Decadal-Scale Dynamics of Land Ownership, Land Management and Carbon Storage Patterns in the Southeastern Coastal Plain Region of the U.S.

LCLUC ST Meeting 2001
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Research Team

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Objectives of the Study

(1) to determine the links between changes in land ownership, land management, land cover change, and carbon storage patterns within the southeastern lower coastal plain region of the United States;

(2) to determine the effects of specific land ownership patterns on the carbon storage and sequestration rates of representative regional ecosystems at already established long-term intensive research sites; and

(3) to establish the study area as a site for long-term monitoring of carbon storage patterns.

Study Area

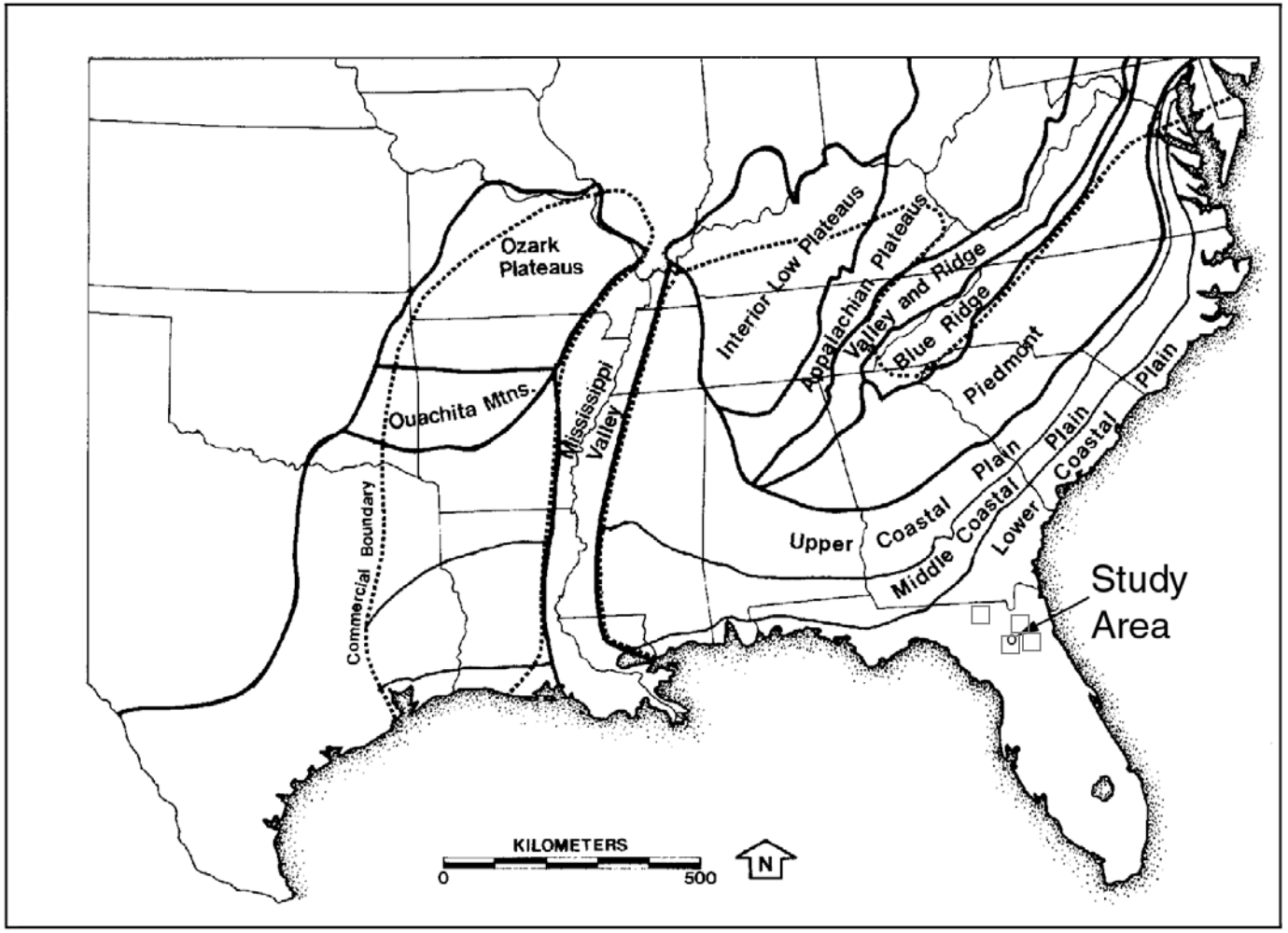
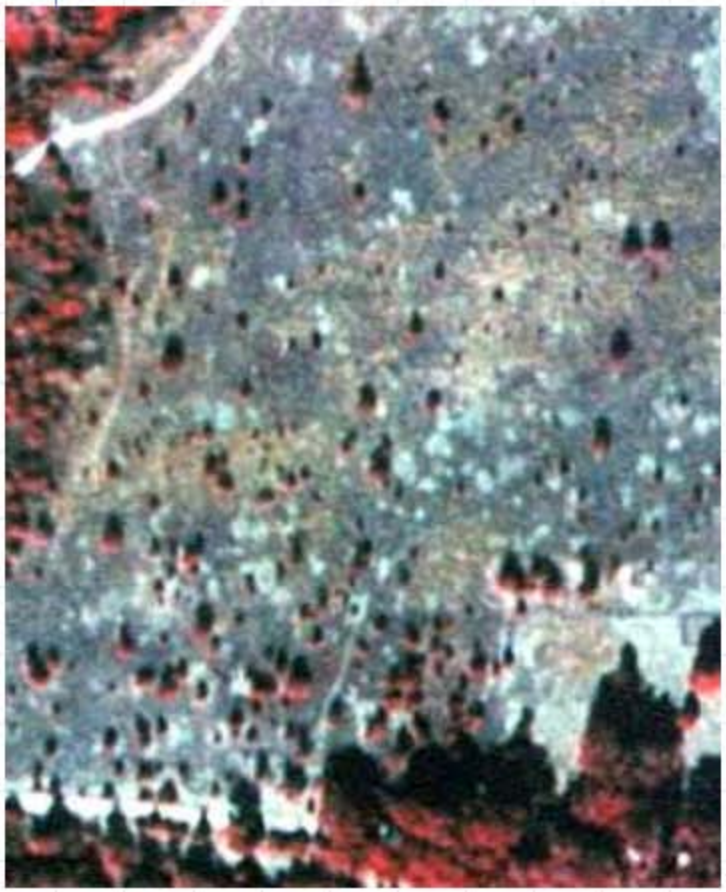


Figure 2. Physiographic provinces of the southeastern U.S.

Agriculture

Improved Pastures



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FIELD PICTURE

Urban and Built-up

Extractive

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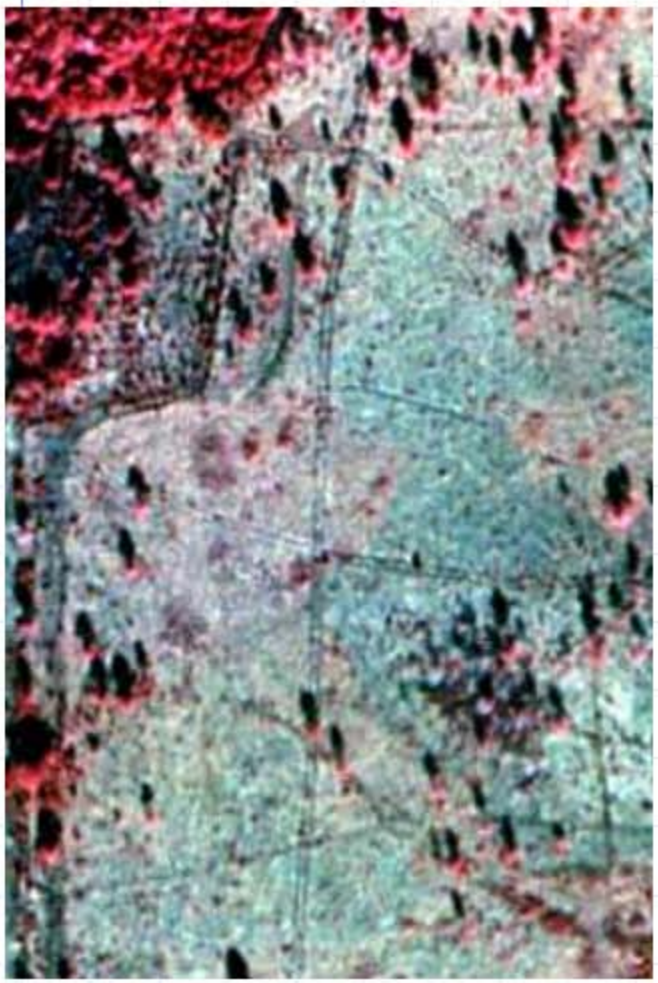
Agriculture

Woodland Pastures



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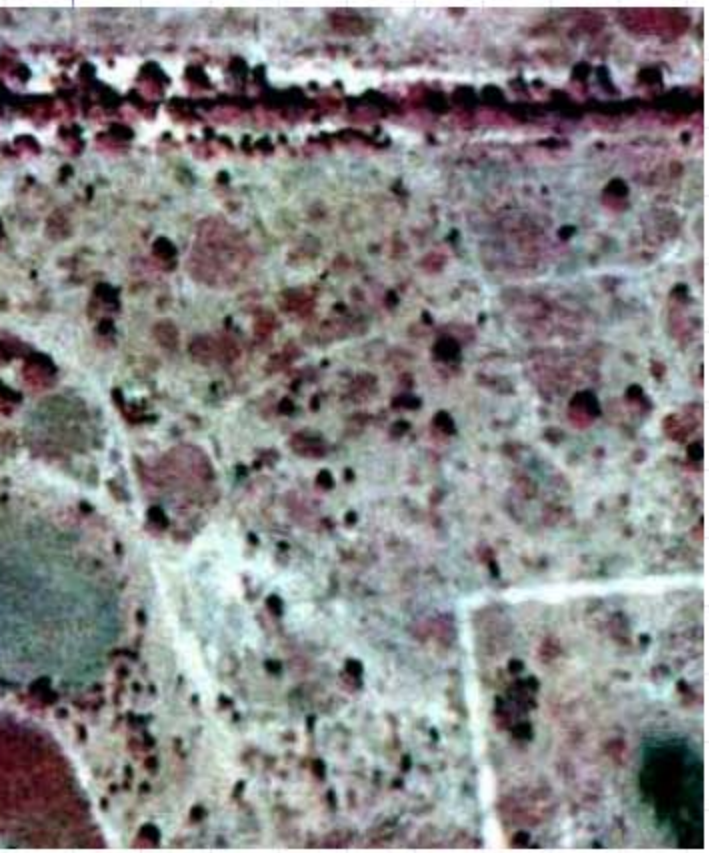
FIELD PICTURE

Upland Non-forested

Shrub and Brushland



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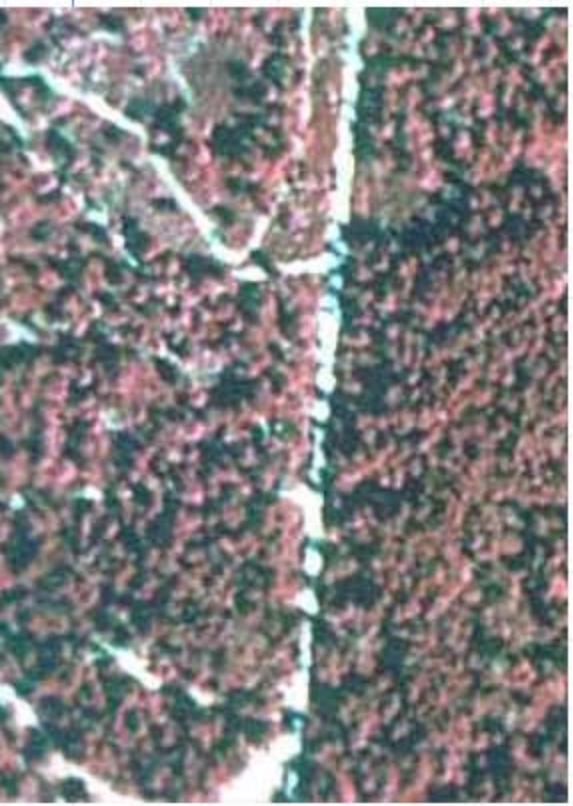
FIELD PICTURE

Upland Forest

Pine Flatwoods



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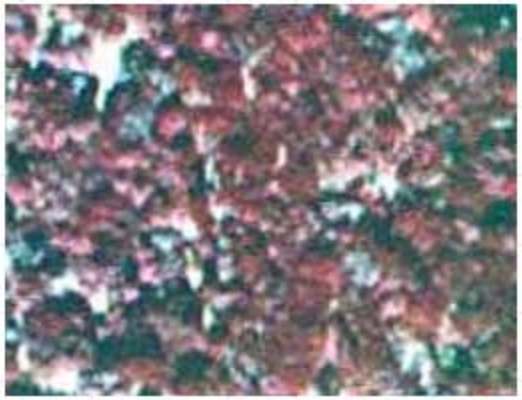
FIELD PICTURE

Upland Forest

Upland Hardwood Forest



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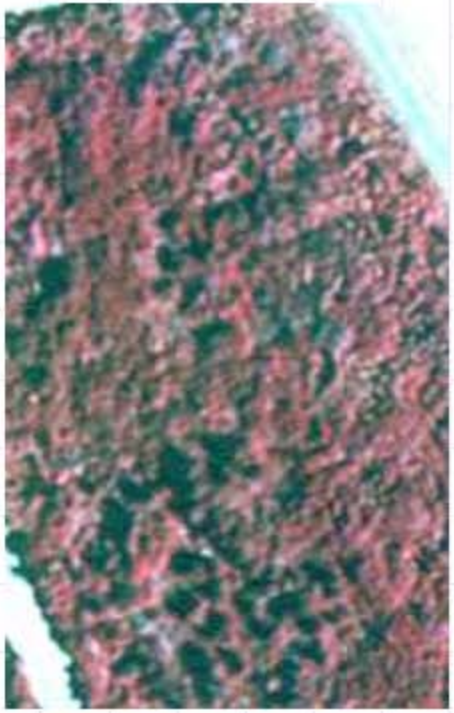
FIELD PICTURE

Upland Forest

Xeric Oak



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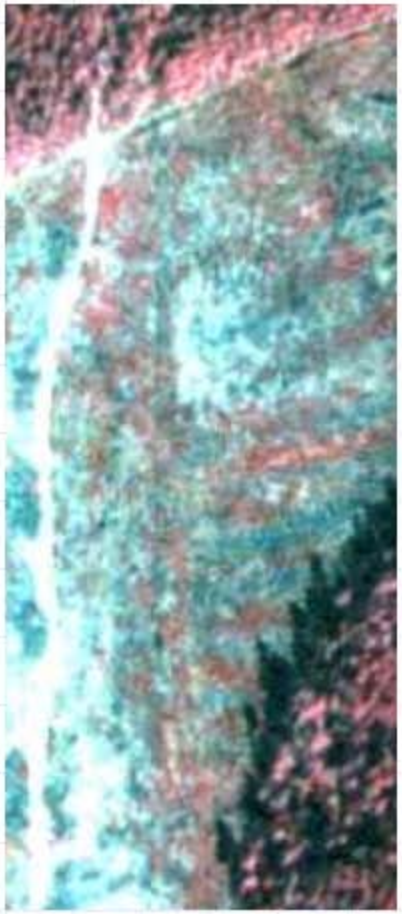
FIELD PICTURE

Upland Forest

Tree Plantations



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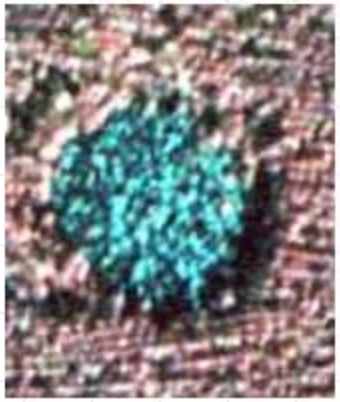
FIELD PICTURE

Wetlands
(Cypress)



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Barren Land

Disturbed Land (After Fire)

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Study Area

- **Lower coastal plain, historically longleaf pine flatwoods with frequent fire.**
- **Soils primarily sands – low nutrients.**
- **Major landowners are forest industries and non-industrial private landowners, many of whom lease forests to industries.**
- **Major land use is plantation loblolly or slash pine forests (~agriculture).**
- **Fire suppression – fire frequency has decreased, intensity increased.**
- **C accumulates in litter – fires rapid, intense, and destructive.**
- **Highly dynamic landscape in space and time.**
- **High spatial variability; flat, but minor elevation changes = desert to wetland.**
- **Highly dynamic temporally**
  - **Harvest cycles; 25-yr recently changed to 20-yr in some cases.**
  - **Climate, moist but inter-annual variability quite high – multi-year droughts.**
  - **Fires**

Study Area - Forests

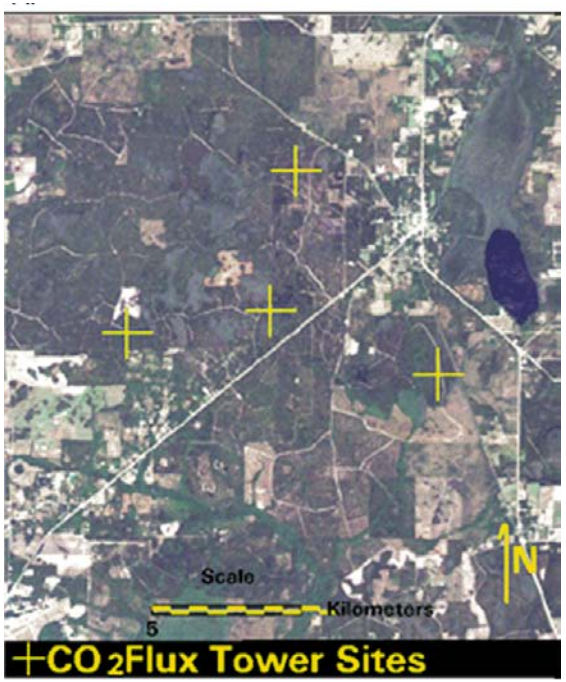
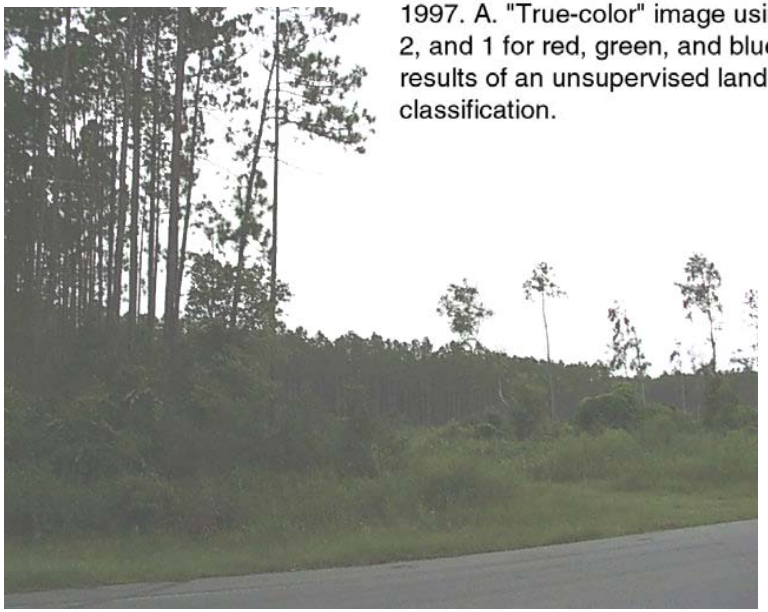


Figure 2. Landsat TM imagery from 27 March 1997. A. "True-color" image using bands 3, 2, and 1 for red, green, and blue. B. Interprete results of an unsupervised land-cover classification.



Study Area - Fire

Prescribed burning in slash pine plantation – rare management practice.

Accidental fire in cypress wetland

Study Area – Other

Phosphate mining in Hamilton County

Heritage for the Study

- Ecosystem studies in SE U.S., especially Florida since ‘50’s
  - H.T. Odum
  - S. Brown, A. Lugo, K. Ewel, et al.
  - H. Gholz
- Forest ecological productivity with remote sensing approaches in study area since 1979
  - Gholz, P. Curran

Methods

- The three objectives will be addressed by:
- 1. Determining changes in land-cover and land-use patterns in the lower Coastal Plain region from 1975 - 2000.
  - Analyses of archived and contemporary satellite remote sensing data in 4 sample areas (~15 by 15 km each) within a single Landsat Thematic Mapper or Multi-Spectral Scanner (TM/MSS) scene from north-central Florida and southeastern Georgia (WRS 2 Path 17, Row 39), using 2-6 scenes per year (or every other year if data budget is insufficient) for the past 25 years.
- 2. Determining changes in land ownership/tenure and management practices across the same sample areas over the past 25 years, and linking the human activities with observed land-cover changes via empirical quantitative models.
  - Analysis of parcel records from archives maintained by county tax assessors offices.
  - Interviews with land-owner representatives, inspection of some corporate records.

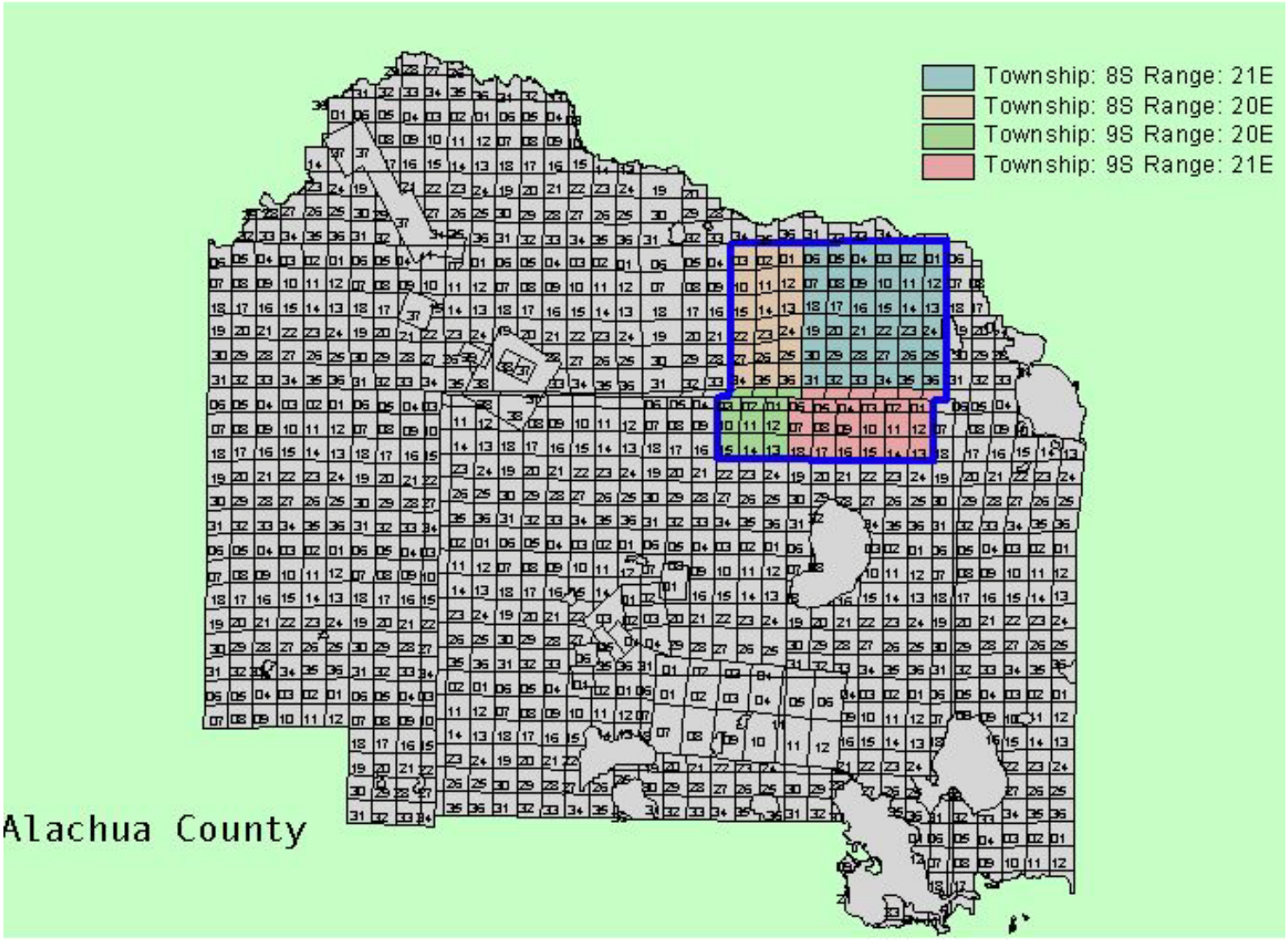
Methods

- 3. Determining changes in the regional C storage over the past 25 years
  - Estimating changes in C stored in tree, understory, leaf litter, and soil biomass over time resulting from land use changes in the sample areas, based on a synthesis of previous studies, existing data, and ongoing studies on carbon storage in regionally representative ecosystems.
  - Look-up tables, vegetation index calibration, LAI estimation, ANN approaches.
- 4. Determining the effects of environmental conditions (e.g. climate), wildfire and prescribed fire, and logging on ecosystem carbon storage, and C sequestration rates within regionally representative ecosystems
  - Measurements at existing long-term carbon dynamics research sites and archival weather and fire (state Department of Forestry) data, and land-cover change analysis of Landsat MSS and TM data.

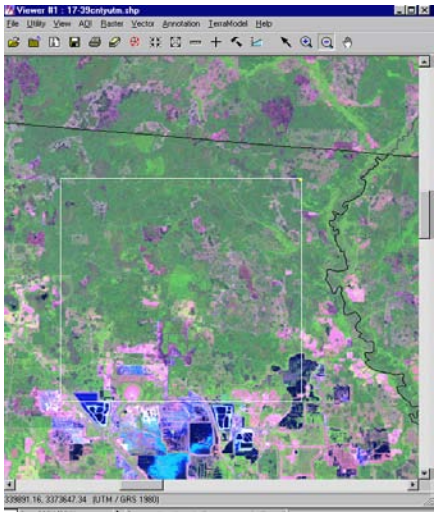
Phenology and Available Landsat Data

- 74 sufficiently cloud-free scenes available over the 25 years of the study period.
  - 2 ETM+ as of August 2000, still looking.
  - 49 TM
  - 23 MSS, some overlap with TM
- Only 2 years have complete phenological coverage
  - 1984 and 1986, maybe 1991. Drought years.
- Fall/Winter/Spring scenes are common, summer scenes are rare.
  - Inter-annual comparisons possible; major LCLUC objectives met.
  - Intra-annual variation will be difficult.

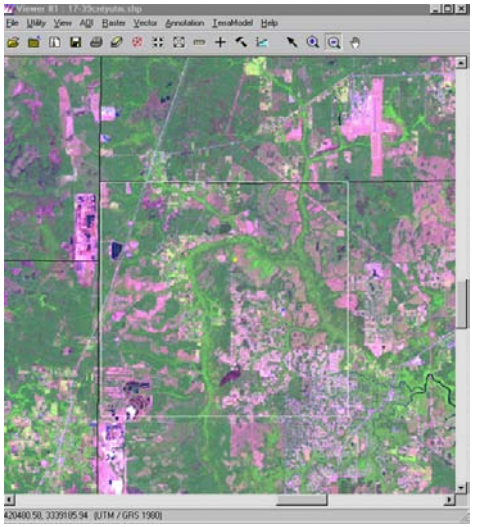
Study Areas and the Land Boundary System.



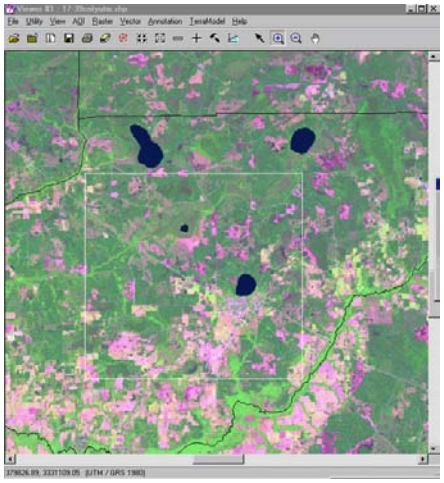
Study Areas and the Land Boundary System

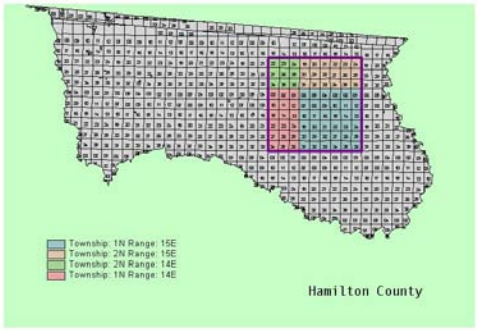


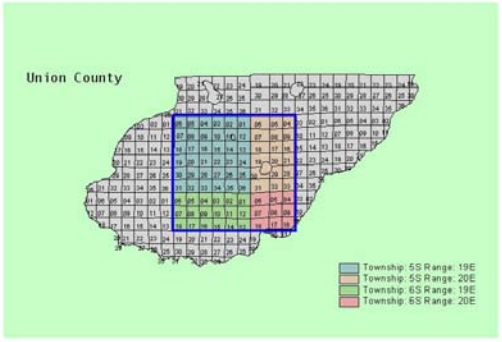
Hamilton County



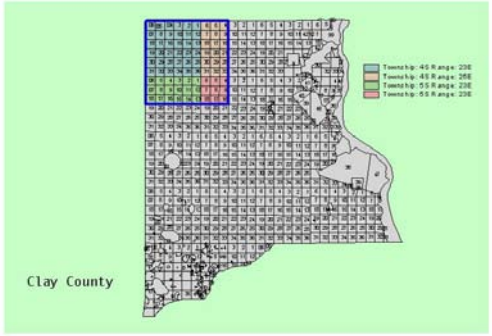
Clay County



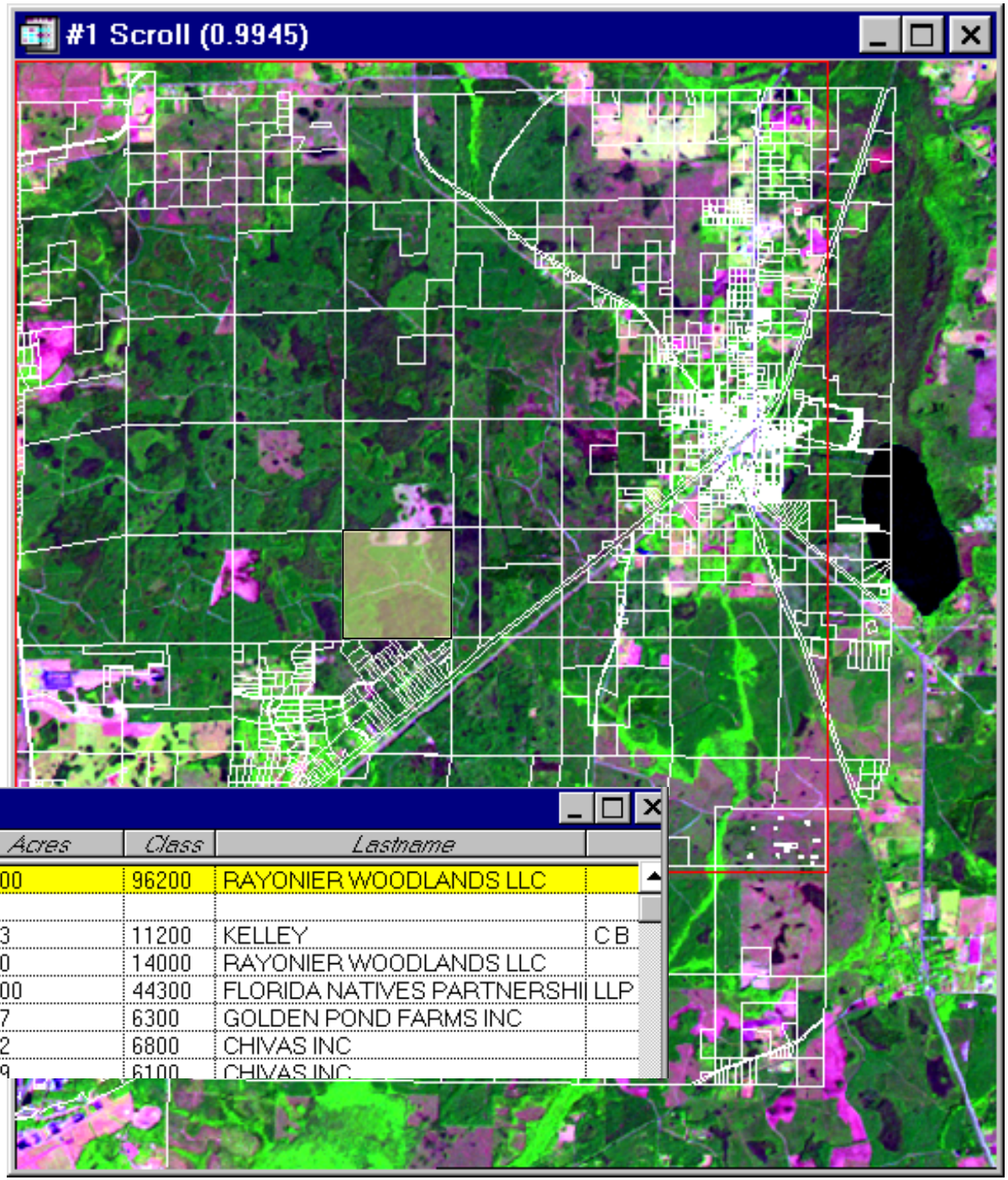


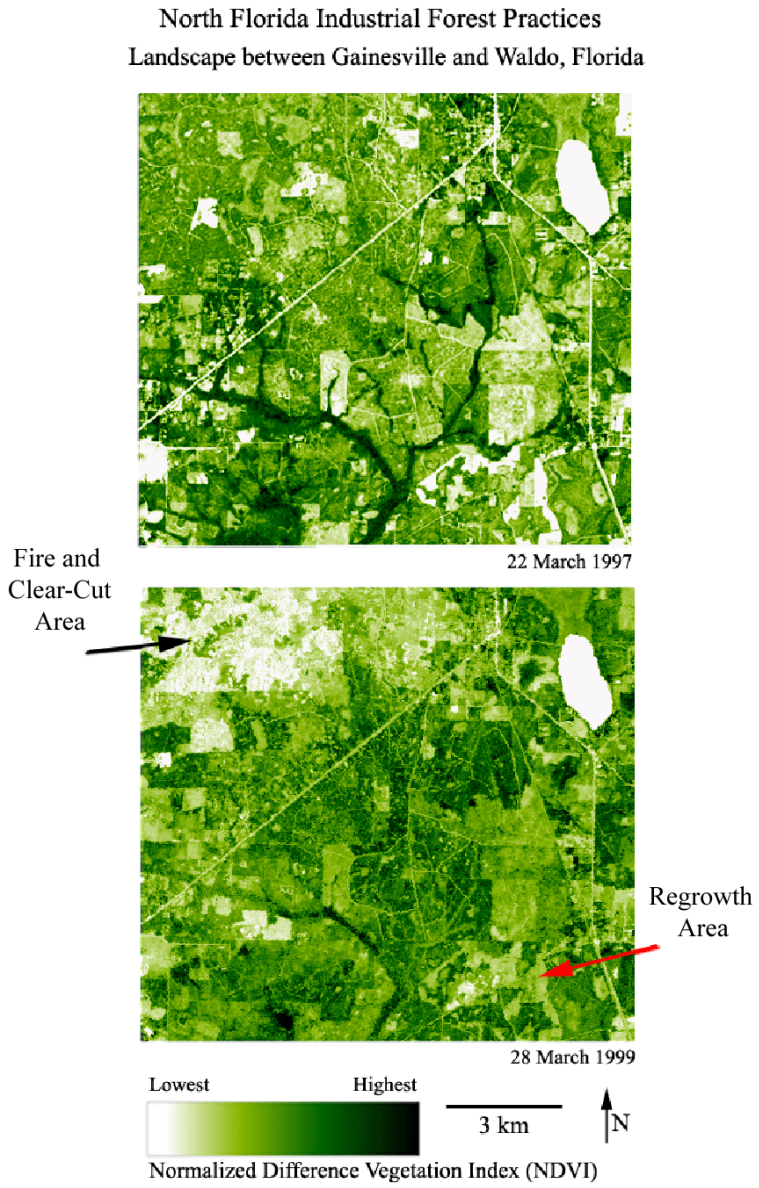


Union County



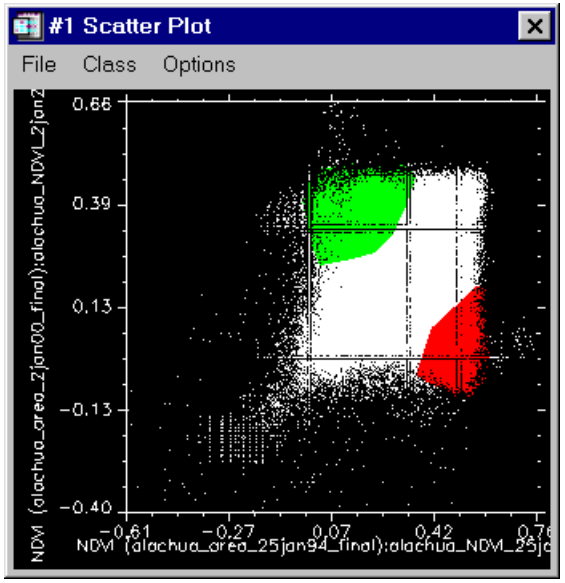
Property Boundaries and Ownership Type

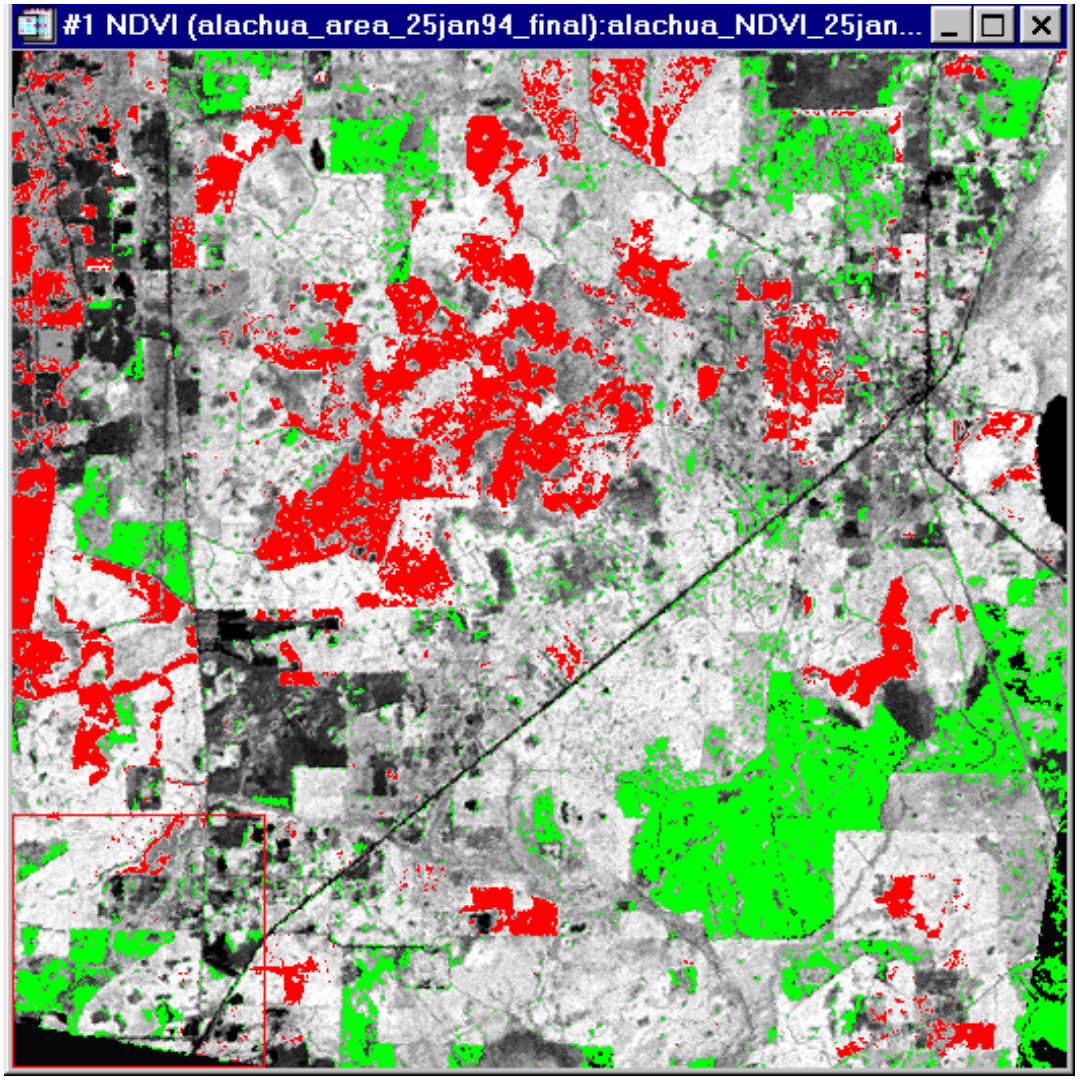




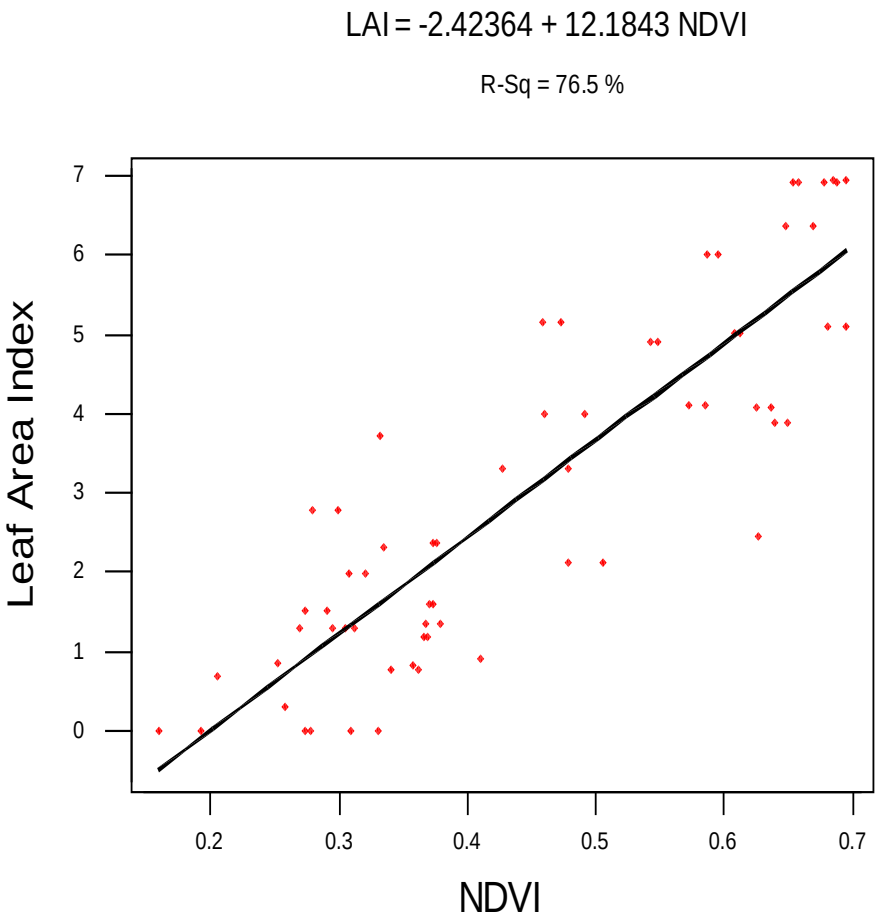
Vegetation Indices and Other Parametric (Continuous Field) Approaches as Proxies of Biomass/C Content

NDVI Jan 94 vs. Jan 00





LAI and NDVI in North Florida Pine Forests



From Jensen, R. 2000. Dissertation.

LAI Distribution in Alachua Area 25 January 1994

LAI Calculated from Regression:

*LAI = -2.423 + 12.184 * NDVI*

(Jensen 2000)

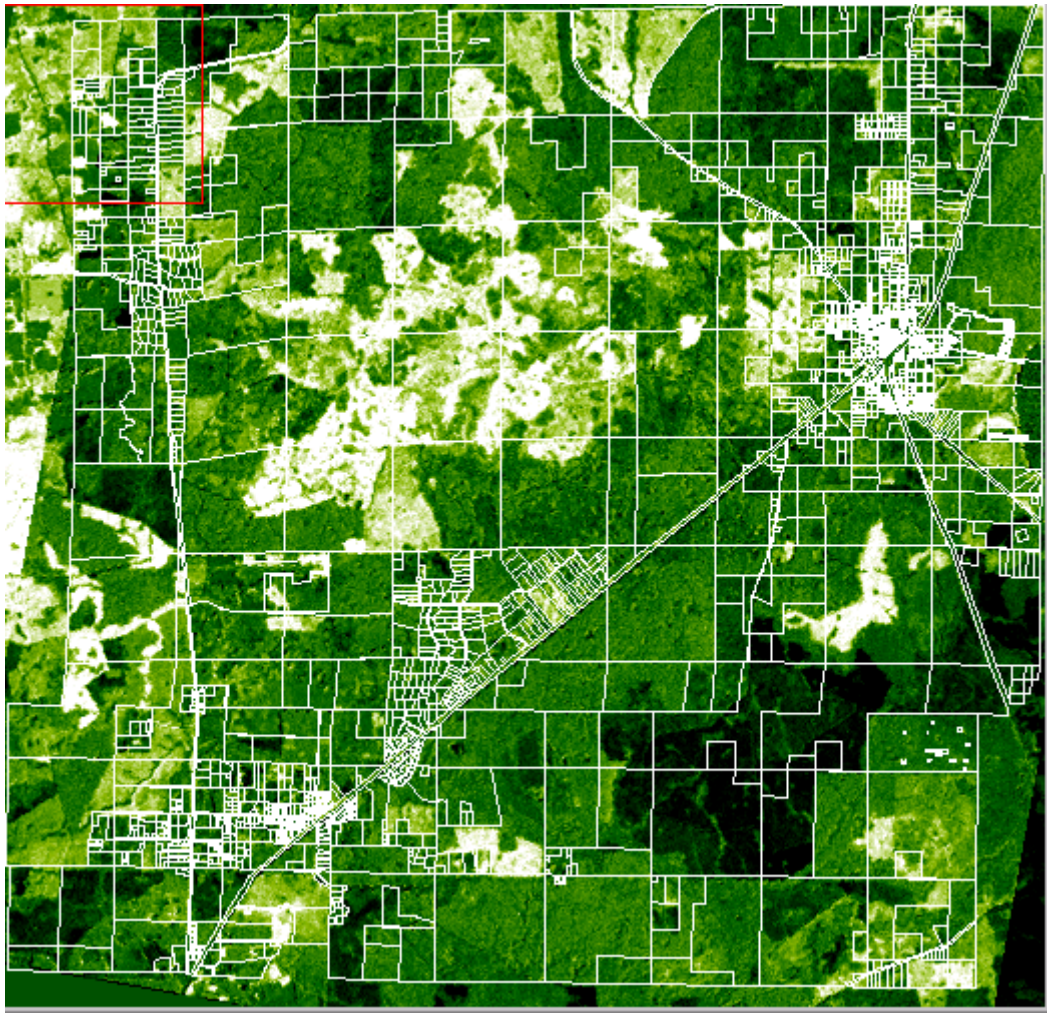
LAI Distribution in Alachua Area 2 January 2000

LAI Calculated from Regression:

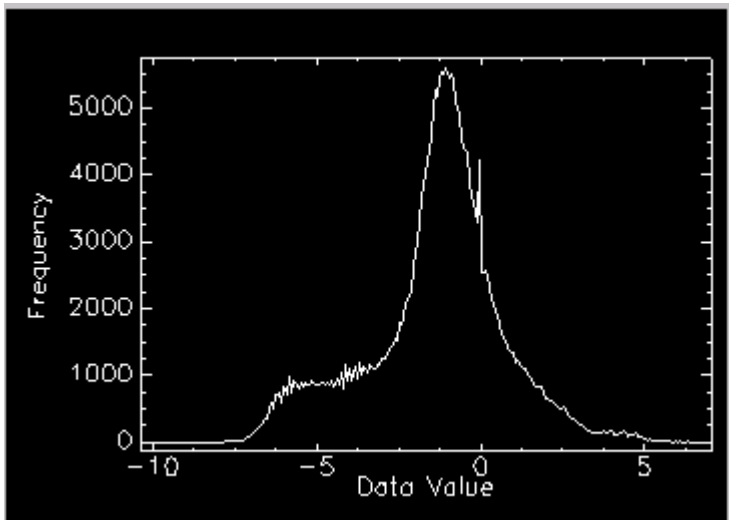
*LAI = -2.423 + 12.184 * NDVI*

(Jensen 2000)

LAI Change in Alachua Area January 1994-2000

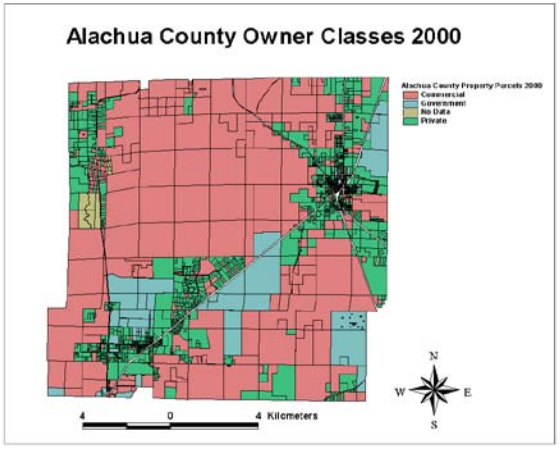


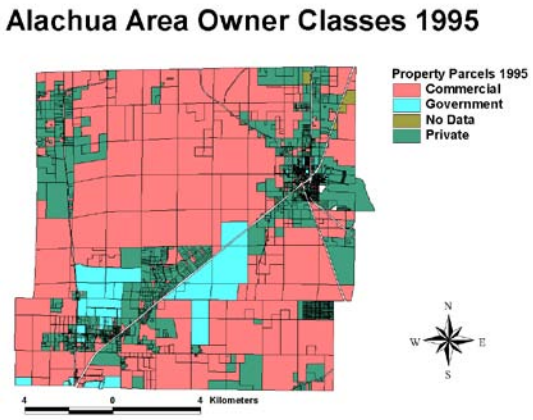
-6 +7

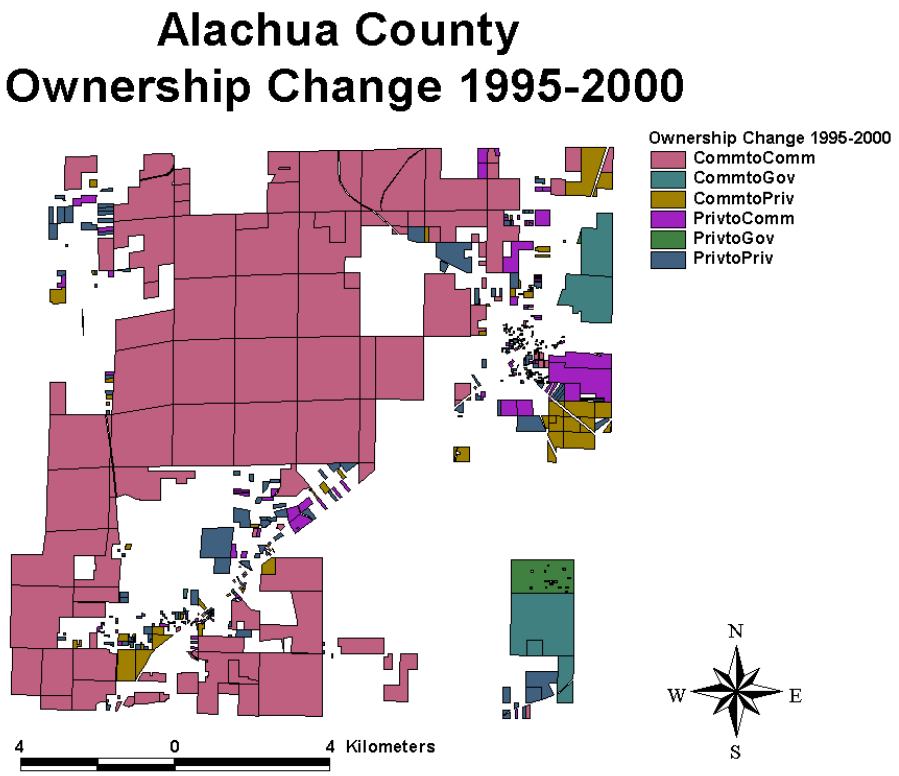


Mean = -1.31; s.d. = 2.07

Alachua Area Ownership 1995-2000



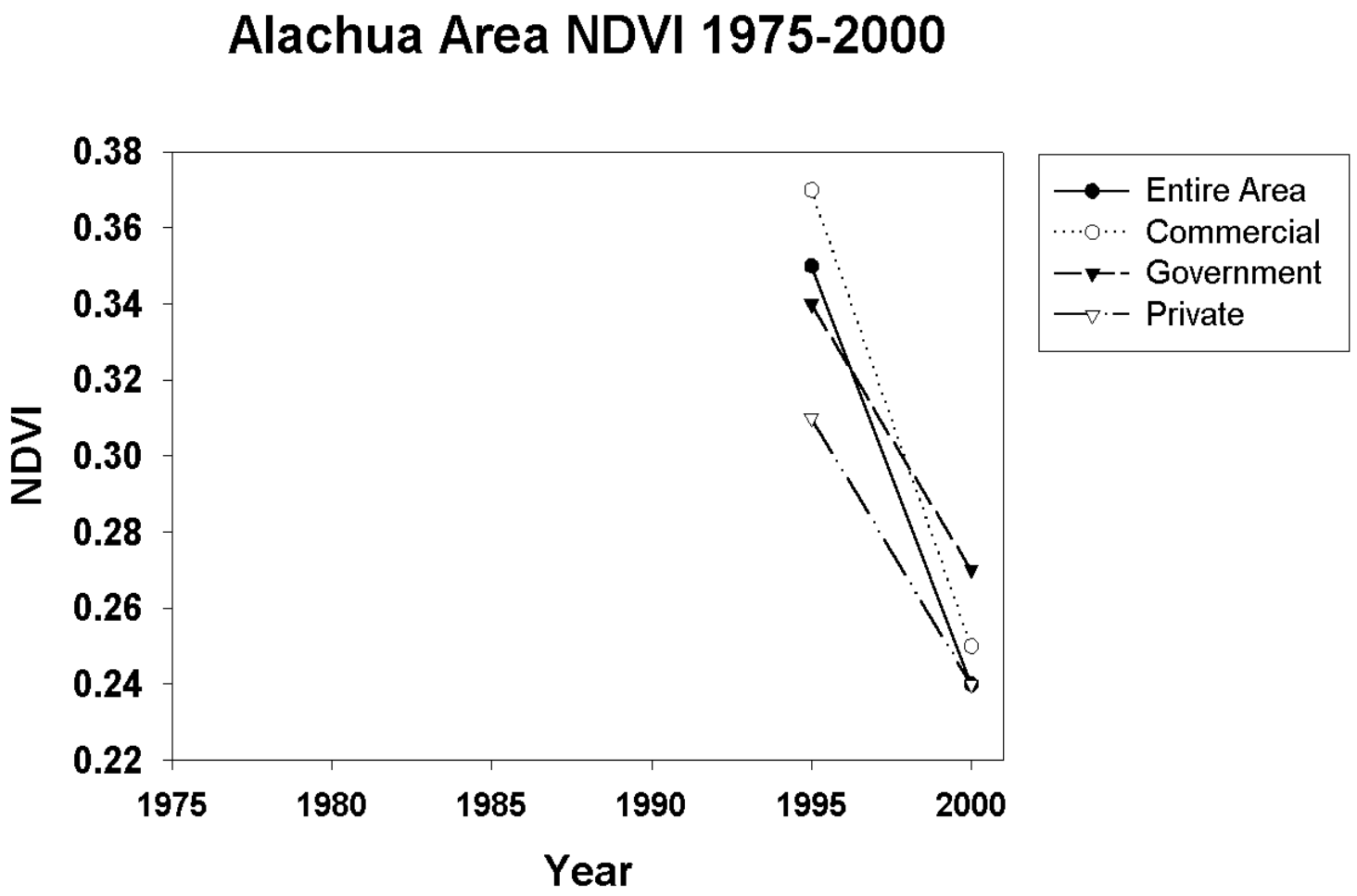




Owner Type and LAI Change

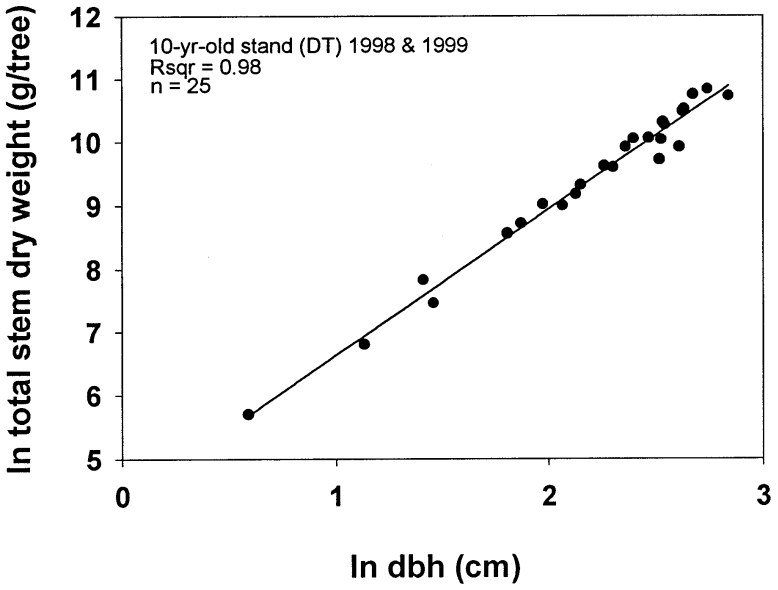
Owner Type	Number of Parcels	Land Area	LAI	LAI	n	s.e.
		ha	mean	stdev		
Total Area 1995	3205	20684.6	1.9	1.7	229950	0.0035
Total Area 2000	2183	20595.4	0.7	1.7	110083	0.0050
Commercial 1995	687	13927.7	2.1	1.5	96608	0.0049
Commercial 2000	469	13623.8	0.6	1.7	4955	0.0242
Government 1995	80	1532.9	1.7	1.9	6300	0.0237
Government 2000	84	2265.2	0.8	1.6	5936	0.0204
Private 1995	2376	5138.9	1.3	1.8	4463	0.0269
Private 2000	1607	4520.7	0.5	1.5	1605	0.0379

Owner Type and NDVI Change

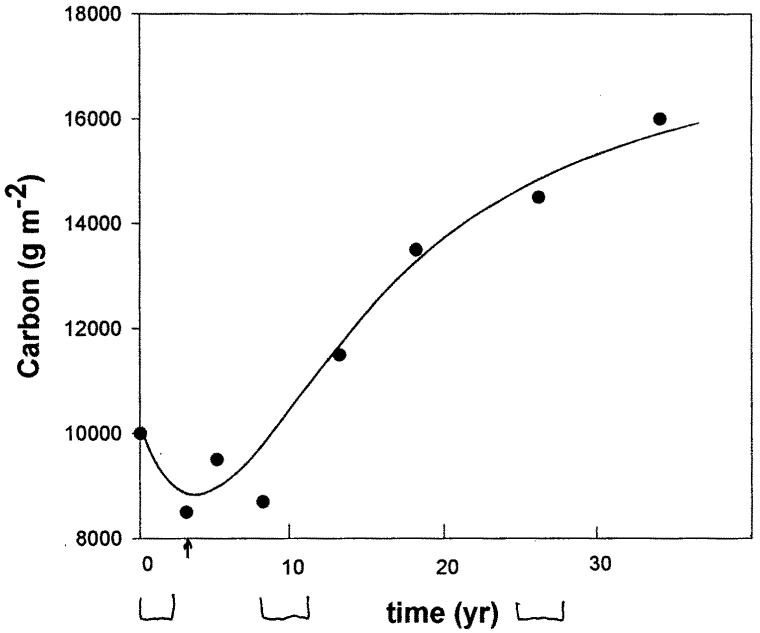


Biomass and Carbon

Allometry



ECOSYSTEM CARBON CONTENT
(vegetation + soil + litter) in the Florida slash pine chronosequence
(Gholz and Fisher 1982)



OPTIONS FOR DETERMINING C FLUXES FOR CLASSIFIED UNITS IN THE FLORIDA LANDSCAPE

- **Look-up tables based on mensurational estimates of tree, understory and litter mass for representative ecosystems; changes over time = annual NEP**

- **Empirical model estimates for pine plantations, where the C contents of chronosequence stands were determined (Gholz and Fisher ‘82); changes over time = annual NEP**

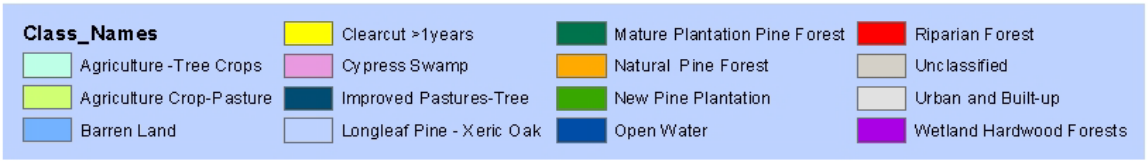
- **Instantaneous values of NEE from tower flux measurements; NEP = annual integration**

- **Simulation models using NDVI/LAI, environment, and time since disturbance; products = NPP or NEP**

Conclusions

- Overall decrease in biomass/C storage (via LAI) from Jan 1995 to Jan 2000, driven by wildfires and commercial harvesting.
- Biomass on commercially owned lands decreased more than on private or government lands (cutting into the inventory).
- Climate variability (drought mid-1998 to present) was much more important factor in the decline than land ownership.
- But, management practices are also more important than ownership.

Land Cover Classification Jan. 2000



ONGOING RESEARCH

- CLASSIFY SATELLITE IMAGES FOR 1975-2000
- LINK CARBON INFORMATION TO CLASSSIFIED IMAGES
- COMPILE LAND OWNERSHIP INFORMATION
- SYTHESIZE DATA ON CARBON, OWNERSHIP AND LAND COVER CHANGE FOR HYPOTHESIS TESTING