

# Landsat Time Series-based Vegetation Change: Context for Understanding Ecological Legacies

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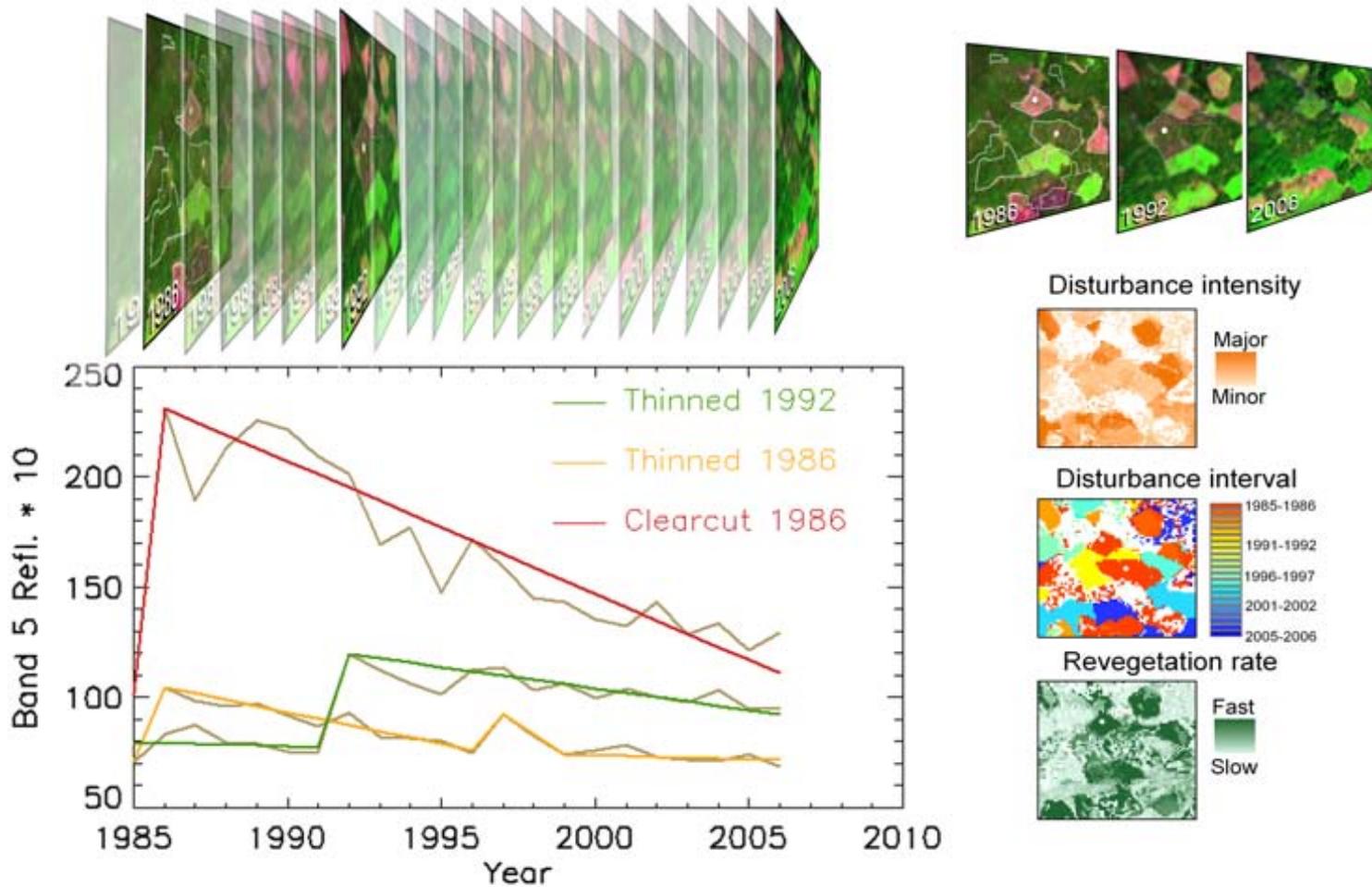
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Landsat Science Team Meeting, June 15-17, 2010

## Landsat: Setting the Ecological Context

- Recent advances in improved radiometric normalization, atmospheric correction, and cloud/shadow masking allow for more efficient processing of large multitemporal (and now, freely downloadable!) image stacks.
- The resultant (and continually evolving) record of vegetation cover and change dynamics is a tremendous resource for ecological investigation because they help explain spatial patterns of *ecological legacies*.
- Studies of ecosystem structure and function will increasingly rely upon understanding these patterns of ecological legacies as established by Landsat.

# Landsat: Setting the Ecological Context



Kennedy et al., 2007

# Ecological Legacies: Forks in the Road

- Anthropogenic activities can create complex feedback loops in ecological systems that persist long after human abandonment

## Pre-Columbian agricultural landscapes, ecosystem engineers, and self-organized patchiness in Amazonia

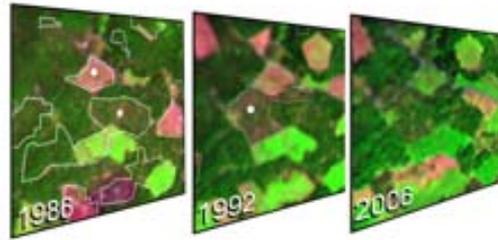
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- These feedbacks lead to new ecological steady states with respect to
  - Ecosystem Structure
  - Species Interactions
  - Biogeochemical Dynamics

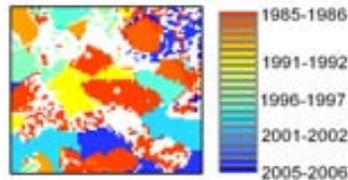
# Ecological Legacies: Landsat as Bellwether



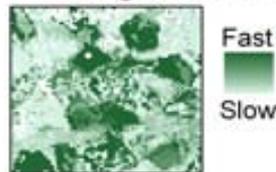
Disturbance intensity



Disturbance interval



Revegetation rate



Will feedbacks lead to new ecological steady states with respect to:

1. Ecosystem Structure

2. Species Interactions

3. Biogeochemical Dynamics

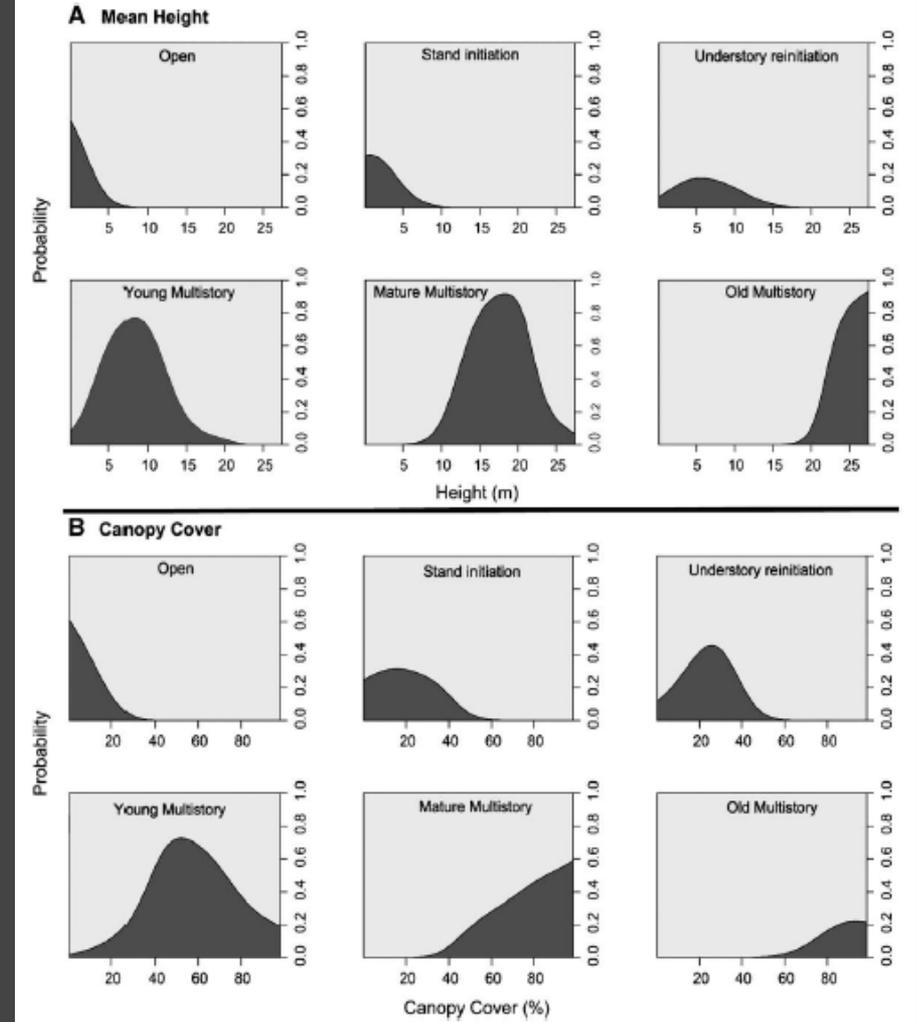
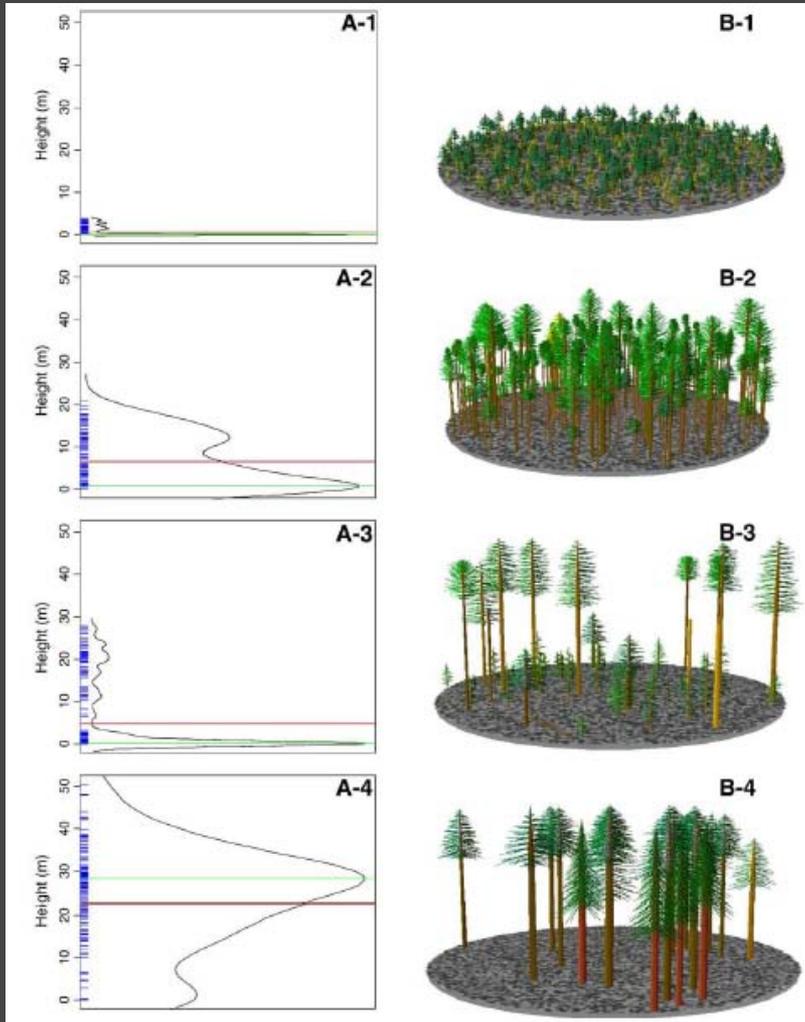
...at landscape to regional scales?

# Natural History at the Landscape Scale

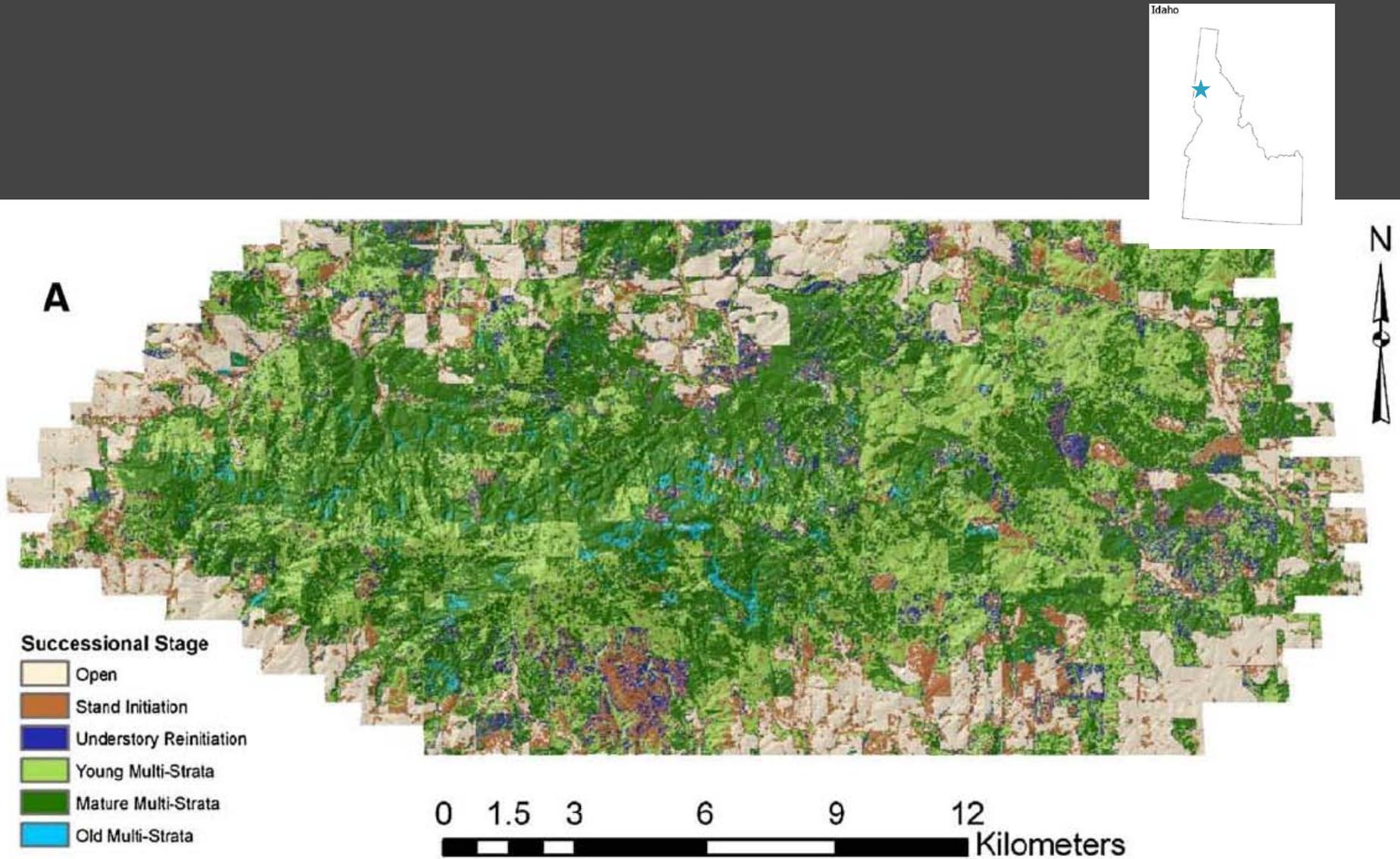
- Our goal is to understand the ripple effects of these Landsat-detected LULC changes on:
  - Successional trajectories
  - Interactions among organisms at multiple trophic levels
  - Ecosystem services
  - Vegetation phenology: inter- and intra-annually
- Many of these changes are subtle. So, we are developing additional remote sensing approaches to complement the capabilities of Landsat
- On to a brief tour....

# The Legacy of Ecosystem Structure

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# The Legacy of Ecosystem Structure

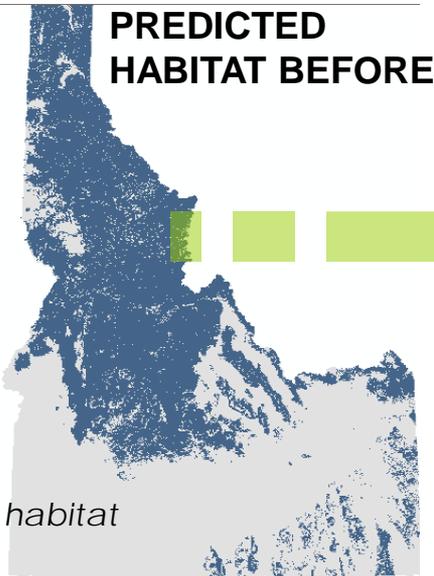


# Ecosystem Structure → Species Interactions

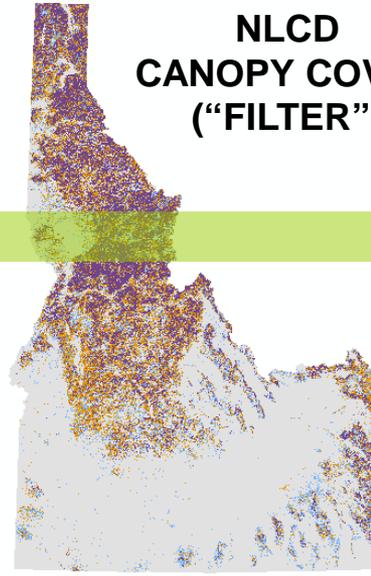


© Mary Clay/CLO

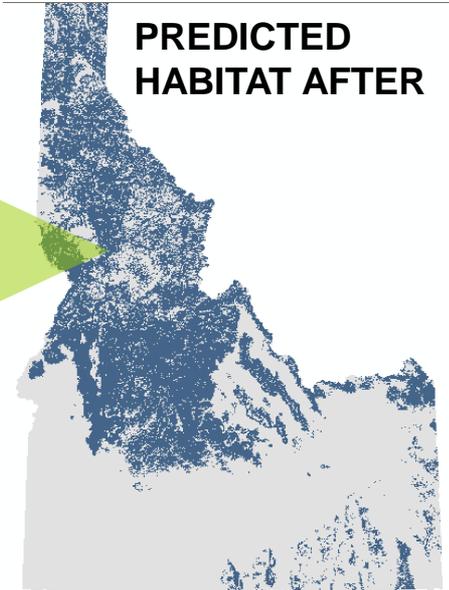
*Clark's Nutcracker habitat*



**PREDICTED  
HABITAT BEFORE**



**NLCD  
CANOPY COVER  
("FILTER")**



**PREDICTED  
HABITAT AFTER**

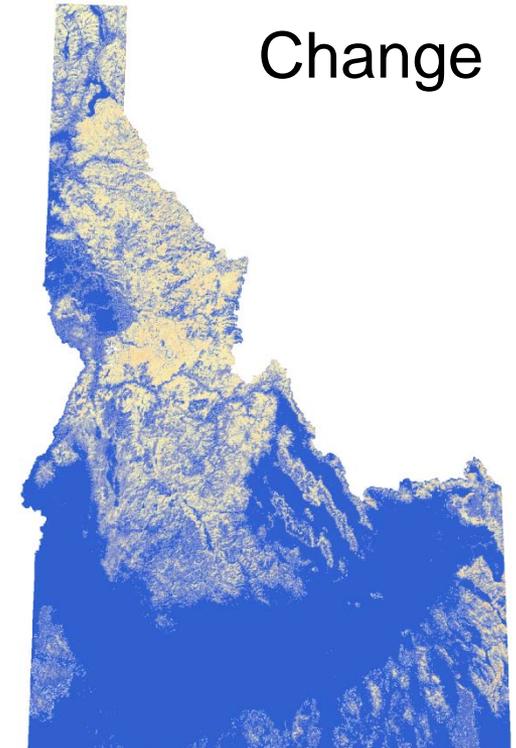
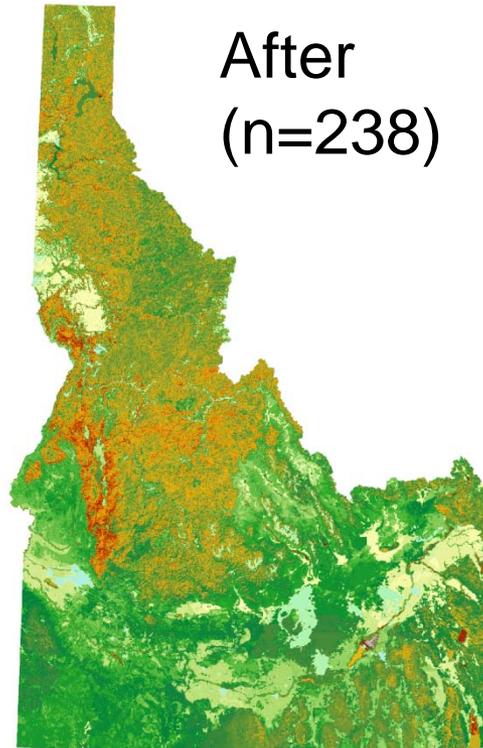
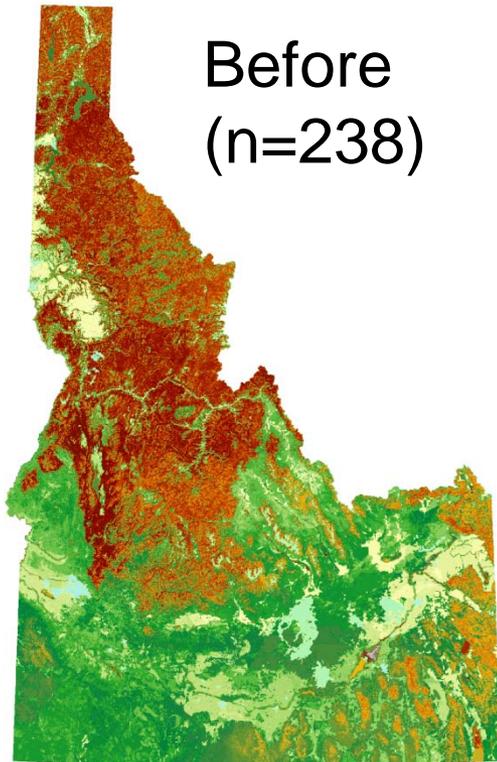


*Blue Grouse habitat*



*Martinuzzi et al., J. Appl. Rem. Sens., 2009a*

# Ecosystem Structure → Species Interactions



Number of species

1 10 20 30 40 50 60 70 90 100 110 121



%

-60 -50 -40 -30 -20 -10 0

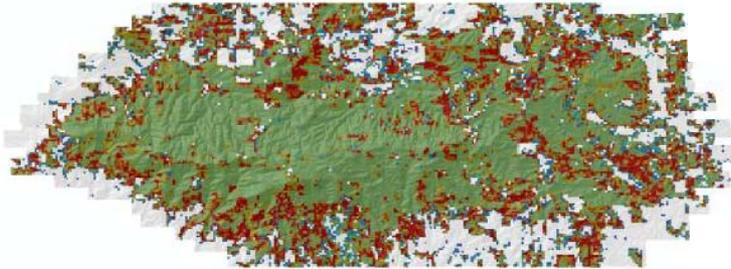


# Ecosystem Structure → Species Interactions

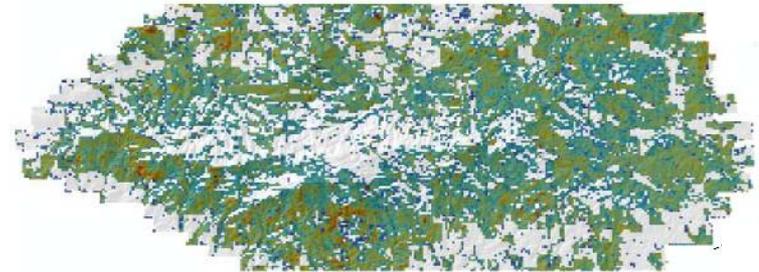


*Moscow Mountain successional map, refined to locate snags and understory shrubs using lidar and Landsat-informed field sampling*

Downy woodpecker



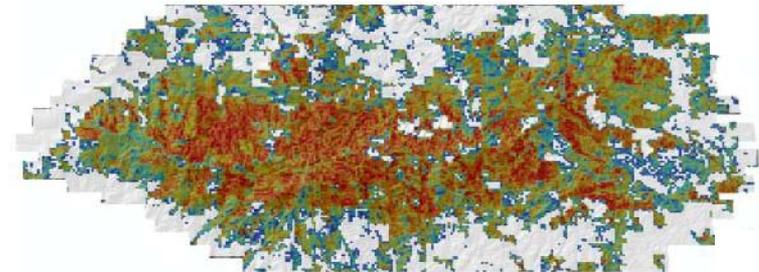
Dusky flycatcher



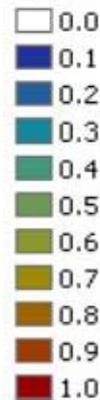
Lewis's woodpecker



Hairy woodpecker



HSI



-5.0 -2.5 0 5.0 km

Mapping accuracy = 79% to 91%

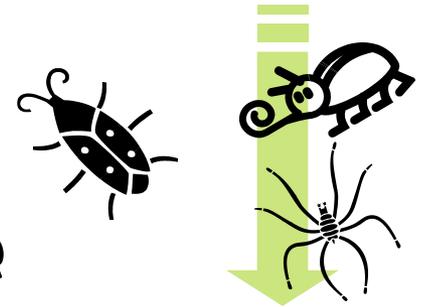
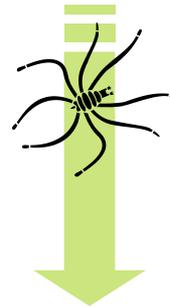
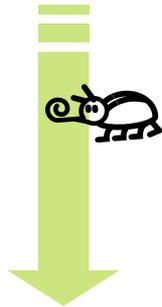
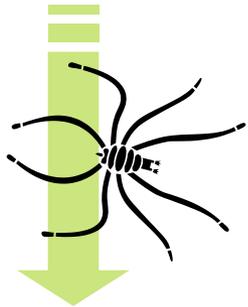
# Primary Producers

Snags  $\geq$  30cm

Understory shrubs

Snags  $\geq$  15cm

Snags  $\geq$  25cm



Lewis's woodpecker



Dusky flycatcher



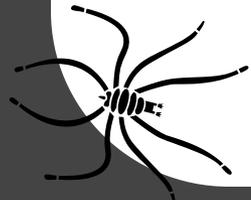
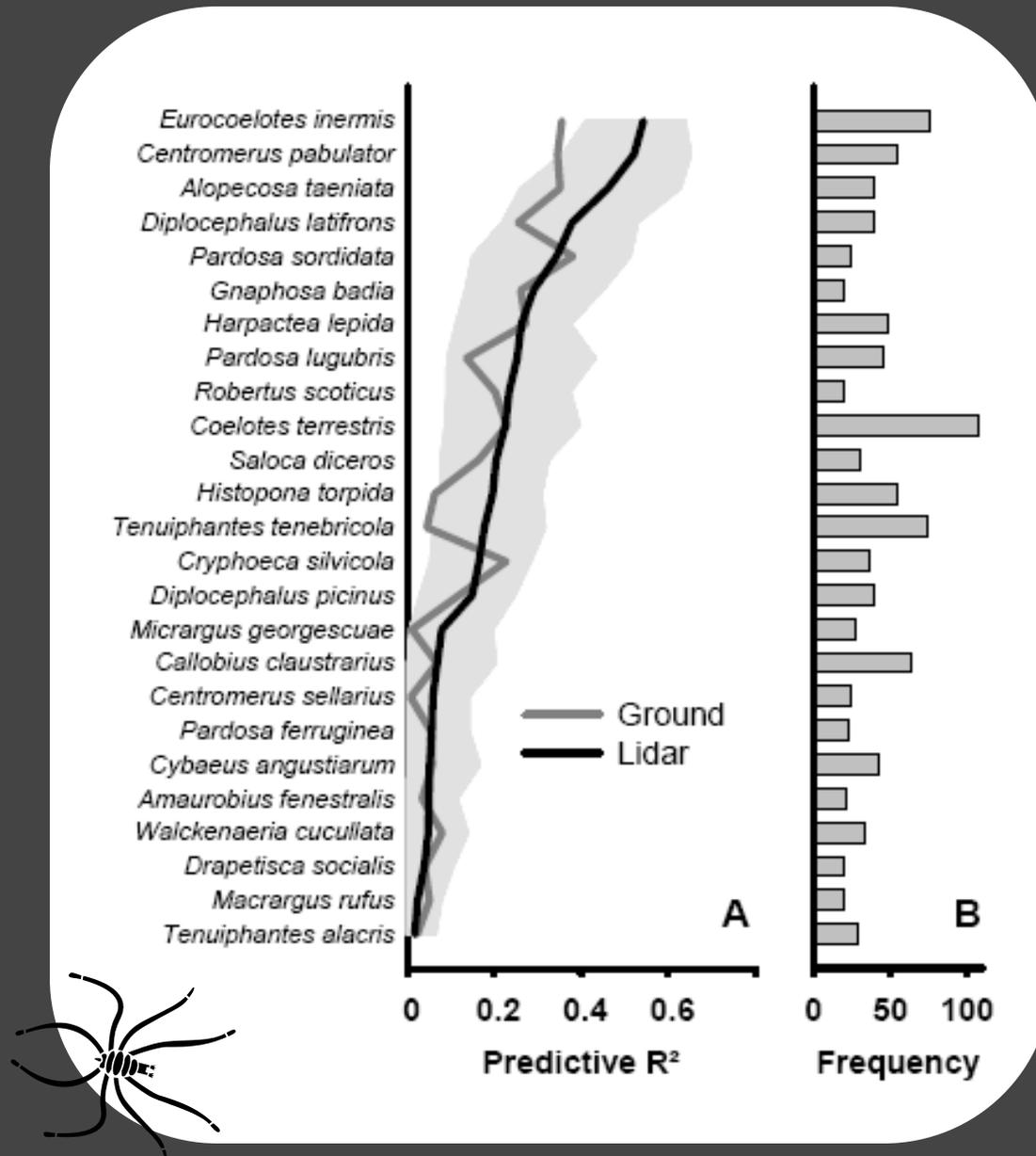
Downy woodpecker



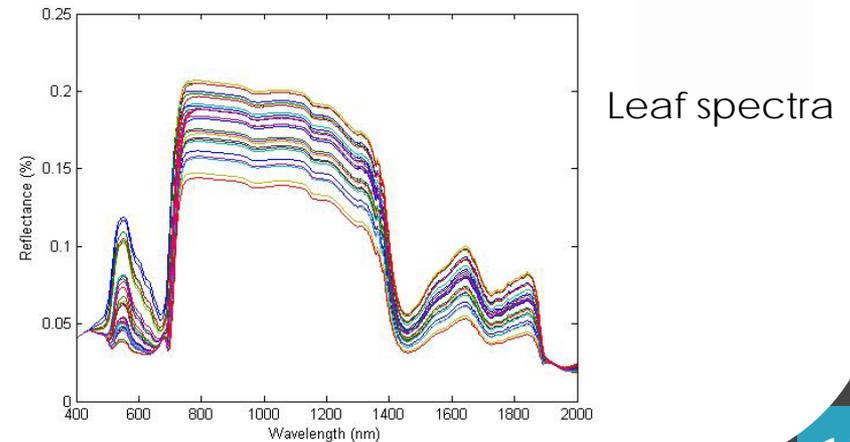
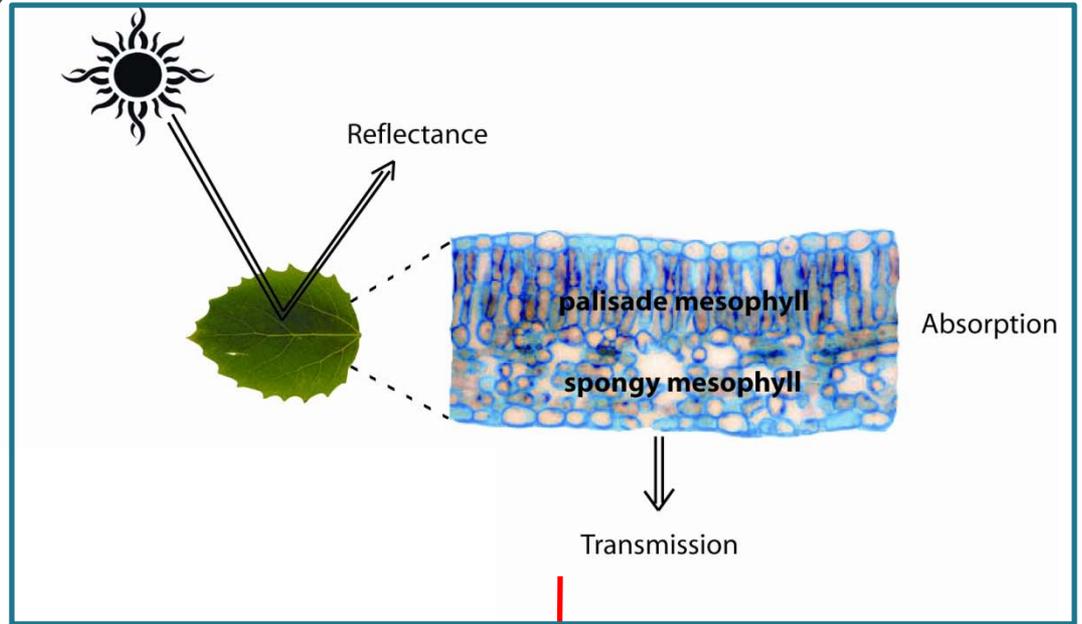
Hairy woodpecker

# Secondary Consumers

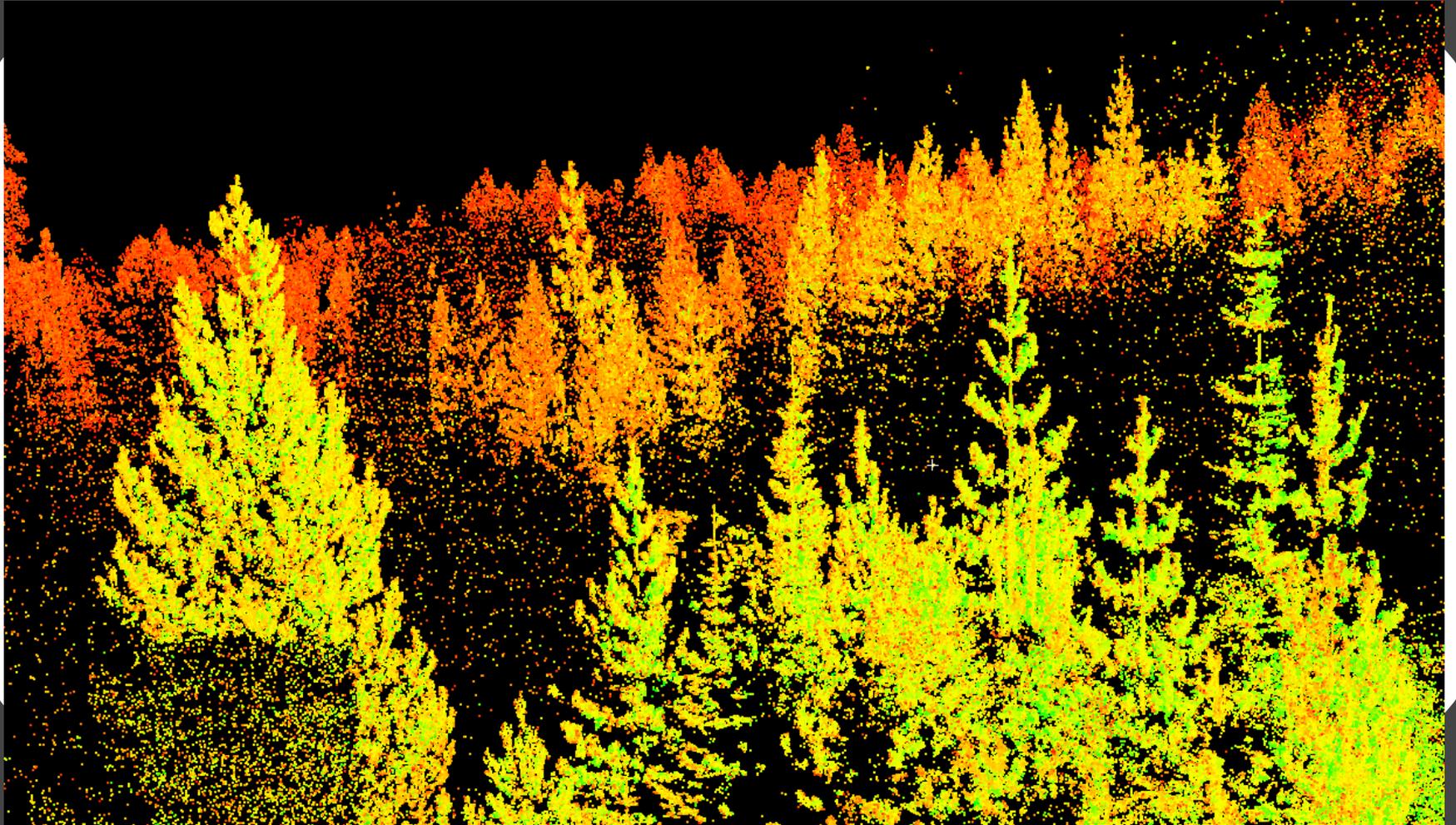
# Ecosystem Structure → Species Interactions



# Insights to Biogeochemical Legacies?



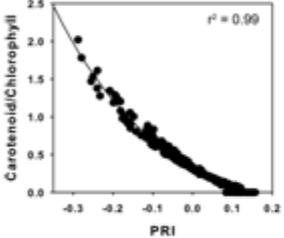
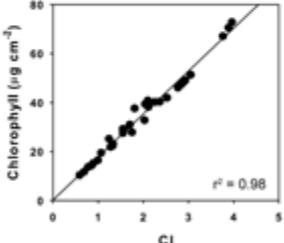
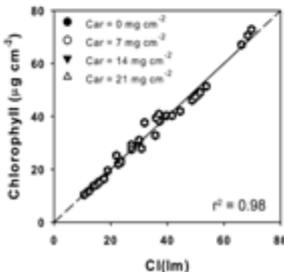
# Insights to Biogeochemical Legacies?



# Insights to Biogeochemical Legacies?

*Goal: deriving pools of foliar pigments using RS*

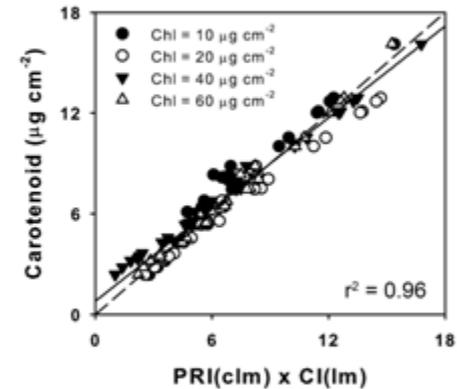
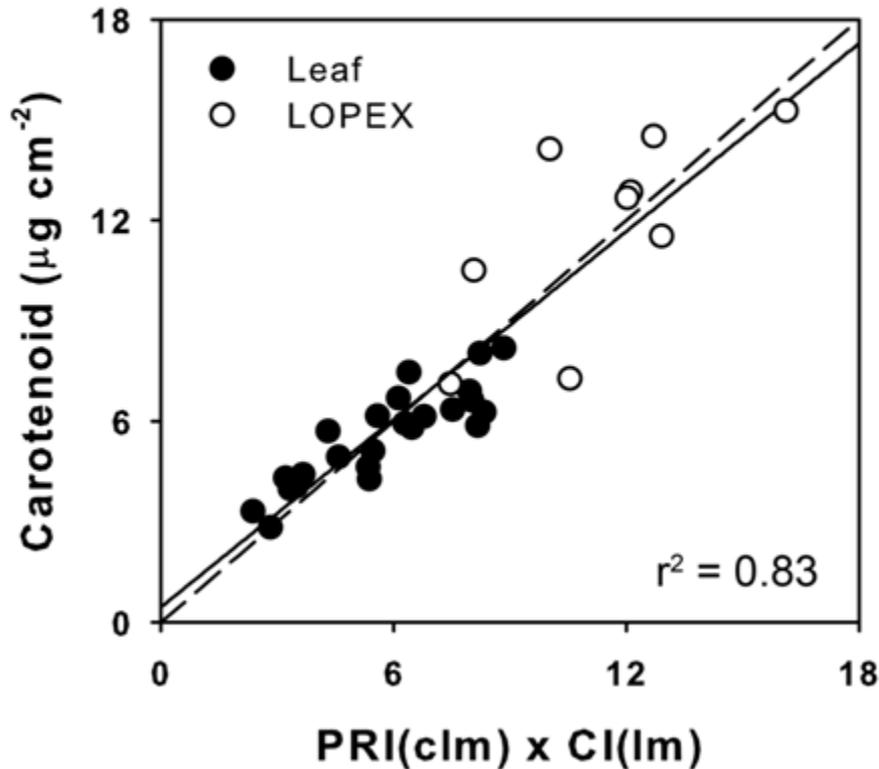
$$\text{Carotenoid} = \frac{\text{Carotenoid}}{\text{Chlorophyll}} \times \text{Chlorophyll} \longrightarrow \text{Carotenoid} = \text{PRI} \times \text{CI}$$

Requirements	Results
1) PRI related to the Car/Chl ratio	
2) Index related to Chl content	
3) Chl index unaffected by Car content	

# Insights to Biogeochemical Legacies?

Goal: deriving pools of foliar pigments using RS

$$\text{Carotenoid} = \text{PRI} \times \text{CI}$$



# Understanding Ecological Legacies at Broad Scales

Disturbance context from the Landsat archive

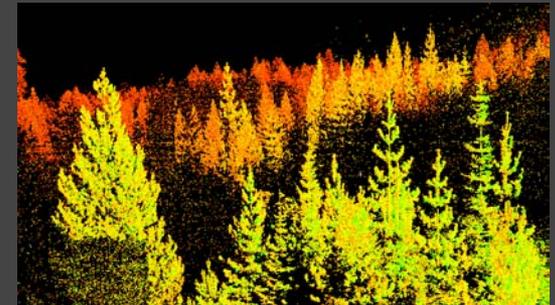


Landscape-scale information about:

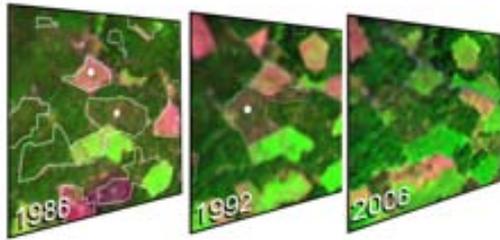
Ecosystem 3D Structure

Species Interactions

Biogeochemical Dynamics



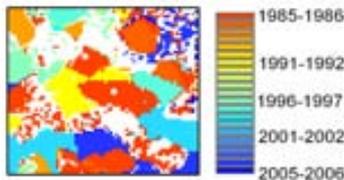
Improved insight into the long-term effects of human land use and land cover change



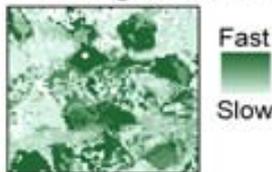
Disturbance intensity



Disturbance interval



Revegetation rate



Thank you.

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