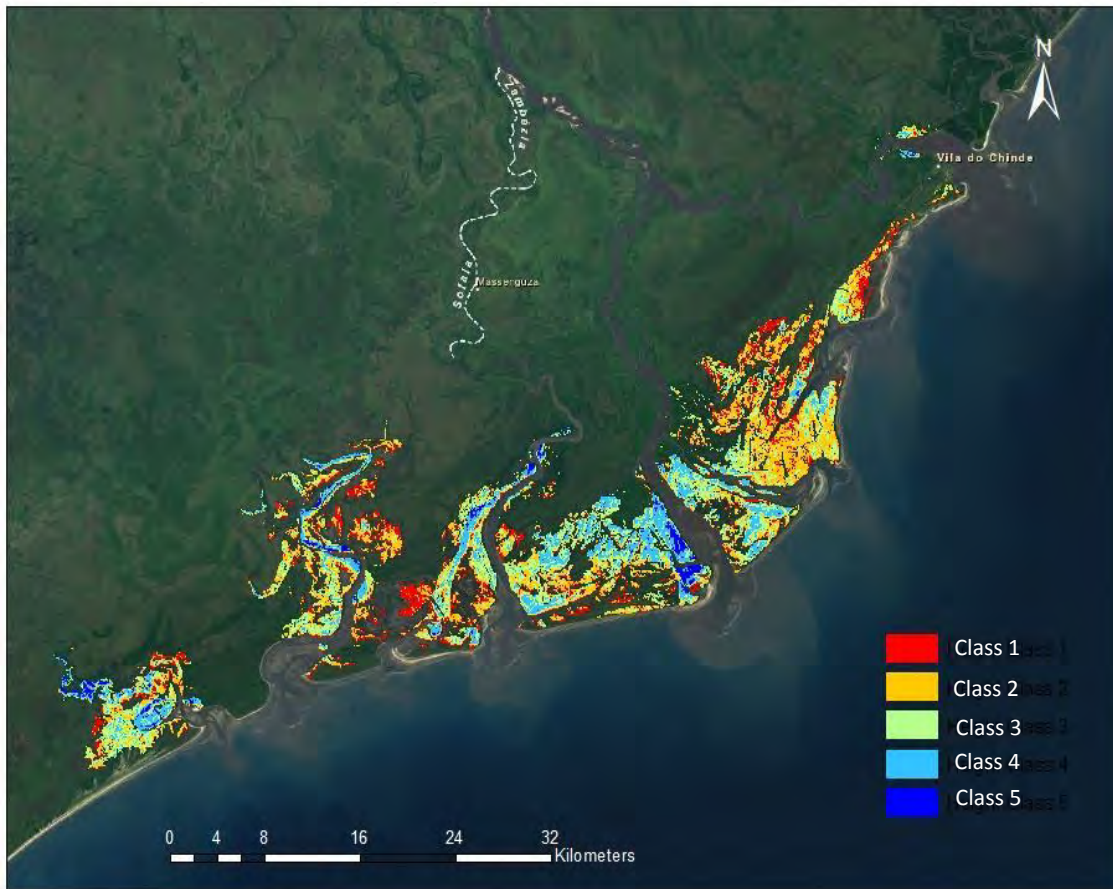


Mangrove Canopy Height Classification

Tree height is functionally related to biomass.

- Lidar canopy height derived from ICESat / GLAS and SRTM data.
- Available for the entire continent.

Class ID	Height (m)
1	2-7
2	7-10
3	10-13
4	13-18
5	18-29



Distribution of canopy height classes within the Zambezi River Delta

(data from Fatoyinbo & Simard 2013)



Spatial Decision Support System: Development and Use Implementing a Field Inventory

Development of Spatial Decision Support System to Inventory Mangroves in the Zambezi Delta, Mozambique

Development of Spatial Decision Support System to Inventory Mangroves in the Zambezi Delta, Mozambique

A report submitted to Dr. Carl C. Trettin, USFS Southern Research Station

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- Use empirical data from remote sensing and pilot study to:
 - Allocate plots among the sample strata (canopy height)
 - Calculate the number of subplots needed to attain accurate estimates for the sampling area
 - Calculate location of sample plots and camping sites based on logistical constraints
 - Water access
 - Transport distance
 - Villages



Sample Plot and Camp Locations 2013 Field Mission







Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests

J. Boone Kauffman
Daniel C. Donato

Harmonization of sampling procedures will facilitate continuity of large-scale inventories, longitudinal assessments, and regional comparisons



Available at: <http://www.cifor.org/online-library/browse/view-publication/publication/3749.html>

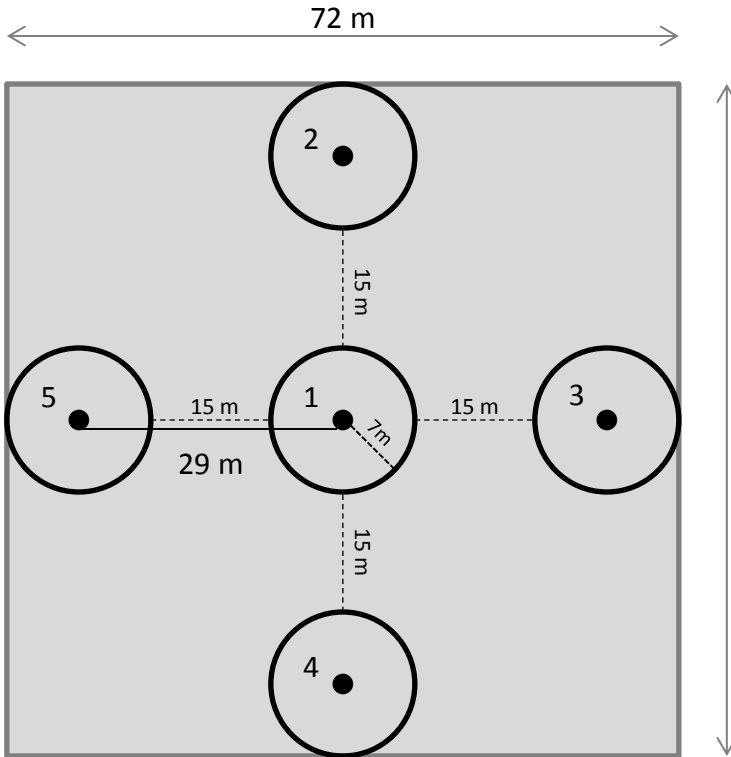
These protocols provided the basis for sampling in the Zambezi River Delta Mangrove Carbon Assessment Project

Projecto de Carbono no Mangal - Missão Zambezi 2013: Métodos de Amostragem
6 Setembro - 11 Outubro



Inventory Design Benefits from Pilot Study

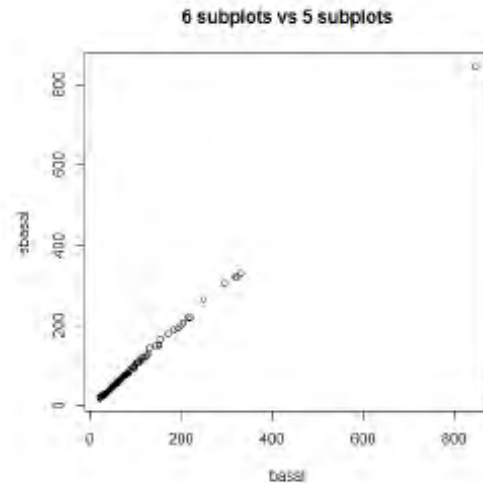
Considerations of Plot Layout



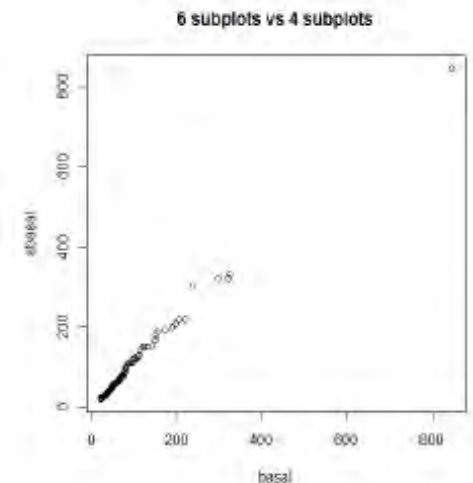
0.4 ha Large Plot for Trees > 50cm DBH

7 m Diameter Subplots

Plot configuration altered to improve efficiency:
of subplots reduced

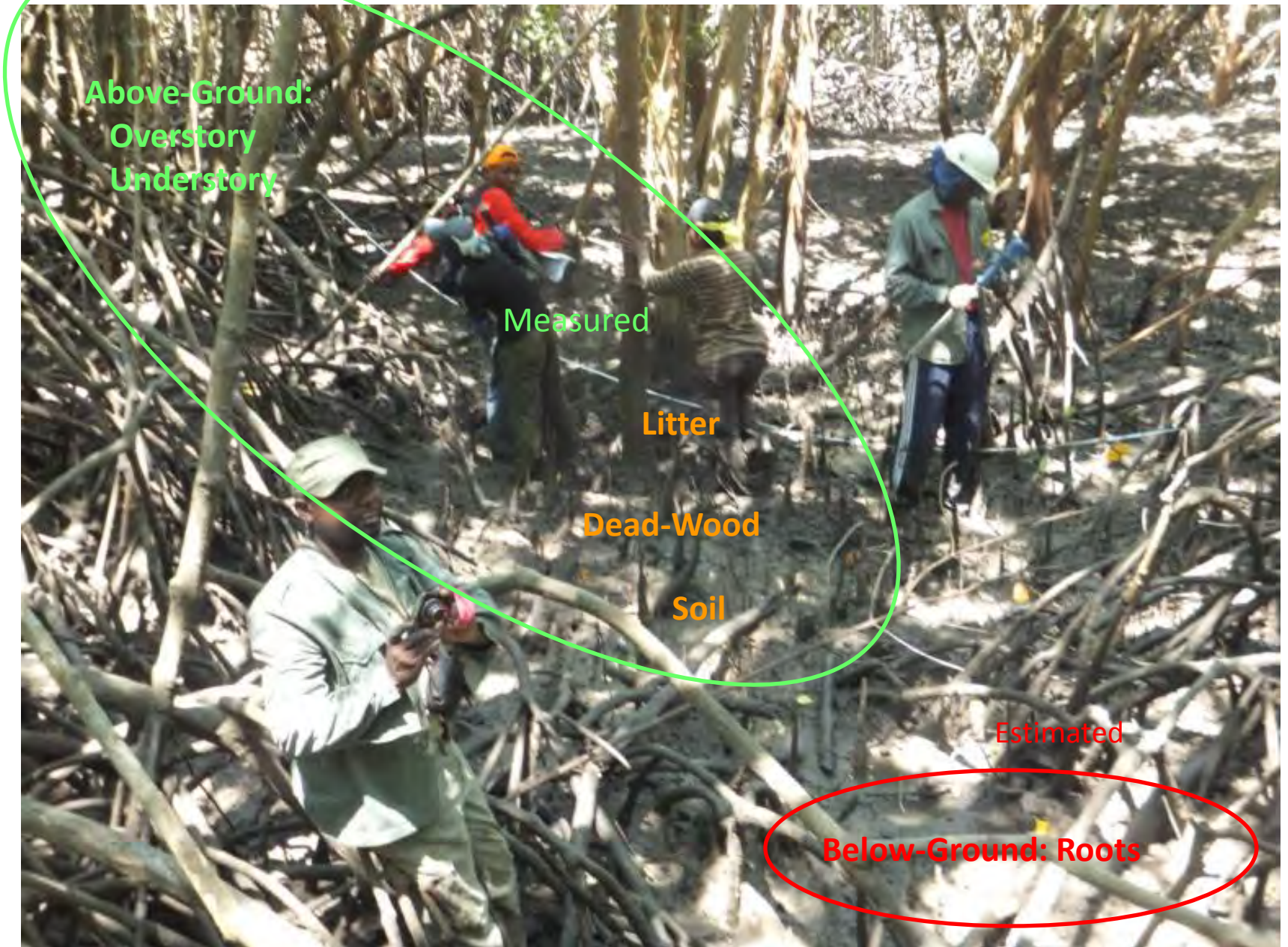


No difference in reducing the number of subplots from 6 → 5.



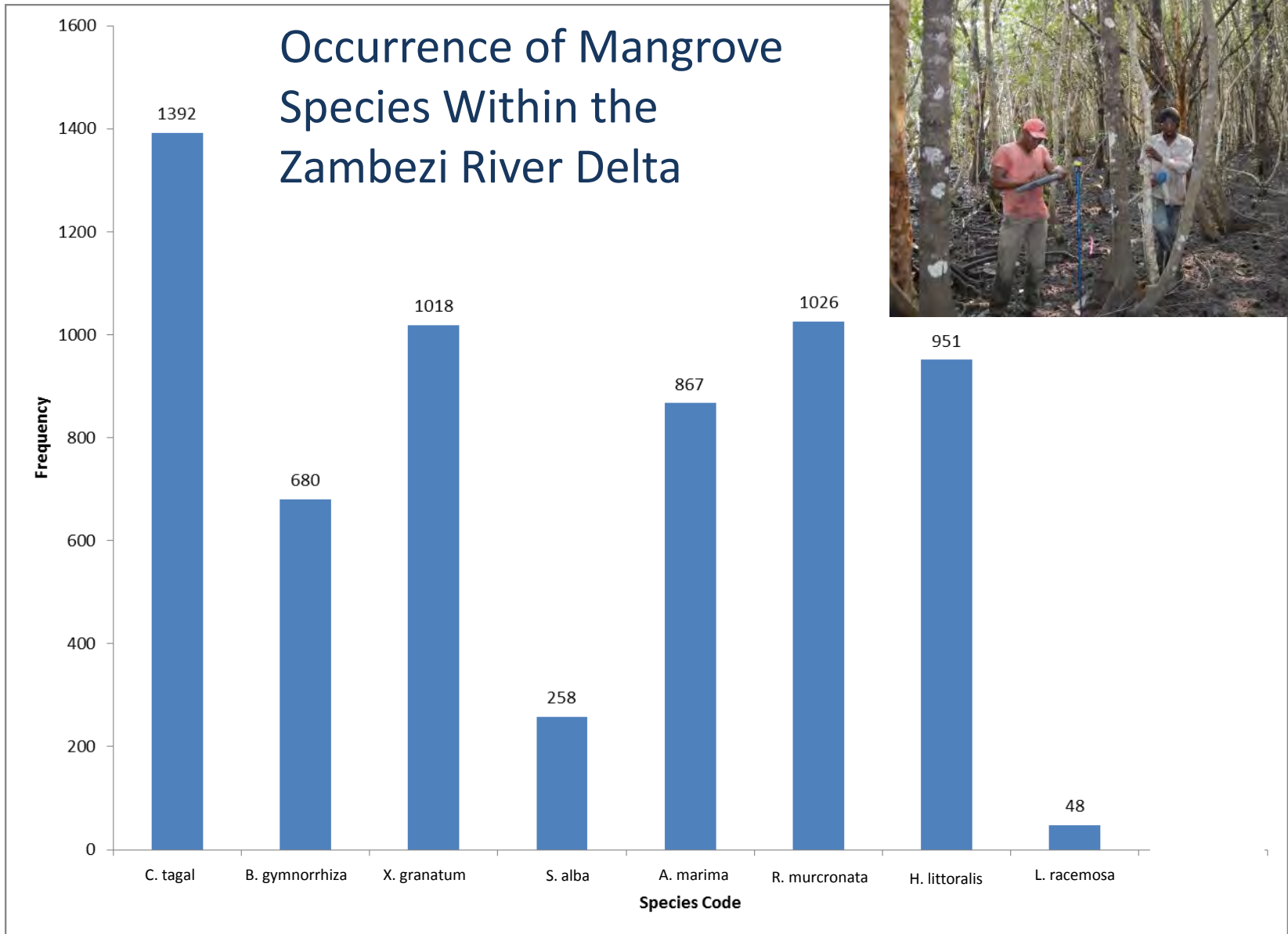
Little difference in reducing the number of subplots from 6 → 4.

Biomass C Pools





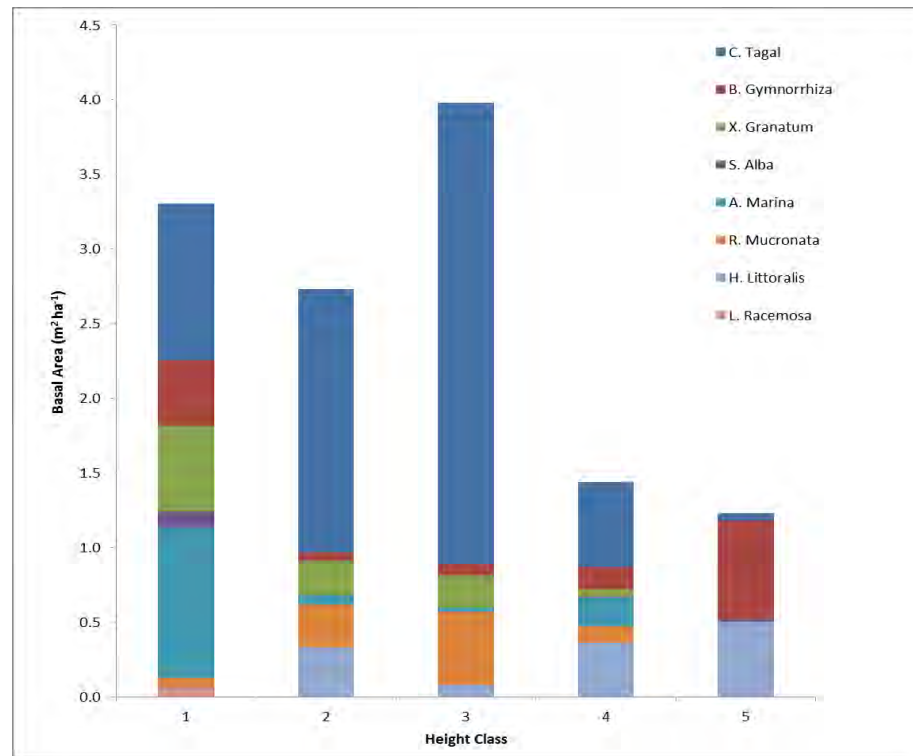
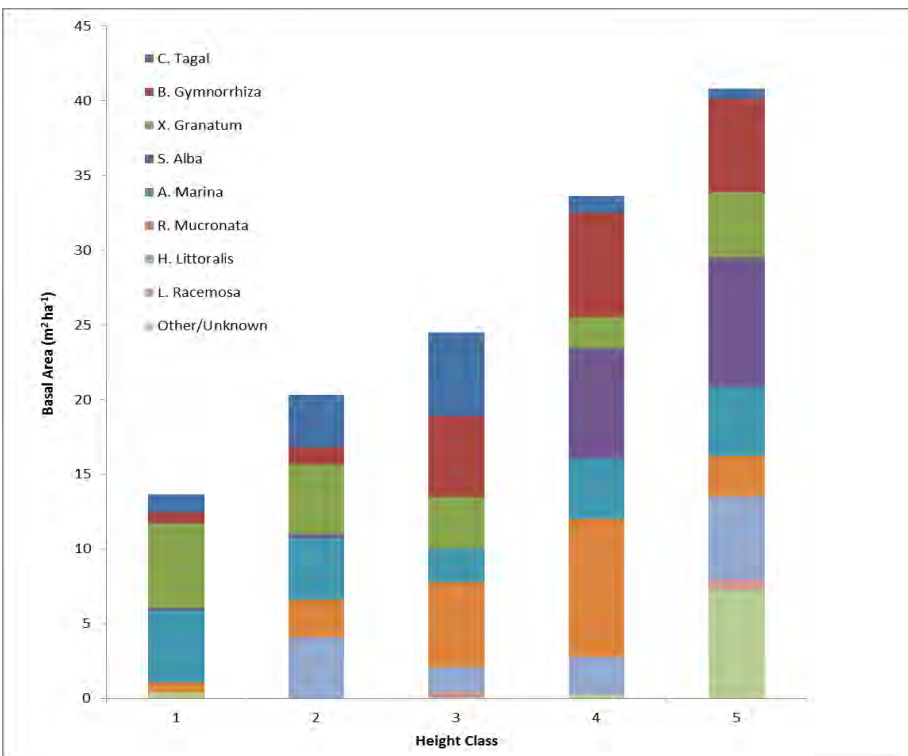
Occurrence of Mangrove Species Within the Zambezi River Delta



Contribution of Mangrove Species to Stand Basal Area

Overstory (> 5 cm DBH)

Understory (< 5 cm DBH)



Relatively Little Variation in the Depth Distribution of Carbon and Bulk Density



Perspectives from Zambezi River Delta C Inventory

- The stratified random sampling design proved effective and efficient,
- Additional efficiencies in the design are likely,
- Very reasonable estimate of C stock (std. err. @ ~3%)
- Plots provide a basis for MRV.



Perspectives from Zambezi River Delta C

Inventory cont'd

- Issues / Needs
 - Validation of allometric equations!!
 - Documentation of mangrove cover change (e.g., erosion, antropogenic),
 - Effects of disturbance on pools & fluxes unknown,
 - Development of remote sensing tools.



Thank-you! Obrigado!

