

VEGEMIX

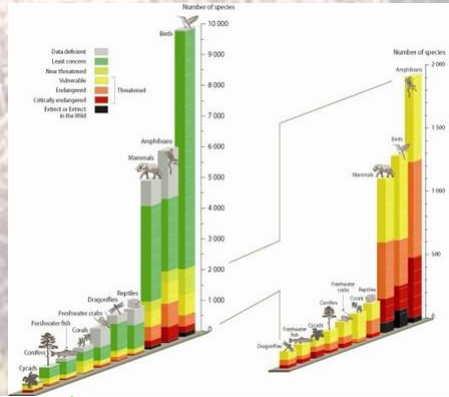
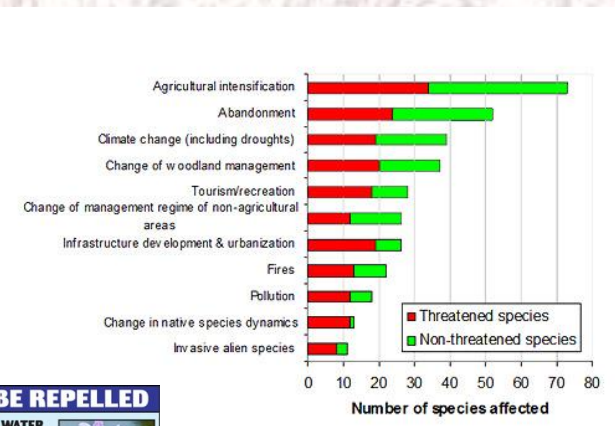
REMOTE MAPPING OF INVASIVE TREE SPECIES IN HAWAIIAN RAINFORESTS: DEMONSTRATING THE POTENTIAL OF HYPERSPECTRAL TIME SERIES

Ben Somers, Gregory P. Asner



Division Forest, Nature & Landscape

BIOLOGICAL INVASIONS?!



THE INVADERS THAT COULD BE REPELLED

- VIRGINIA CREEPER** (left): Widely found in verges and hedges and used to adorn houses, it directly competes with native species.
- ROSY-FACED LOVEBIRD** (below): Loud native of southwest Africa, it is a pest for fruit growers.
- WATER HYACINTH**: Floating mats remove oxygen from water and destroy animal life.
- AMERICAN BULLFROG**: One of the most invasive species, it spreads diseases and threatens native amphibians.
- RHODODENDRON**: Shades out native plants in acid woods and heathlands.
- RUDDY DUCK** (left): Escaped from captivity in the UK and has spread to the UK.



STOP THE SPREAD
of invasive alien species



BIOLOGICAL INVASIONS?!



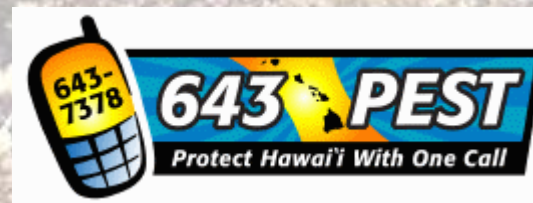
Daniel Akaka US Senator for Hawaii

Nearly \$4.5 Million Stimulus Funds Will Fight Invasive Species in Hawaii

Thu, May 14, 2009

WASHINGTON - Senate Appropriations Chairman Daniel K. Inouye and Senator Daniel K. Akaka announced today that the State of Hawaii will receive \$4,486,000 to fight invasive plant species across the islands. The United States Department of Agriculture is distributing the funding as part of the American Recovery and Reinvestment Act. Specific projects on both state and private lands will be selected by the State government.

"Many of our irreplaceable native forests and flora are in danger of being lost forever because of invasive species that have come to Hawaii from other parts of the world," said Chairman Inouye and Senator Akaka. "This funding will be a big help in our battle to save our unique Hawaiian plants that exist nowhere else, while creating job opportunities for workers across the islands. We will continue our efforts to get federal funding for this serious challenge."



BIOLOGICAL INVASIONS?!

Field Scouting

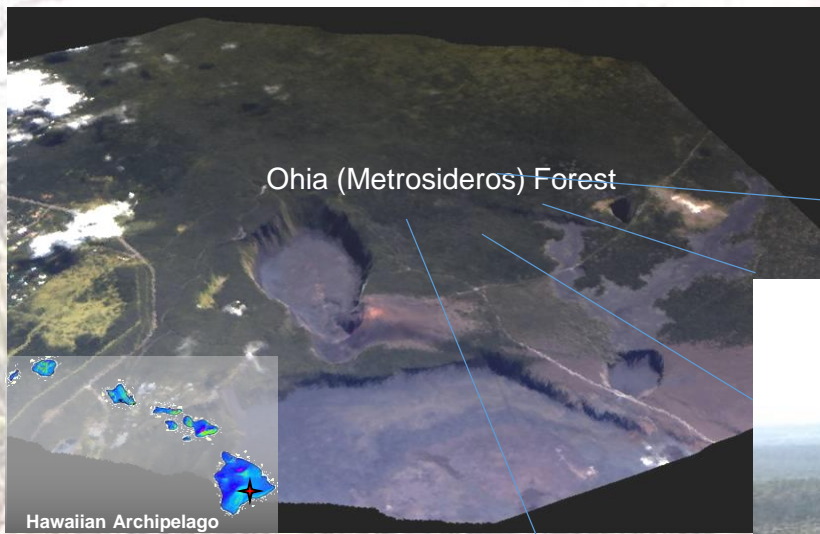


Remote Sensing



BIOLOGICAL INVASIONS IN HAWAII?!

Hawaii Volcanoes National Park



BIOLOGICAL INVASIONS IN HAWAII?!

Hawaii Volcanoes National Park

Native vegetation



Acacia koa



Metrosideros Polymorpha



Invasive vegetation



Morella faya

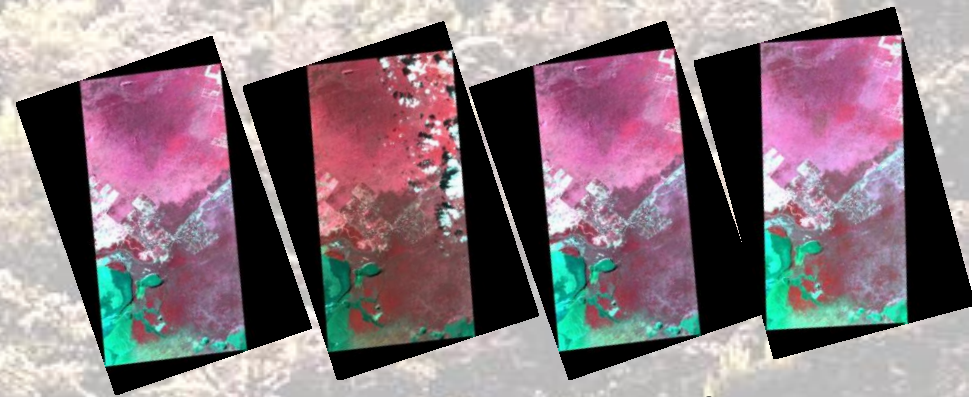
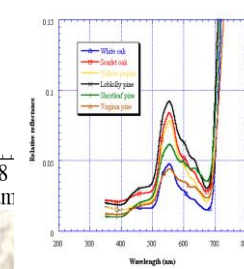
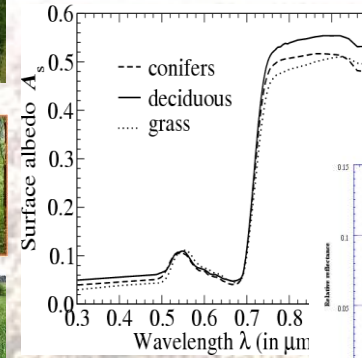


Psidium cattleianum

CHALLENGES FOR REMOTE MAPPING OF FOREST FLORISTIC COMPOSITION?

Image interpretation is complicated by the high spectral similarity between different co-occurring plant species

**Multi-temporal
spaceborne imaging
spectroscopy?**

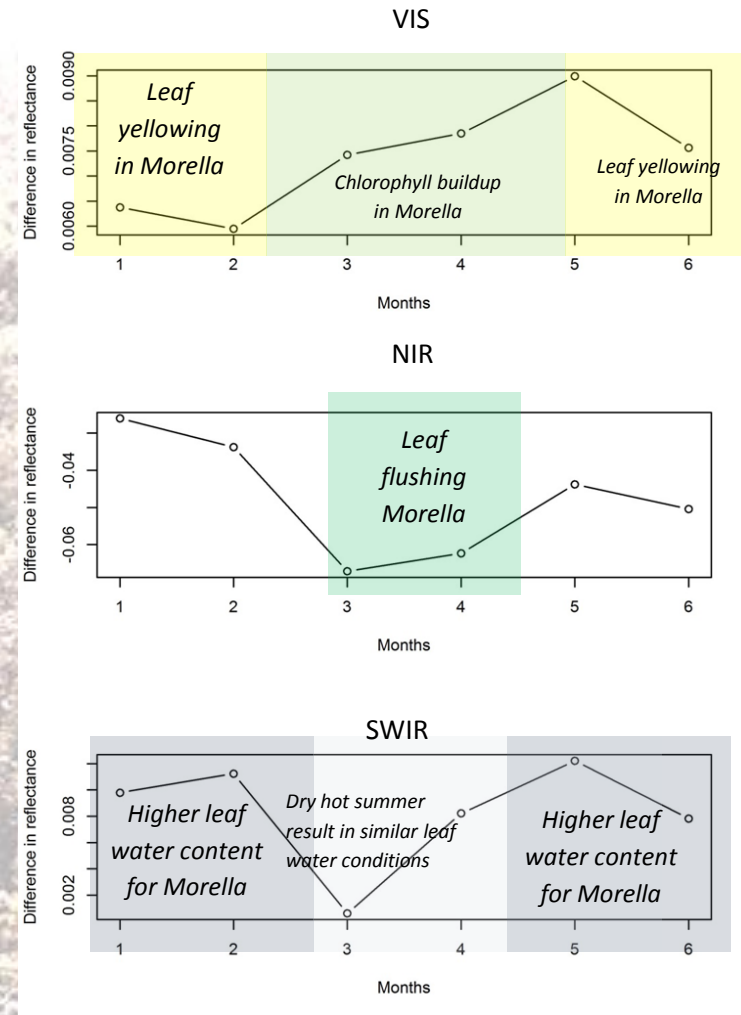
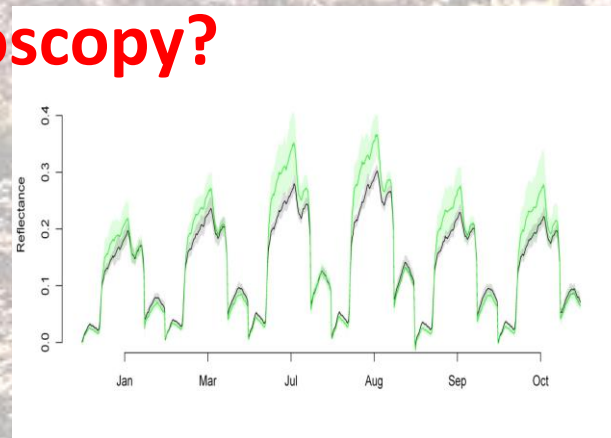


EO-1 Hyperion data

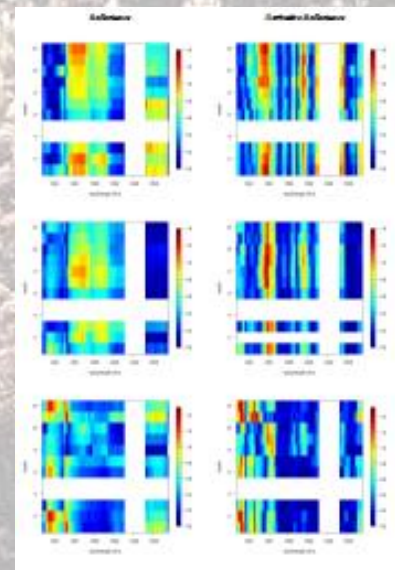
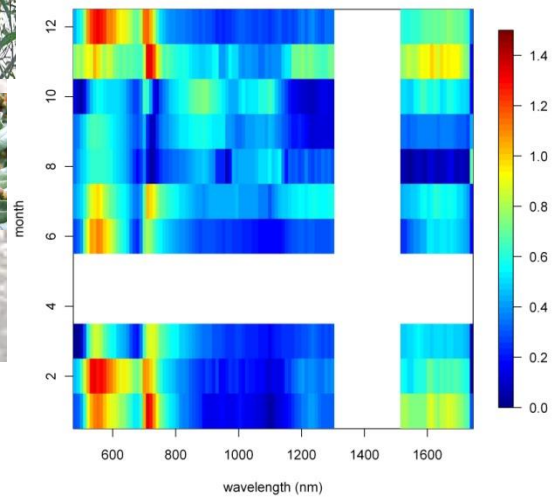
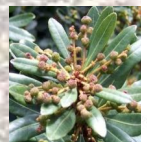
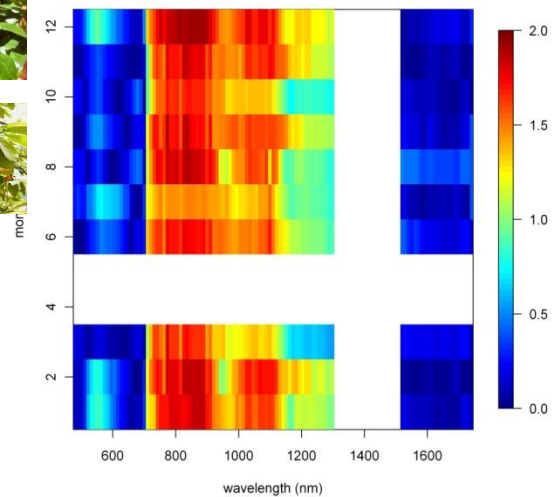
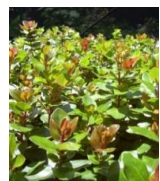
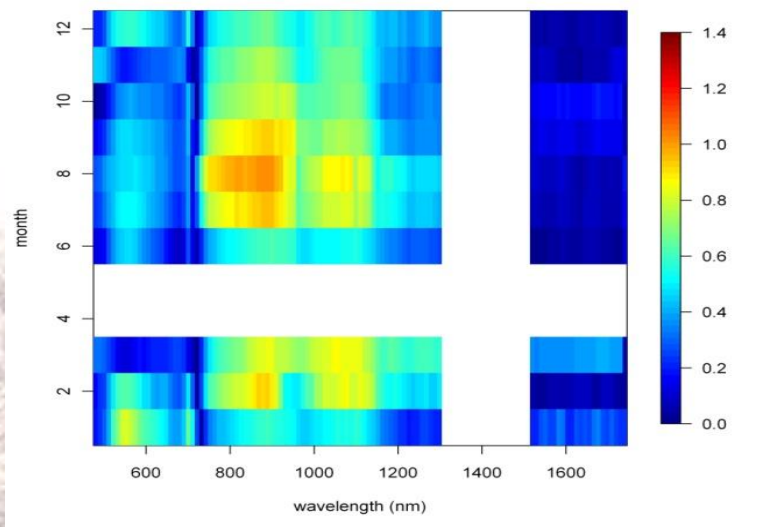
MULTI-TEMPORAL IMAGING SPECTROSCOPY?

Image interpretation is complicated by **the high spectral similarity between different co-occurring plant species**

**Multi-temporal
spaceborne imaging
spectroscopy?**



MULTI-TEMPORAL IMAGING SPECTROSCOPY?



Somers & Asner, 2012, Remote Sensing

MULTI-TEMPORAL IMAGING SPECTROSCOPY?

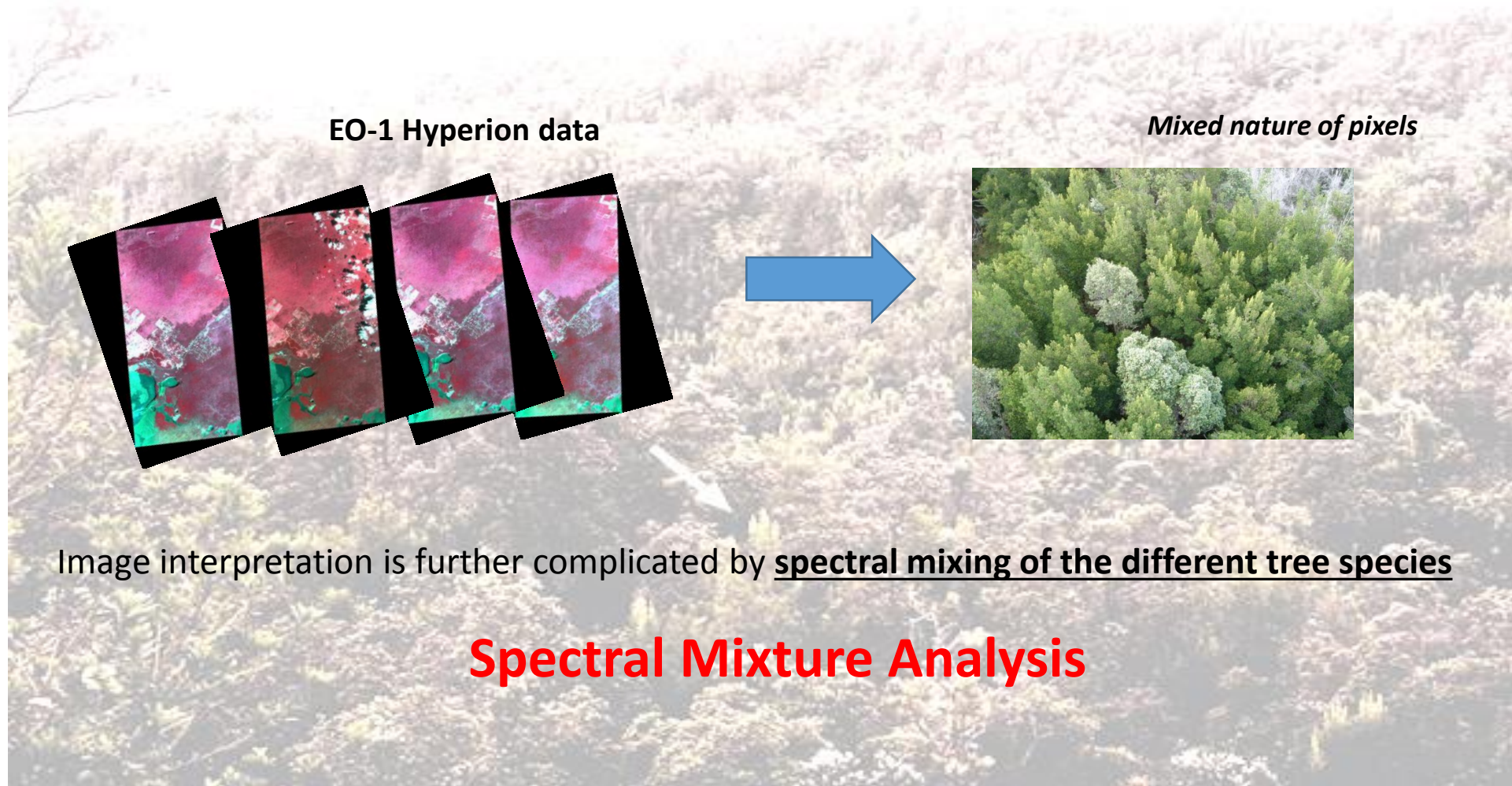


Phenology important to improve spectral separability among species!

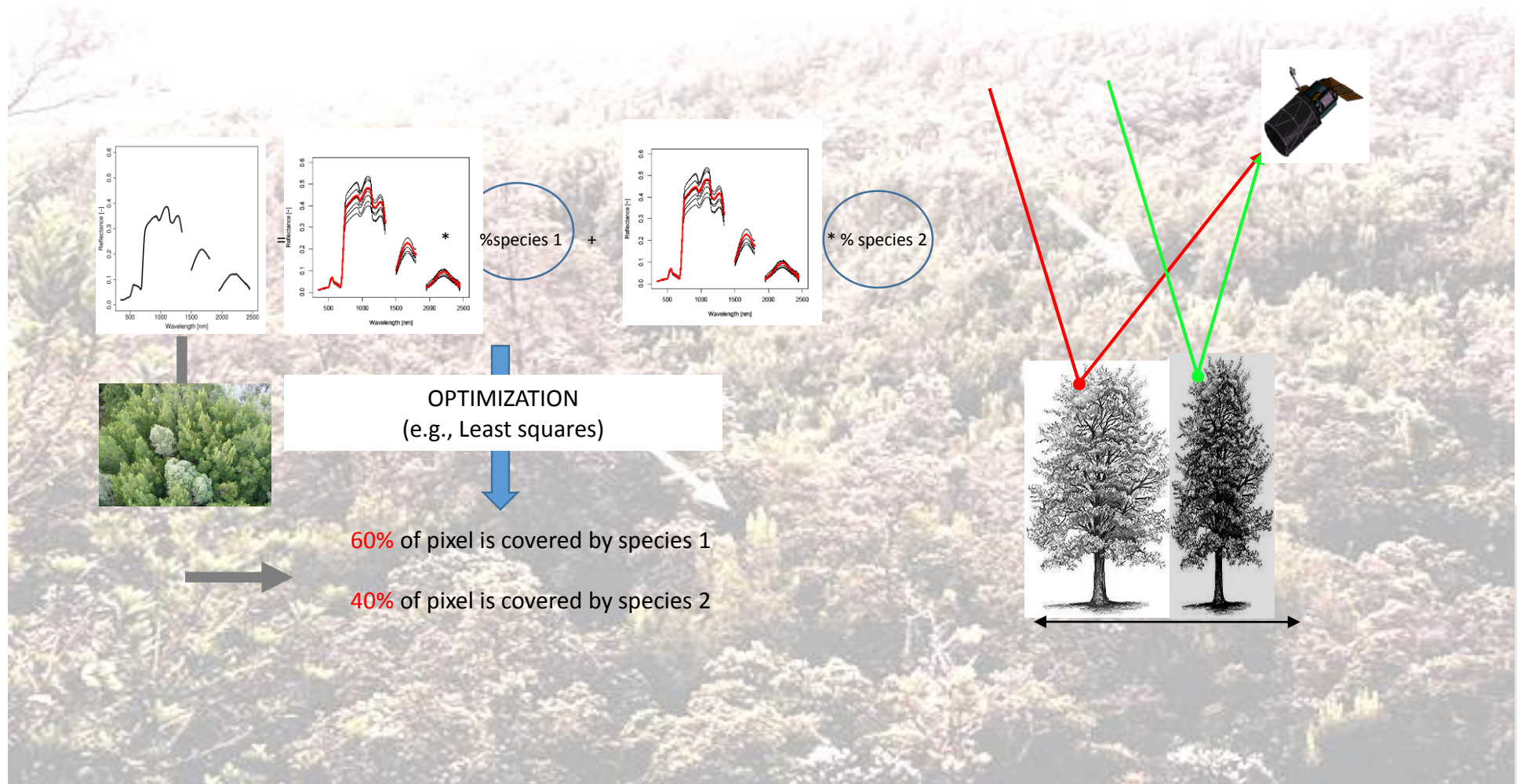
BUT: there is no specific time window or a single spectral region that always defined the separability of all species groups

SO: we need multiple images and the full spectrum!

MULTI-TEMPORAL IMAGING SPECTROSCOPY?

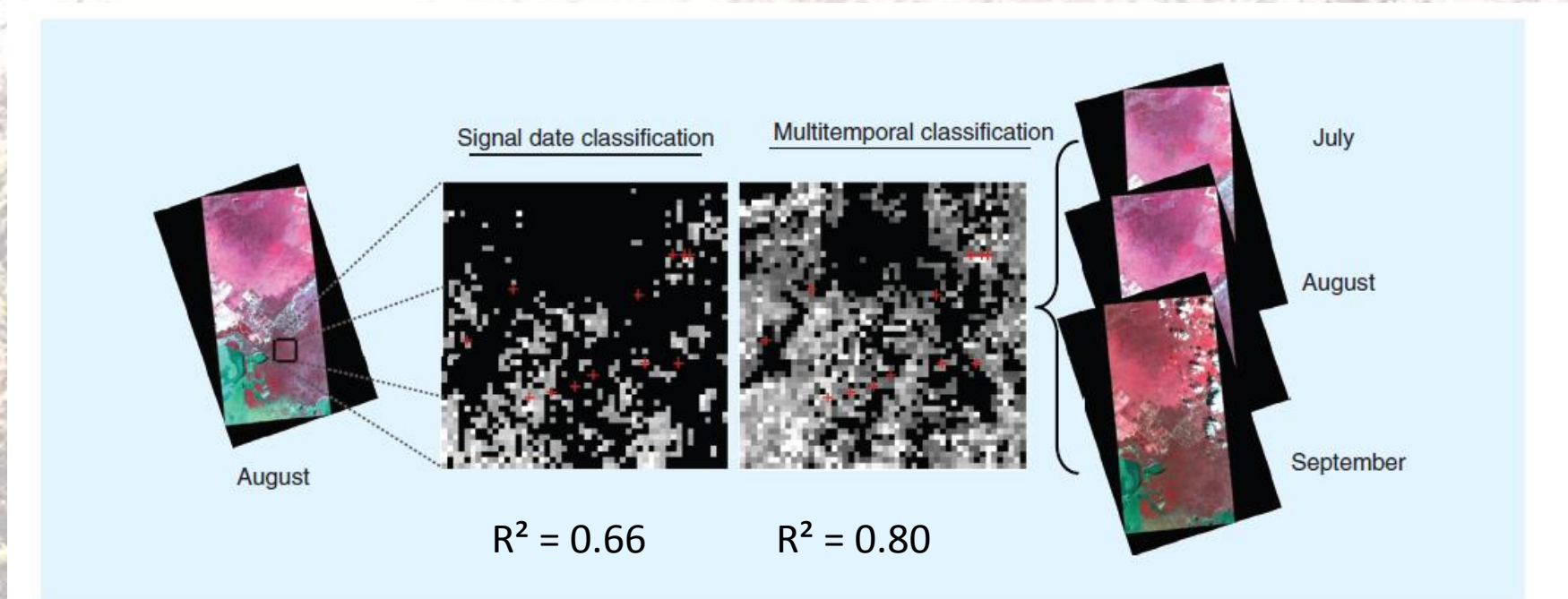


REMOTE SENSING FOR FLORISTIC MAPPING?



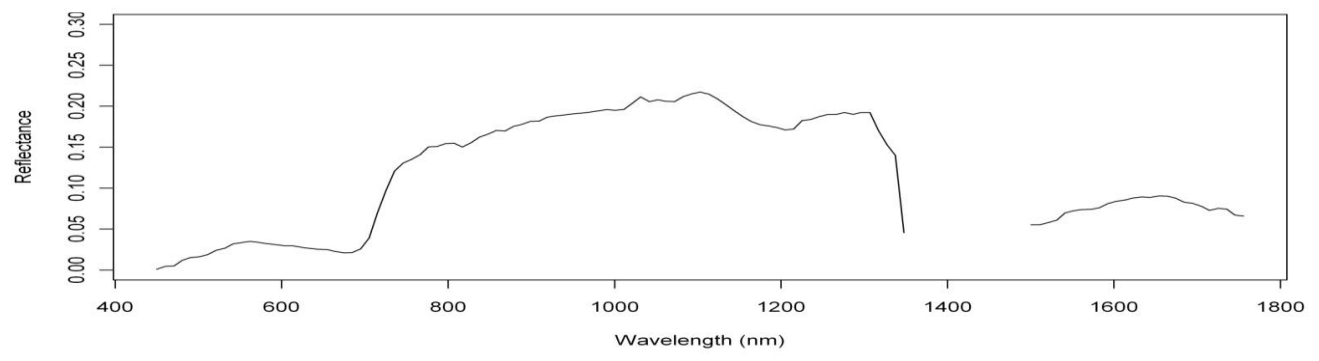
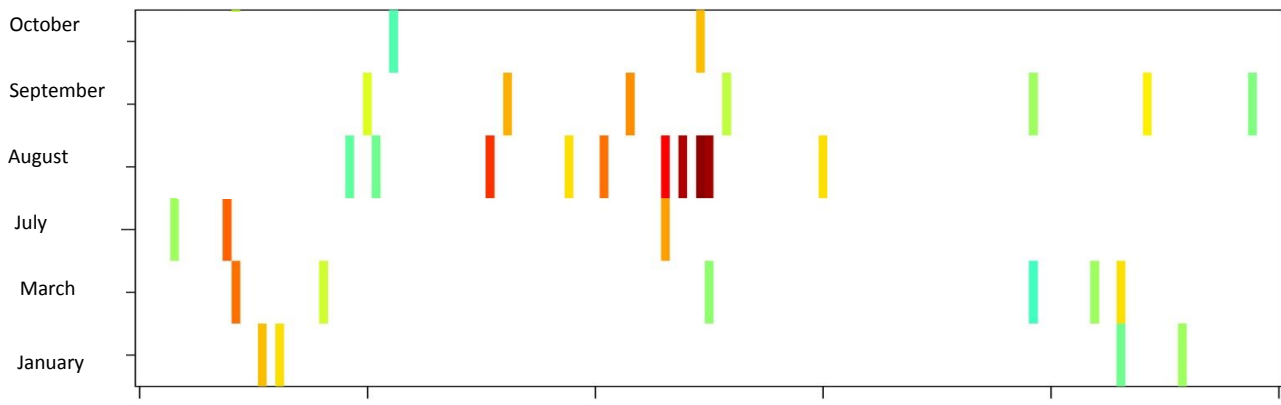
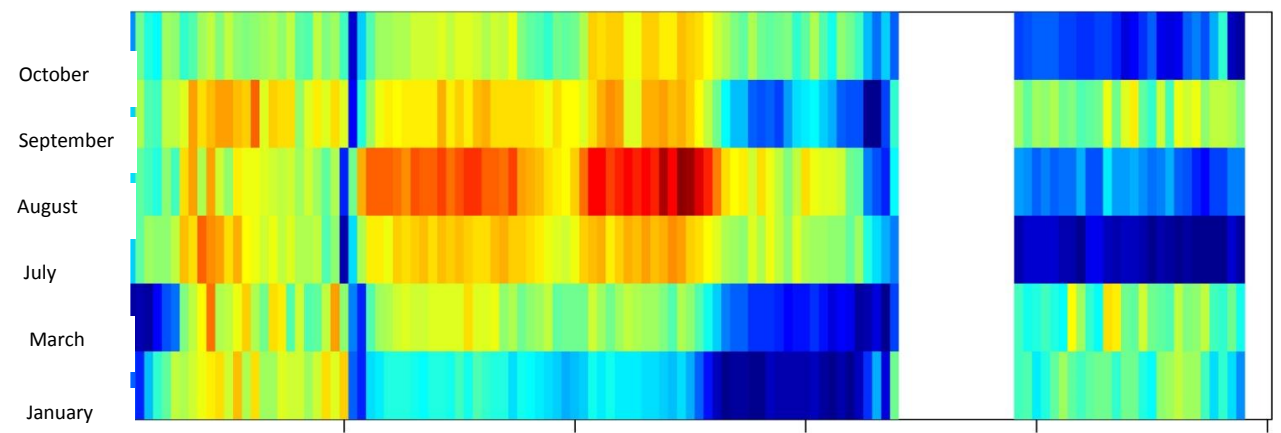
REMOTE SENSING FOR FLORISTIC MAPPING?

Multi-temporal Spectral Mixture Analysis



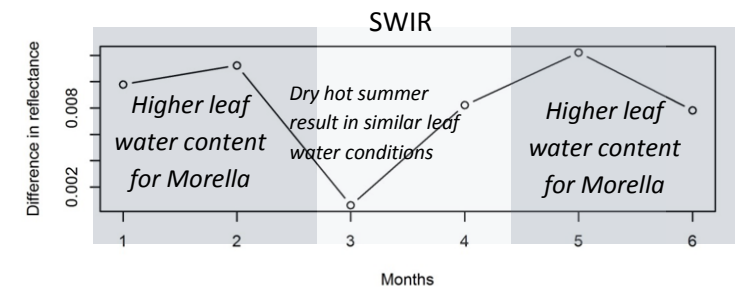
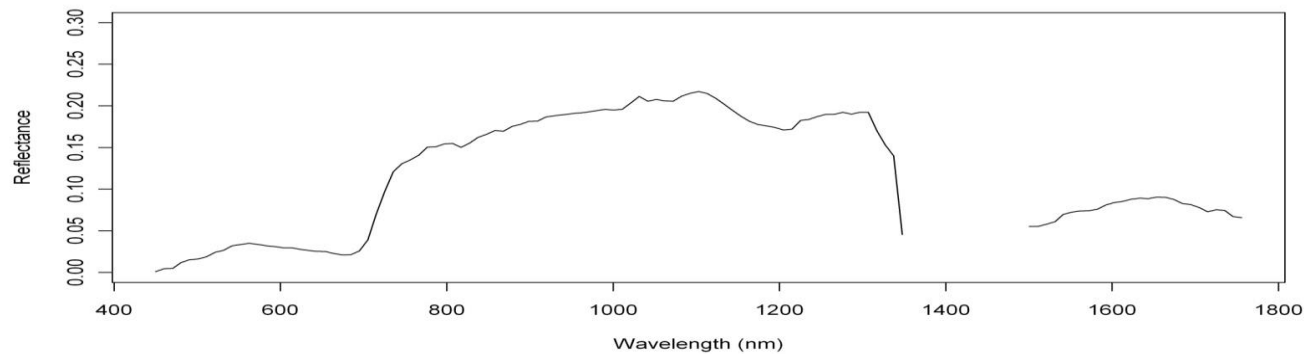
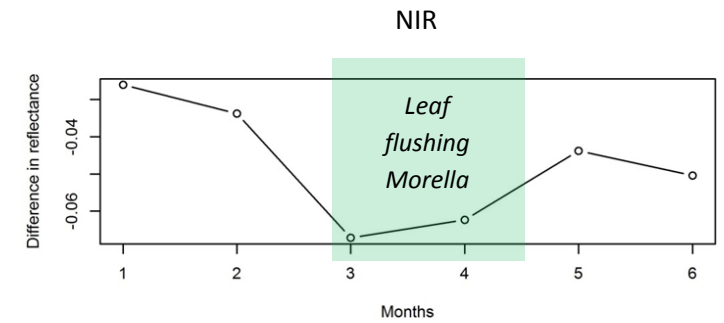
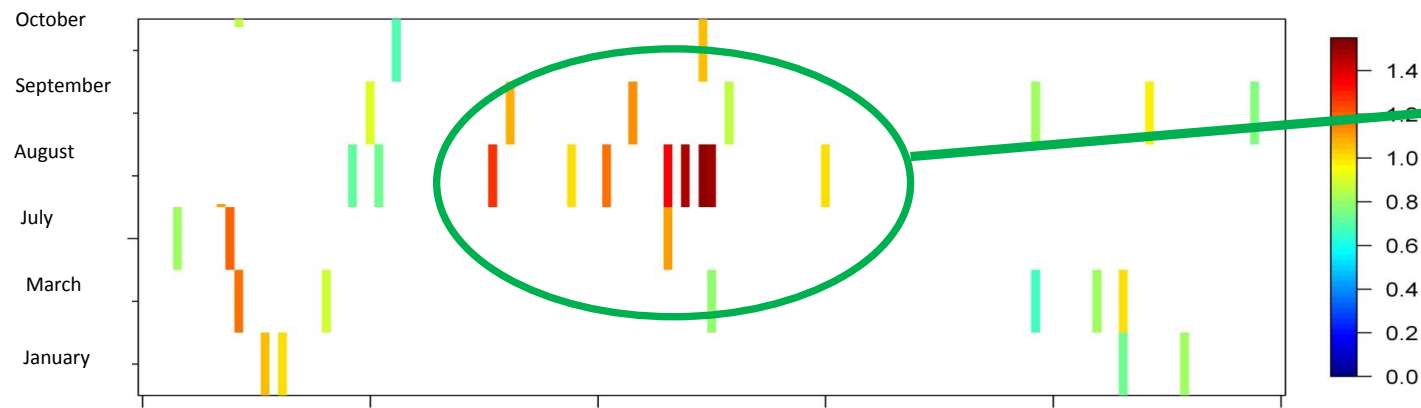
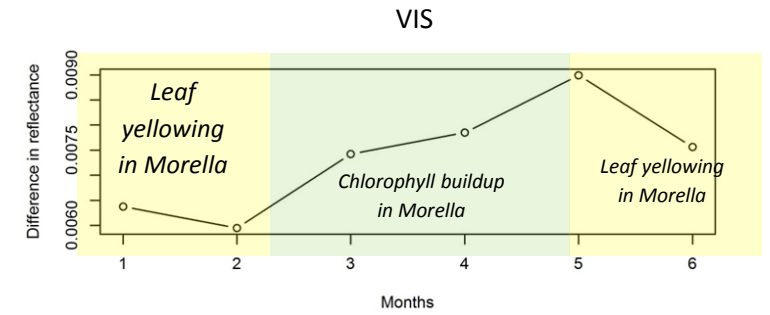
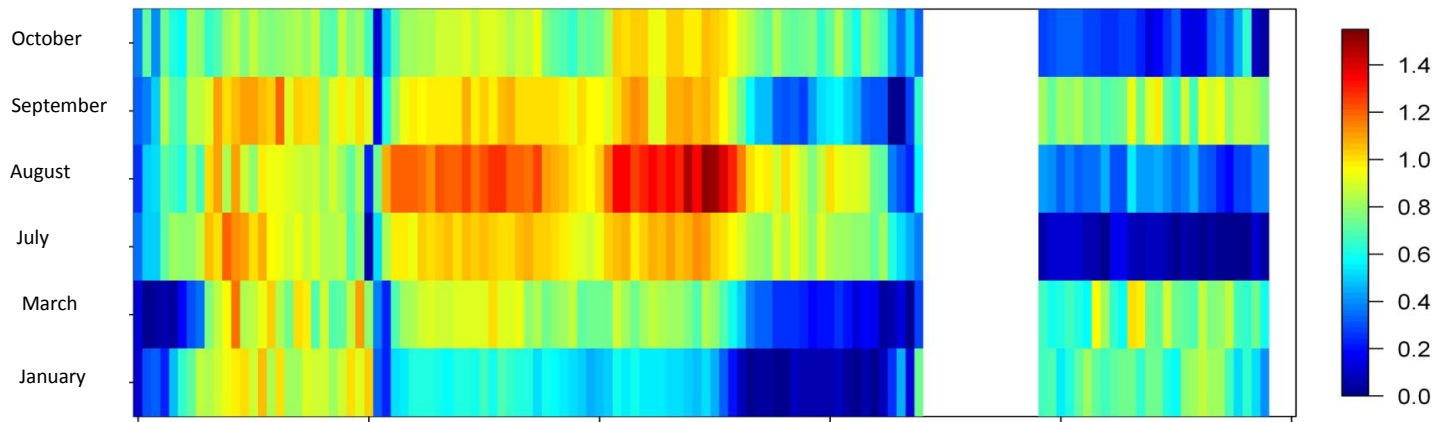
Optimal results only after proper band selection!

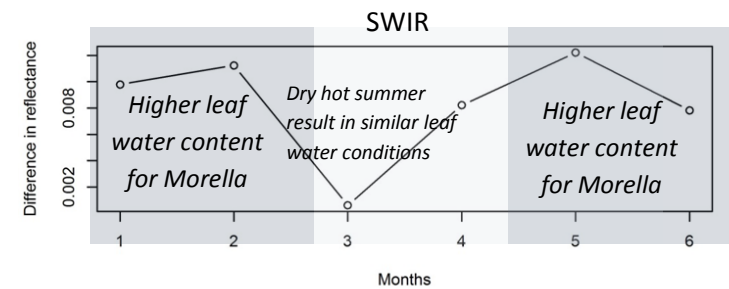
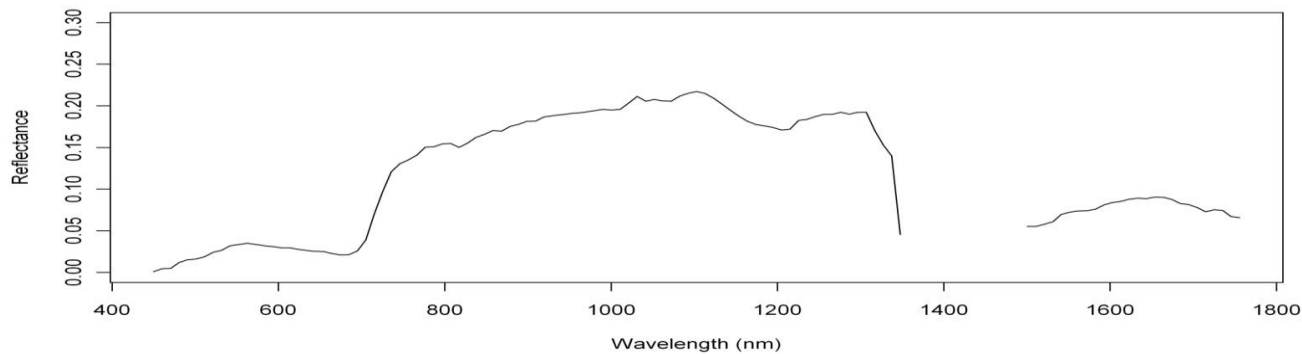
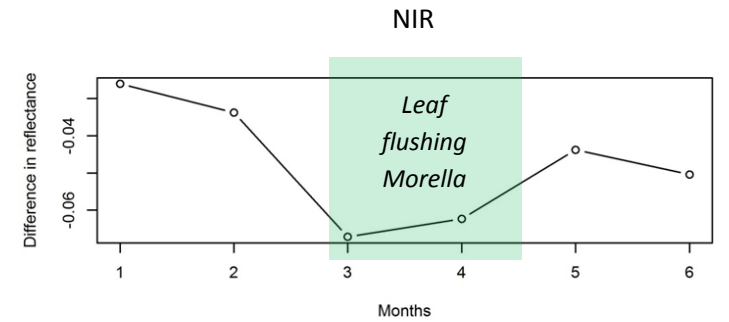
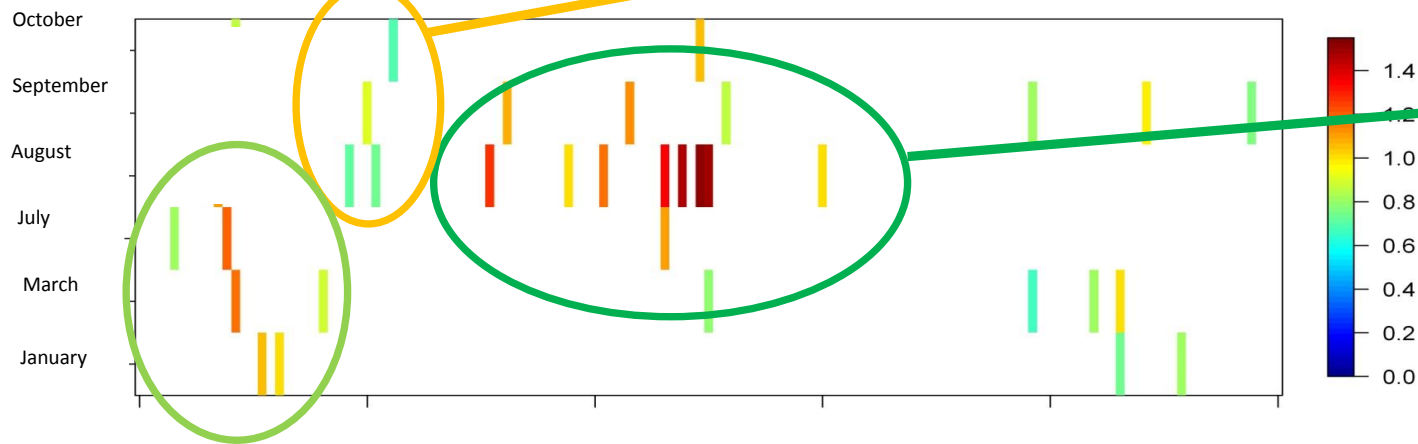
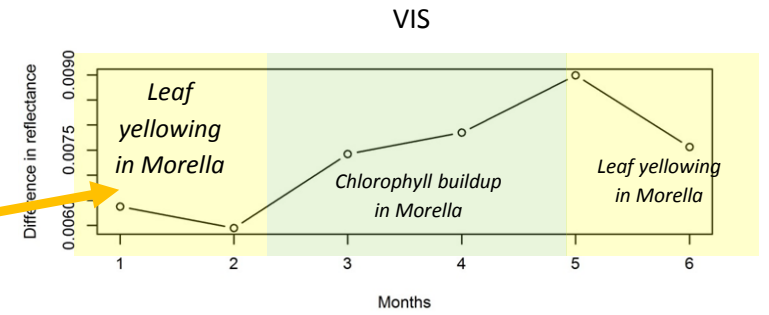
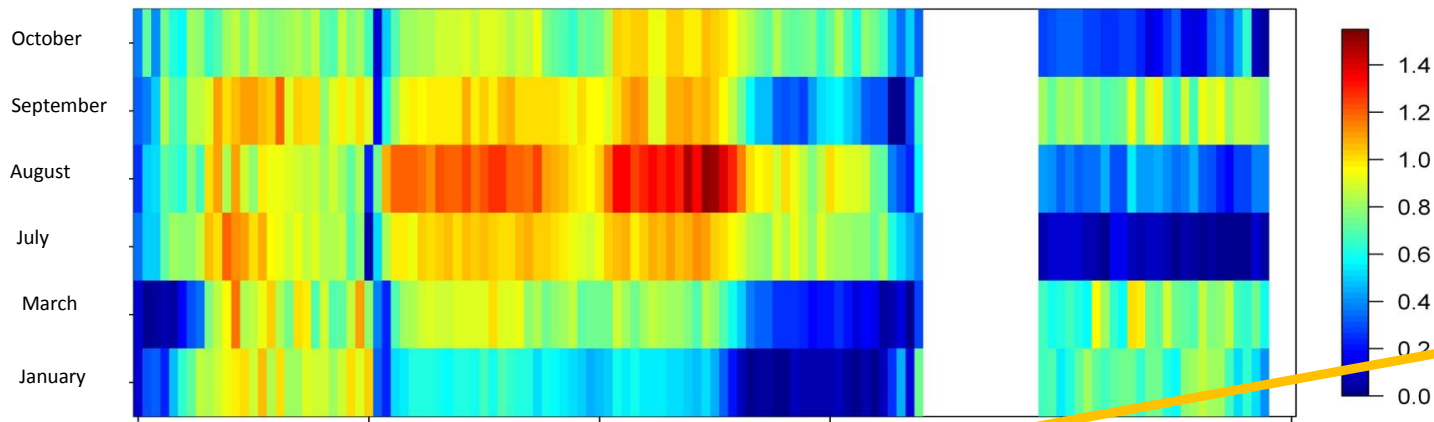
Somers & Asner, 2013, RSE
Somers & Asner, 2013, JSTARS

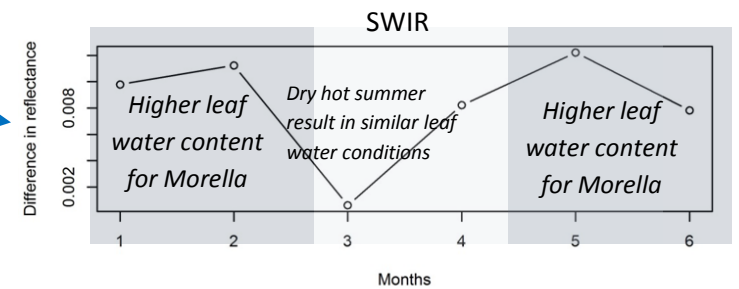
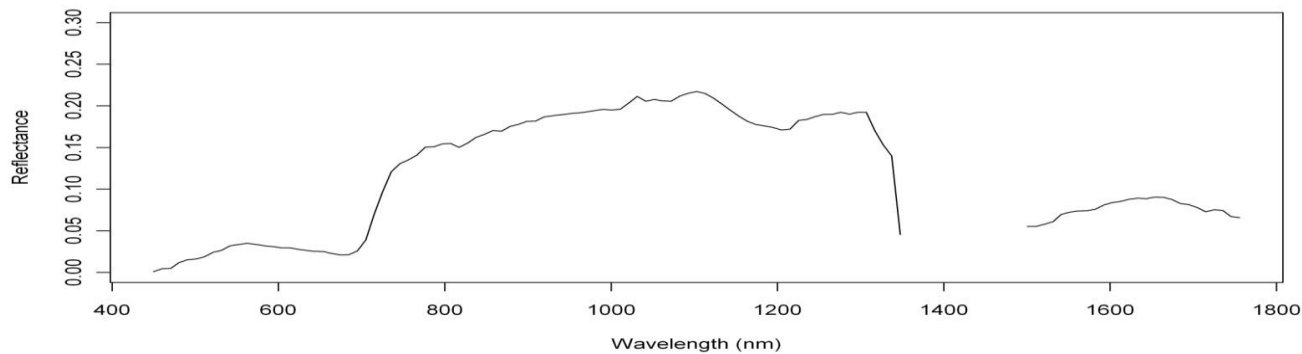
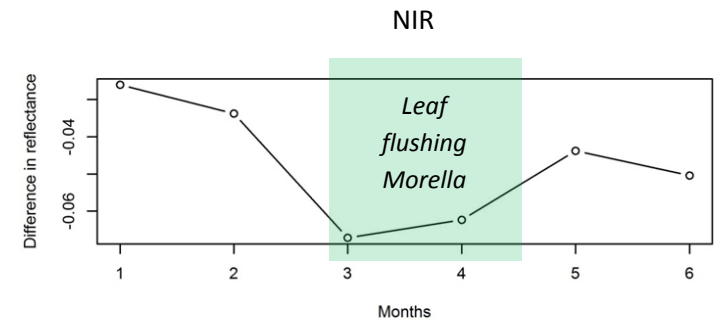
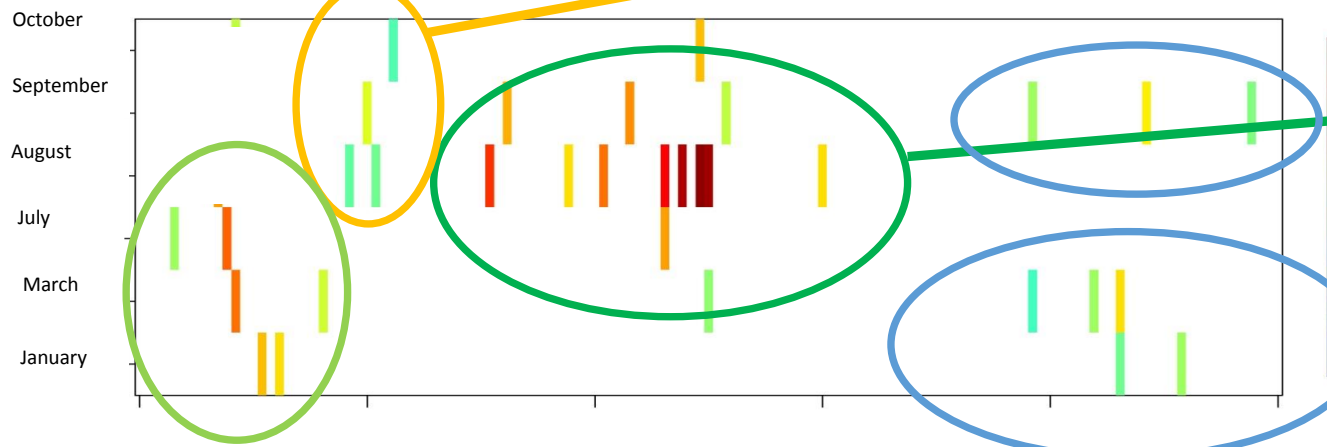
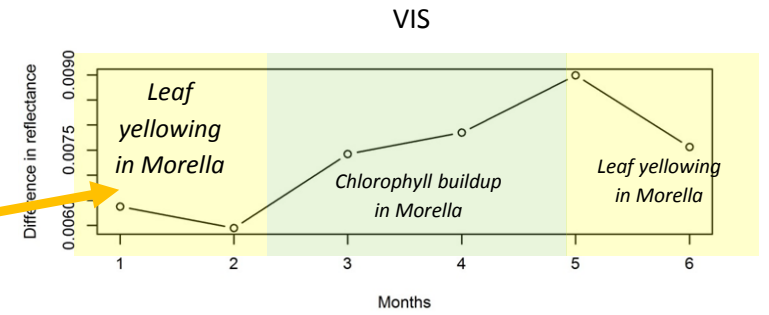
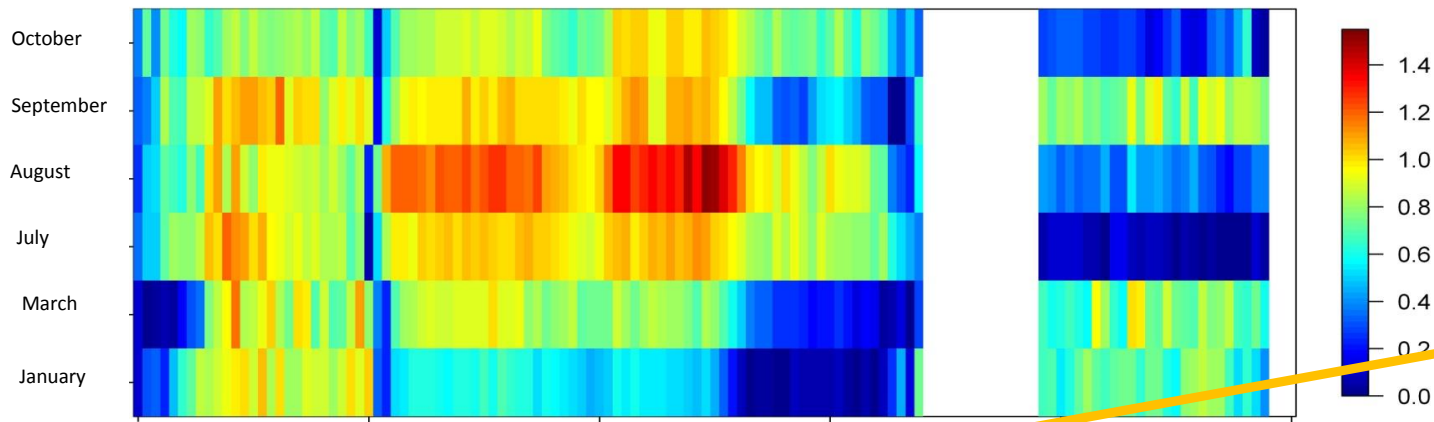


Automated
band selection
based on
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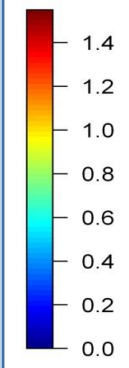
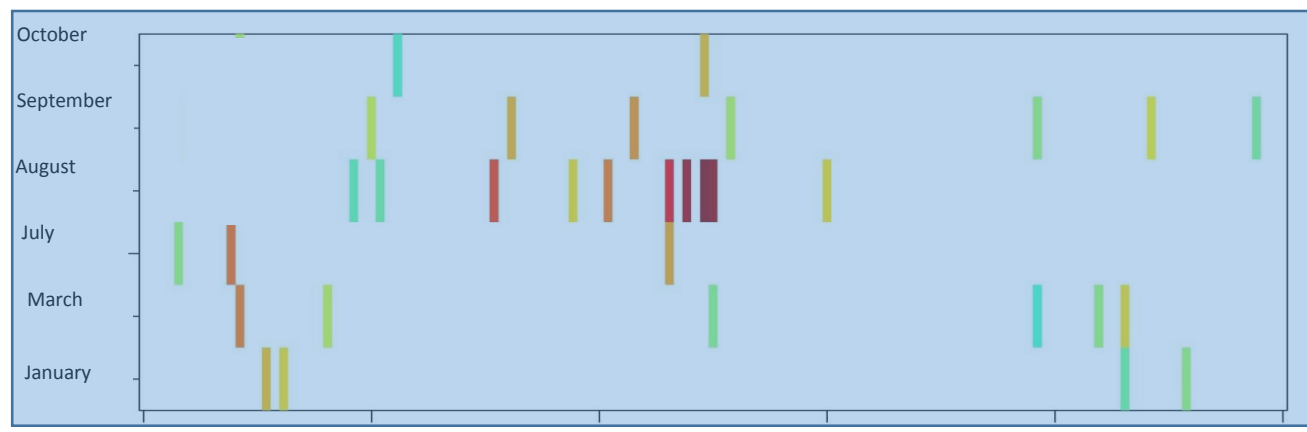
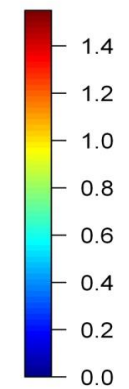
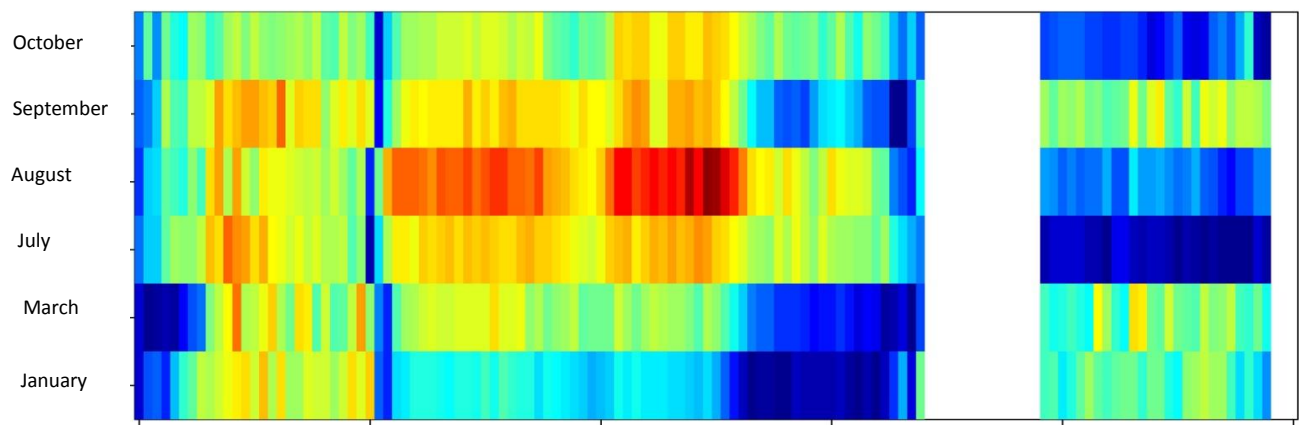




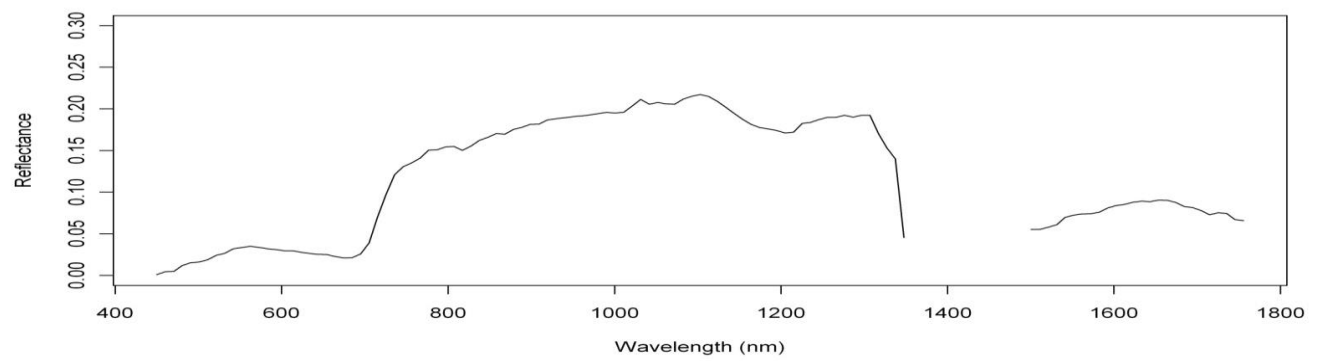


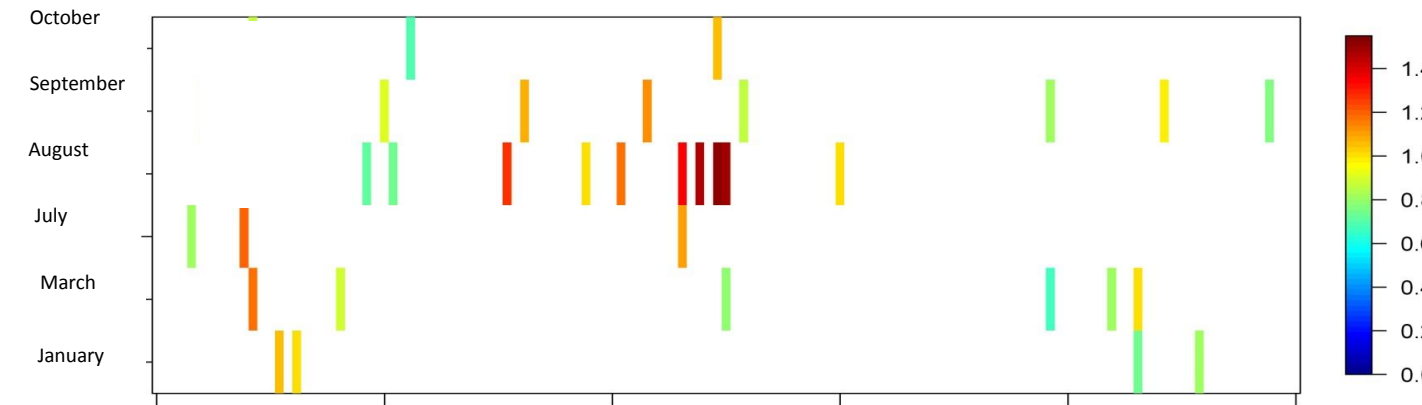
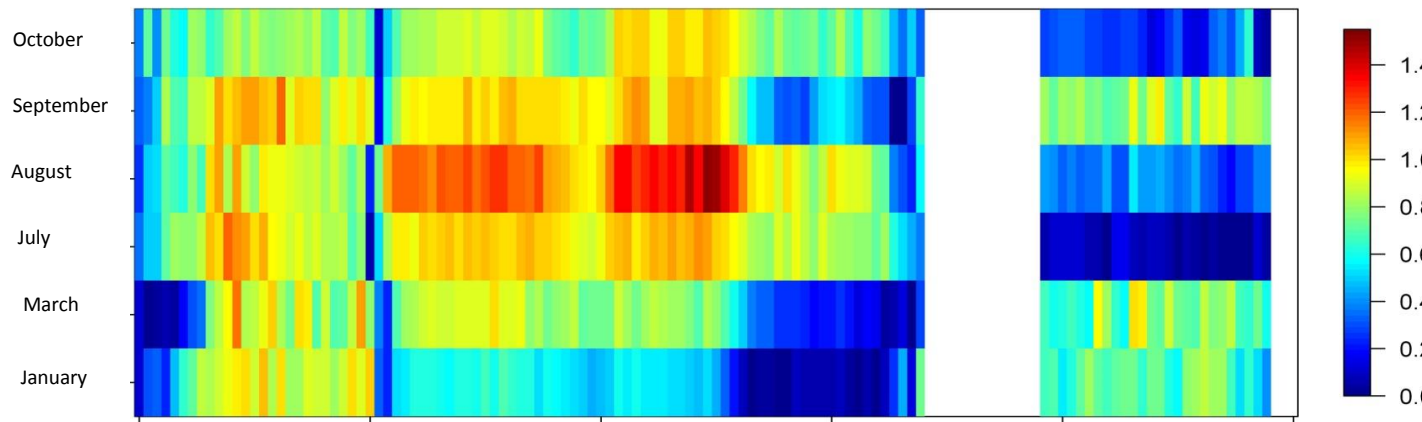


Somers & Asner, 2013, RSE
Somers & Asner, 2013, JSTARS

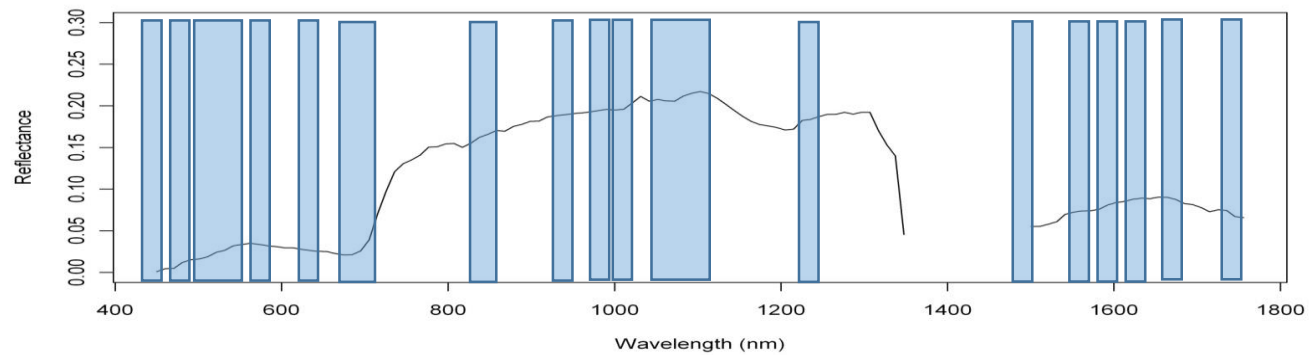


Automated
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Automated
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CONCLUSIONS

- ✓ Species mapping with remote sensing?

Multi-temporal Hyperspectral Unmixing

- ✓ Imaging spectroscopy because we need the spectral detail to highlight subtle differences among species
- ✓ Multi-temporal Unmixing because we need to capture species phenology
- ✓ Intelligent band selection, maximizing spectral separability among considered/presented species is important to highlight the critical phenological events
- ✓ Provides great benefits for mapping tree species (but also other applications in which highly similar endmembers need to be unmixed can benefit!)

CONCLUSIONS



agricultural fields



savannas



forests



QUESTIONS?

Somers, B., Asner, G.P. (2013). Invasive species mapping in Hawaiian rainforests using multi-temporal Hyperion spaceborne imaging spectroscopy. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 6, 351-359

Somers, B., Asner, G.P. (2013). Multi-temporal mixture analysis and feature selection for invasive species mapping in rainforests. *Remote Sensing of Environment*, 136, 14-27

Tits, L., De Keersmaecker, W., Somers, B., Asner, G.P., Farifteh, J., Coppin, P. (2012). Hyperspectral shape-based unmixing to improve intra- and interclass variability for forest and agro-ecosystem monitoring. *ISPRS Journal of Photogrammetry and Remote Sensing*, 74, 163-174

Somers, B., Asner, G.P. (2012). Hyperspectral time series analysis of native and invasive species in Hawaiian rainforests. *Remote Sensing*, 4, 2510-2529

Somers, B., Zortea, M., Plaza, A., Asner, G.P. (2012). Automated extraction of image-based endmember bundles for improved spectral unmixing. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 5, 396-408

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