Pattern to Process:
Research and Applications for Understanding Multiple Interactions and Feedbacks On Land Cover Change

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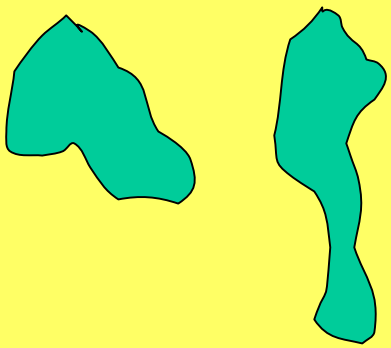
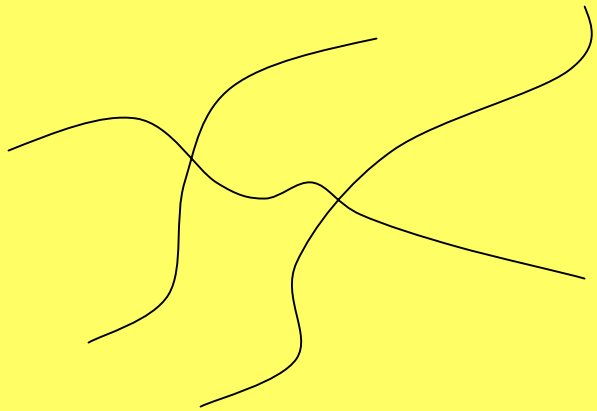
Pattern,
Vegetation, physical attributes

HUMAN DERIVED

Forest Fragments



Road system



PROCESS….
The socially based forces
that create the patterns

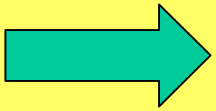
1) Agricultural development
2) Road Building
3) Logging

Not just tropical forests,

Urban sprawl, suburbanization, etc.

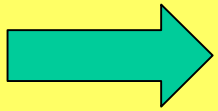
CONCEPTUAL MODEL

Human Drivers



PATTERN IN THE LANDSCAPE

(measured by remote sensing)



Biodiversity Impacts

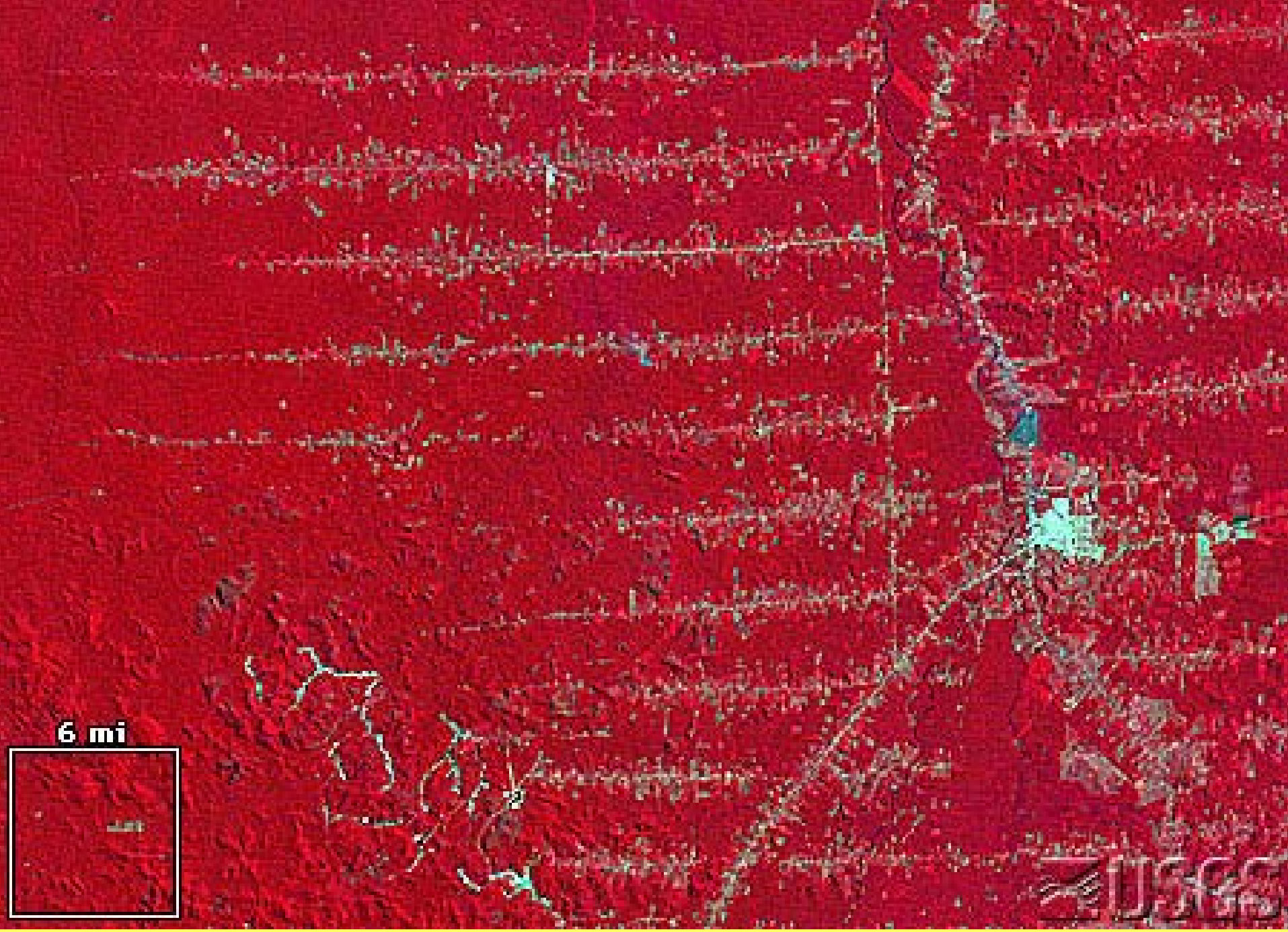
That part of the project addressing human drivers:

A ***Behavioral*** Model of Landscape Change,

depicting the dynamic indicated by the

following two slides of a Settlement frontier in Brazil:


6 mi
USGS


6 mi

Traditional agronomy of the Amazon

if it were a classical system,
off-the-shelf models…..

need a new description,

1) allows for secondary regrowth
2) secondary growth is transient
3) reflects system “switching”

- Existing models of shifting cultivation Limited…..

- Production intervals, continuous time,
- no consumption, profit maximization

$$\sum_{t=0}^{\infty} \beta^t U(l, S)$$

the behavioral model,

allows for rotations, and secondary regrowth

reflects the constraints of nature

rates of fertility recovery, labor costs

integration of Chayanov (Nakajima) model
with the Household Production formulation
…….non-market to market setting

allows for switching to permanent agriculture

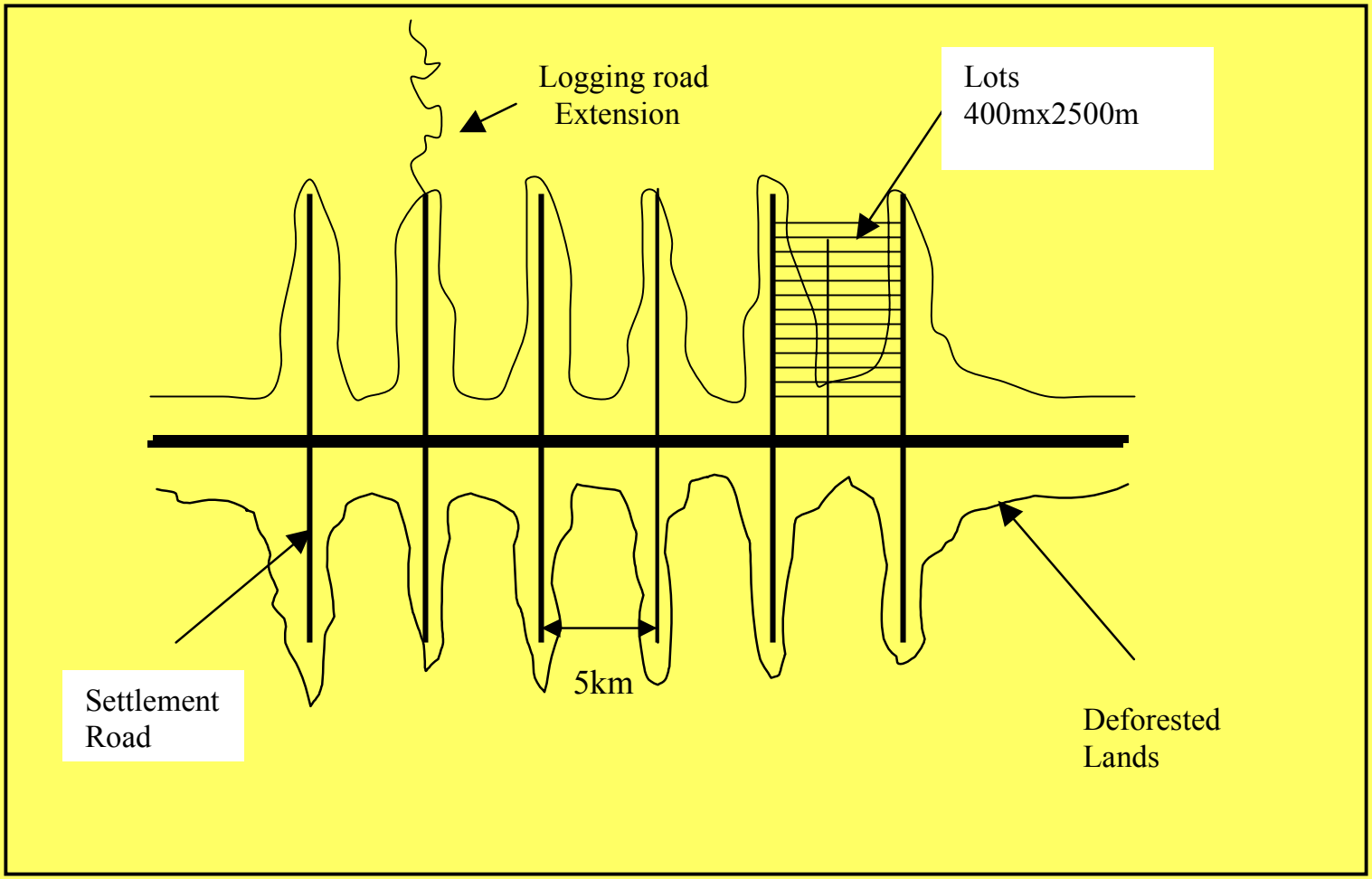


Figure 2 Fragmentation Pattern

Model Solution

# of deforestation events, a

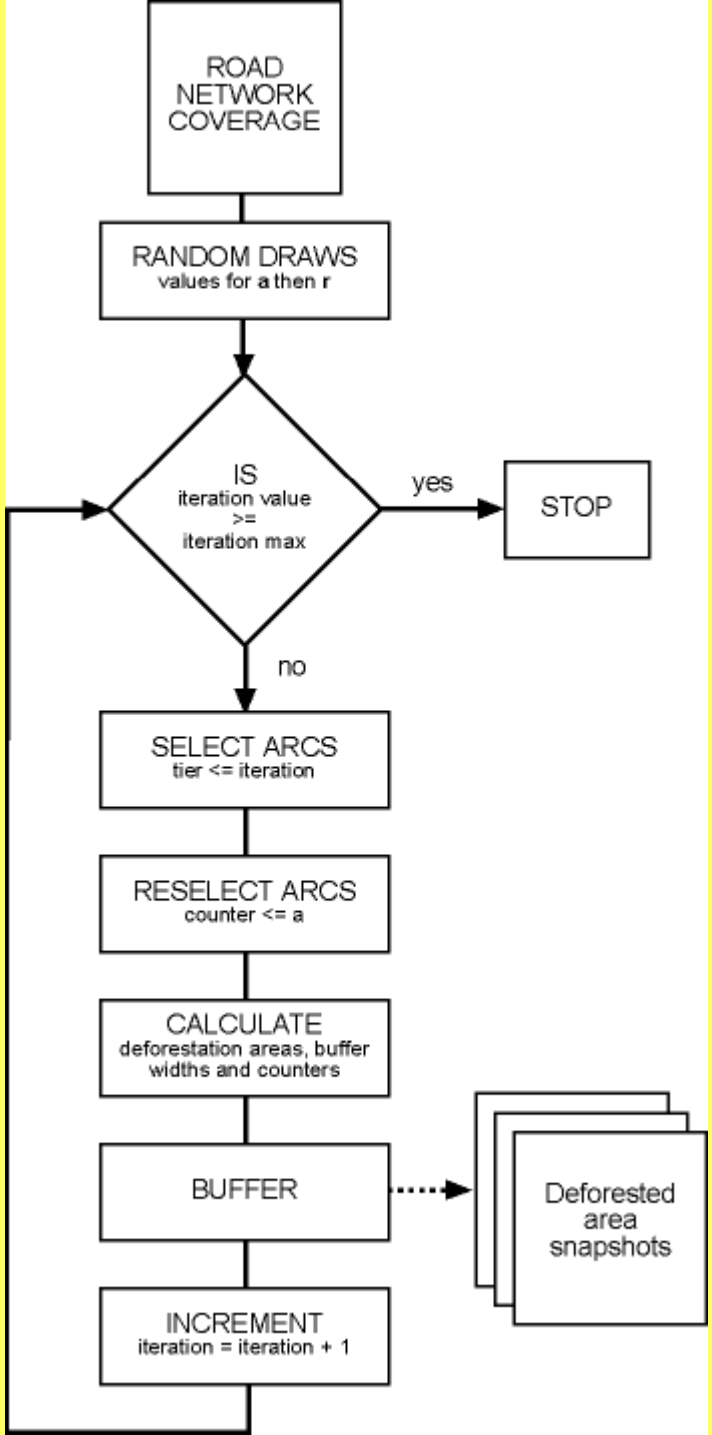
deforestation event magnitudes, r

…..leads directly to the spatial simulation

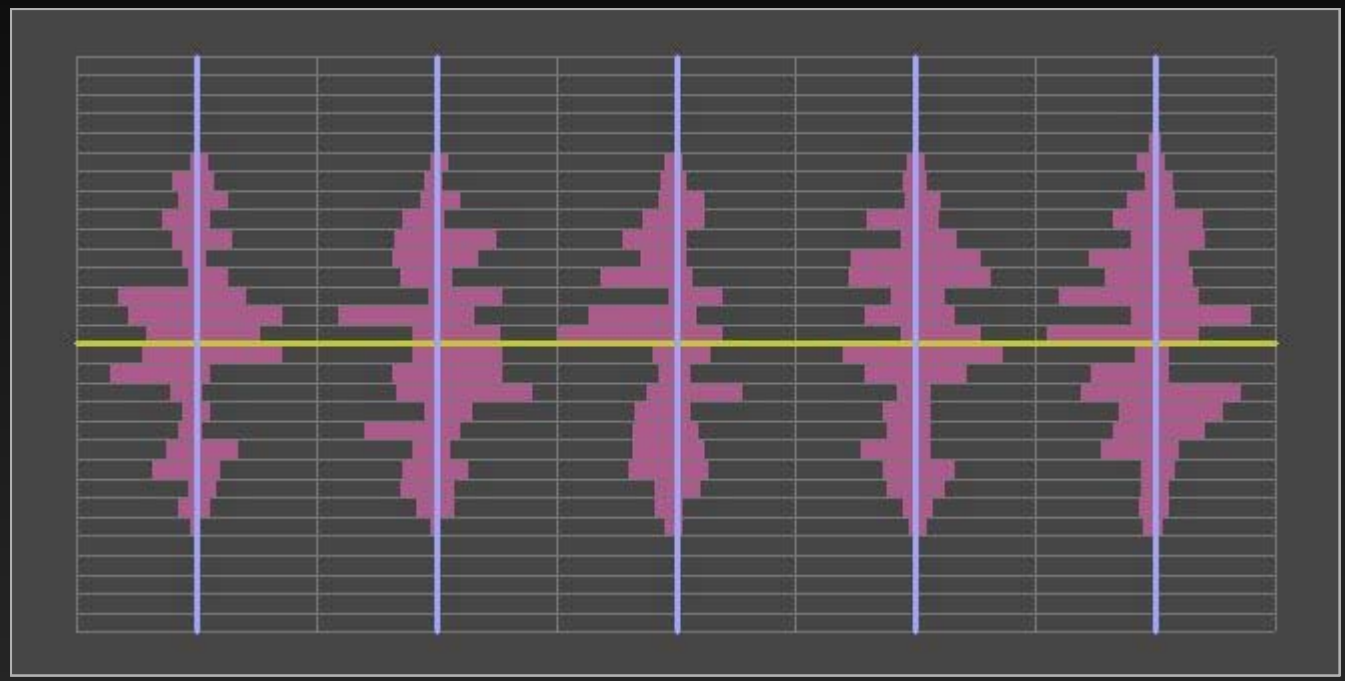
a, r random variables

put a road network in a GIS
draw a and r from reasonable distributions
allow properties to develop, front to back
assign a “rate” of colonization

a spatial model

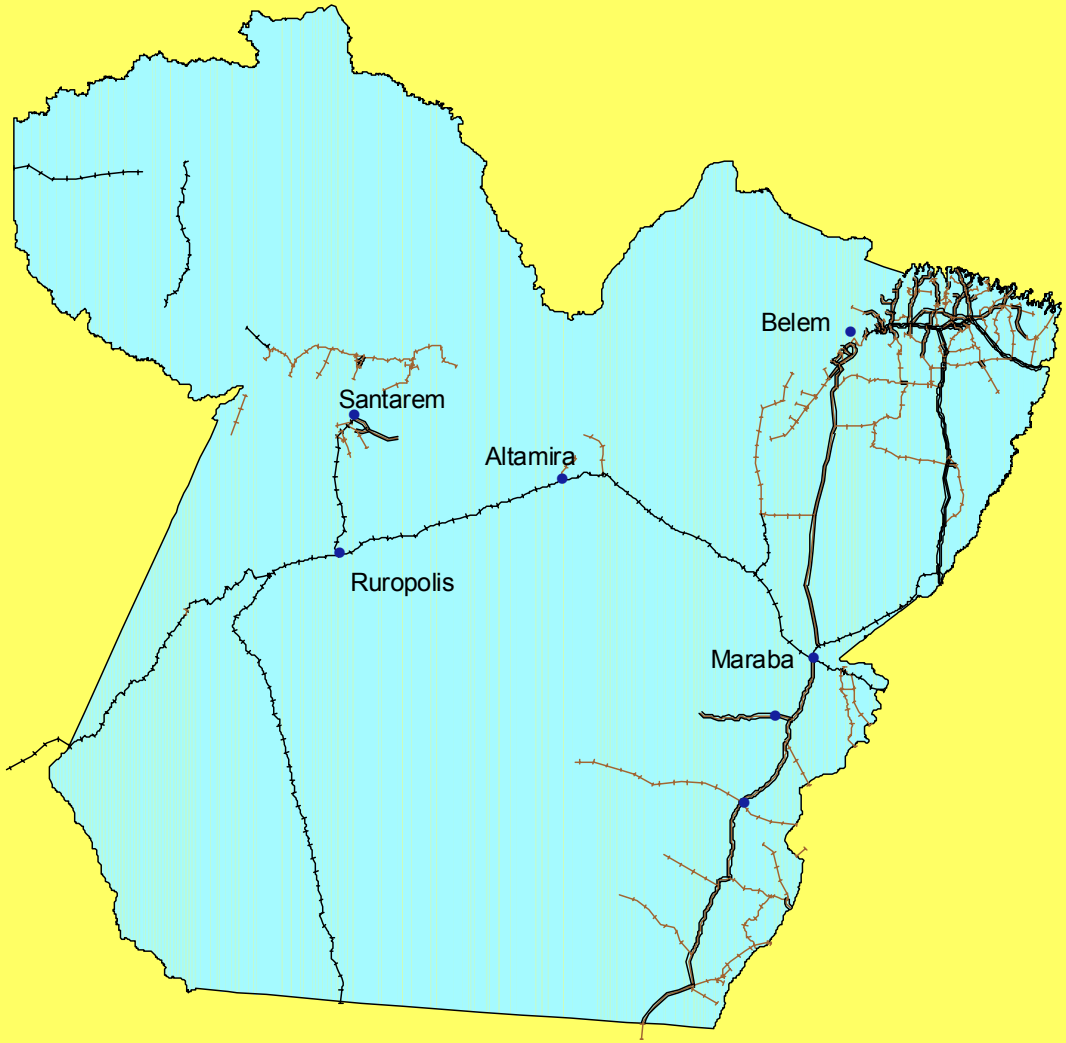

ROAD NETWORK COVERAGE
RANDOM DRAWS
values for a then r
IS
iteration value
>=
iteration max
yes
STOP
no
SELECT ARCS
tier <= iteration
RESELECT ARCS
counter <= a
CALCULATE
deforestation areas, buffer widths and counters
BUFFER
Deforested area snapshots
INCREMENT
iteration = iteration + 1

Model simulation

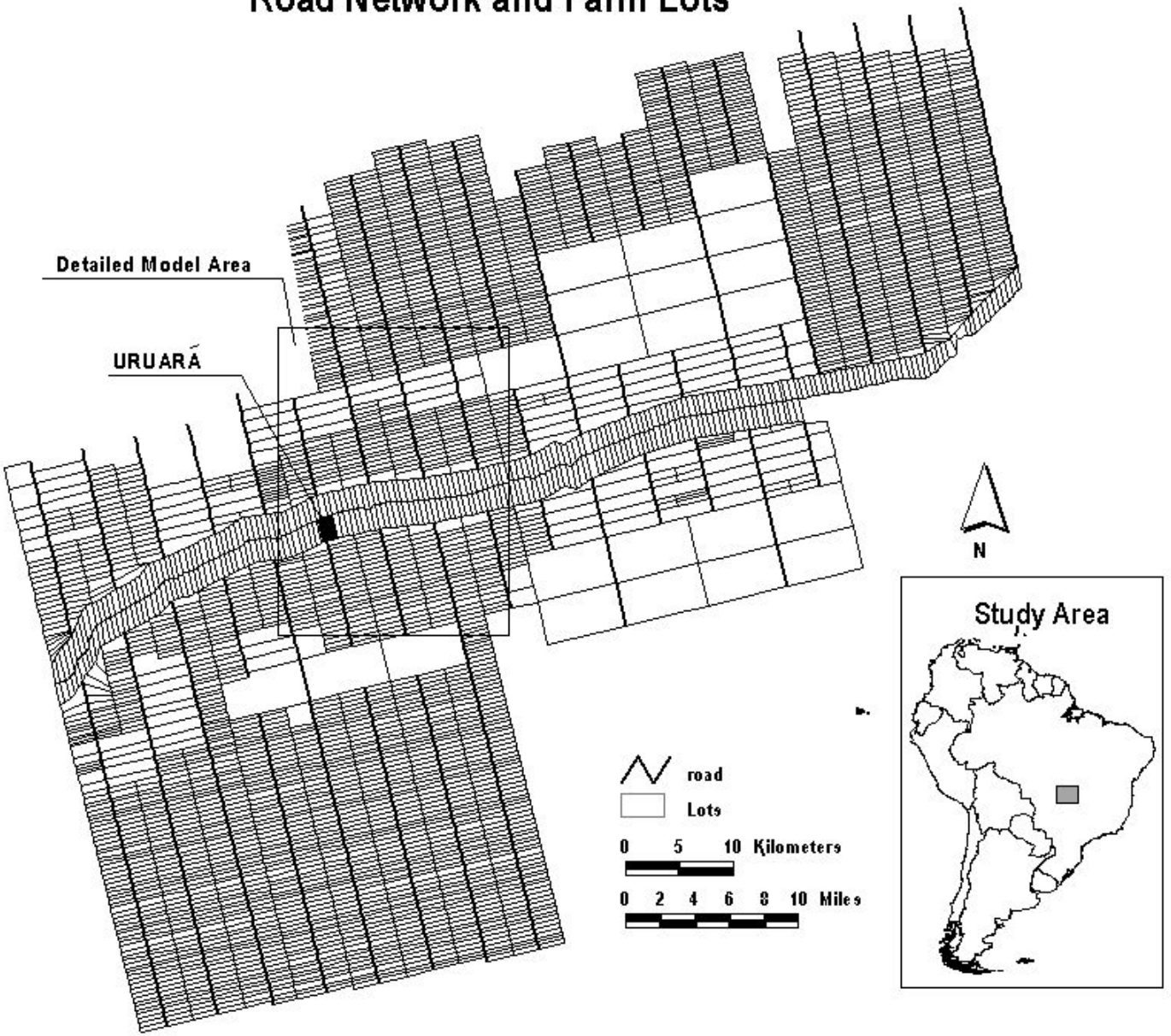


Step 10

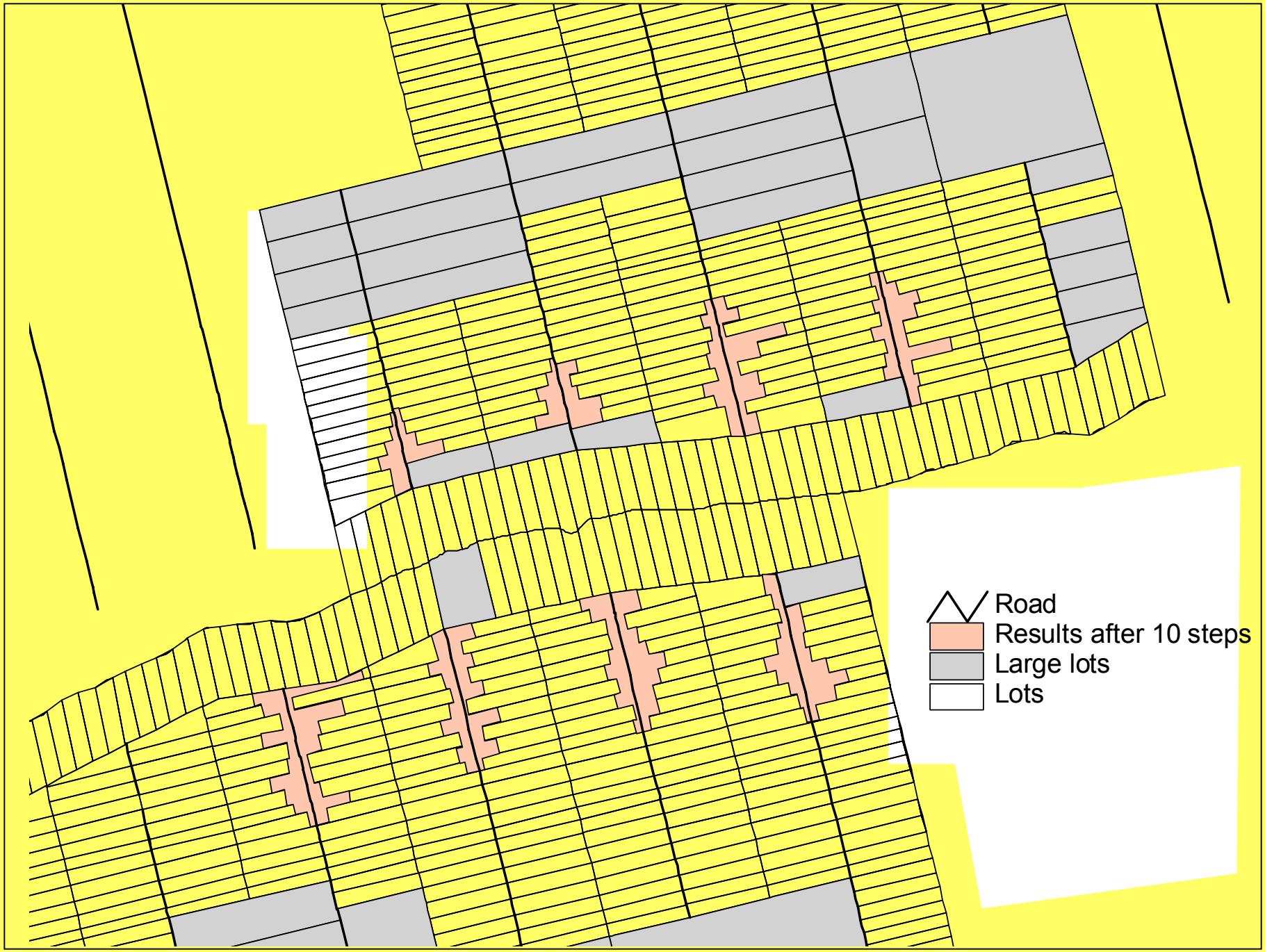
State of Pará

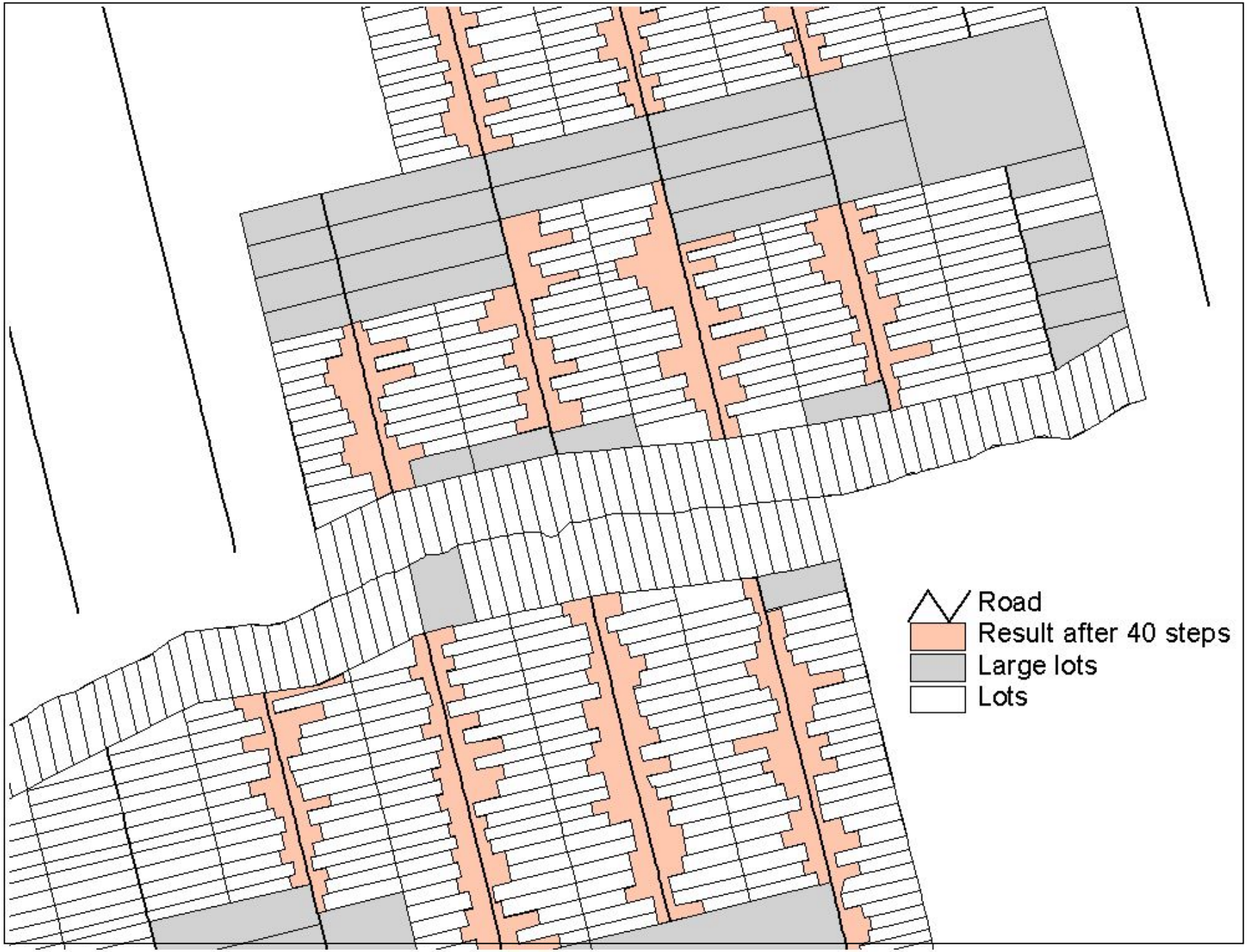


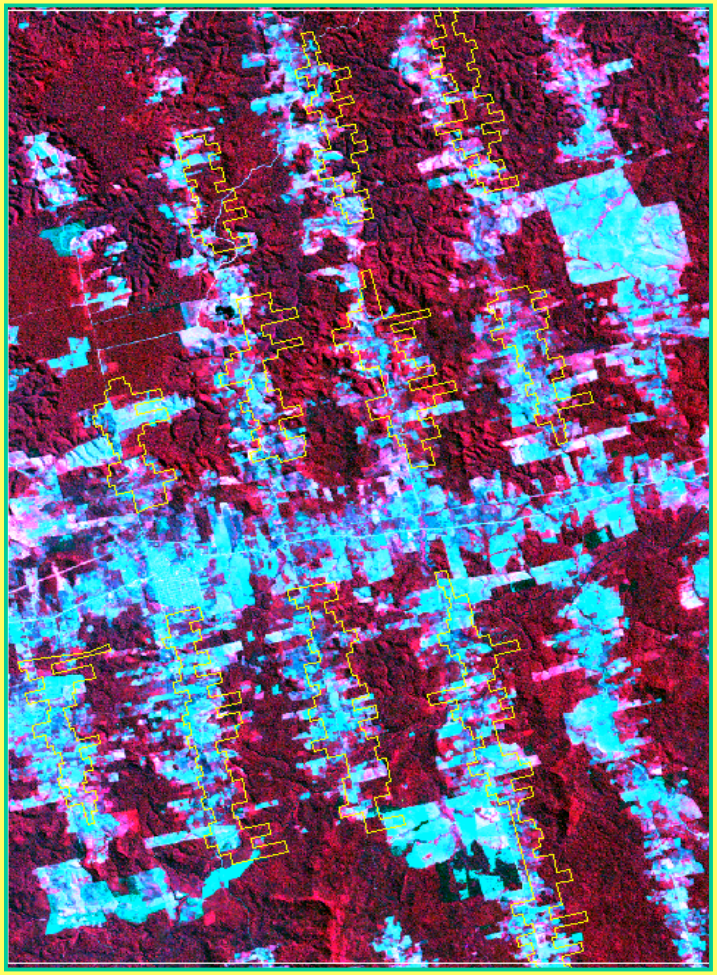
Road Network and Farm Lots



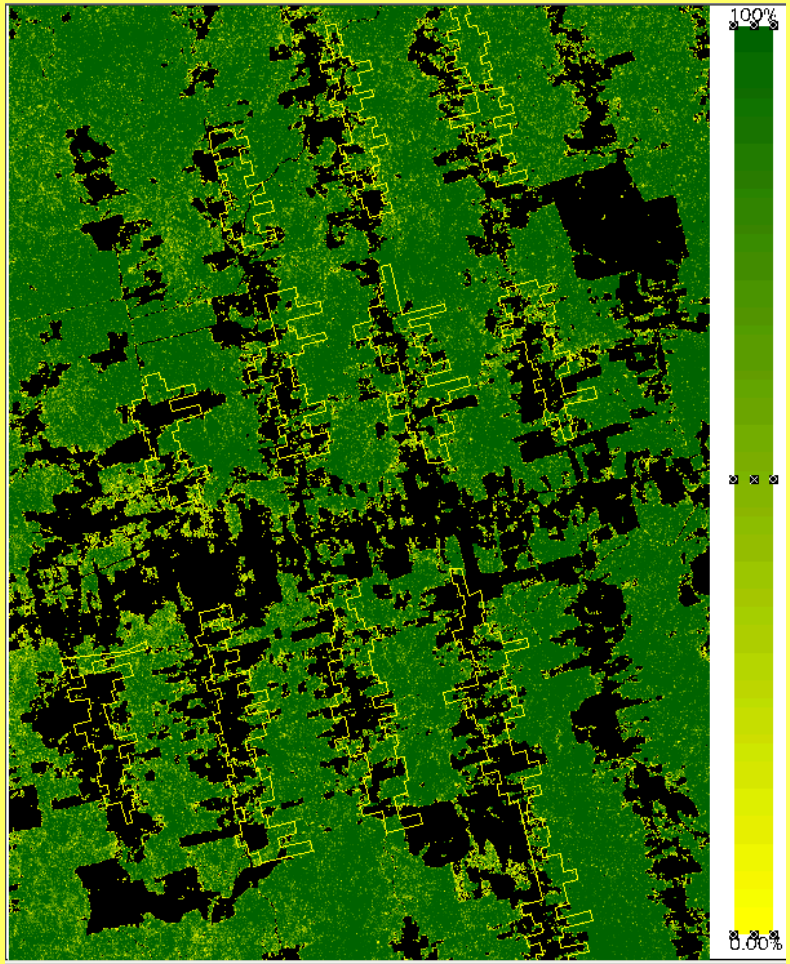

* Tier number
Road
Large lots
Lots
URUARA


Road
Results after 10 steps
Large lots
Lots

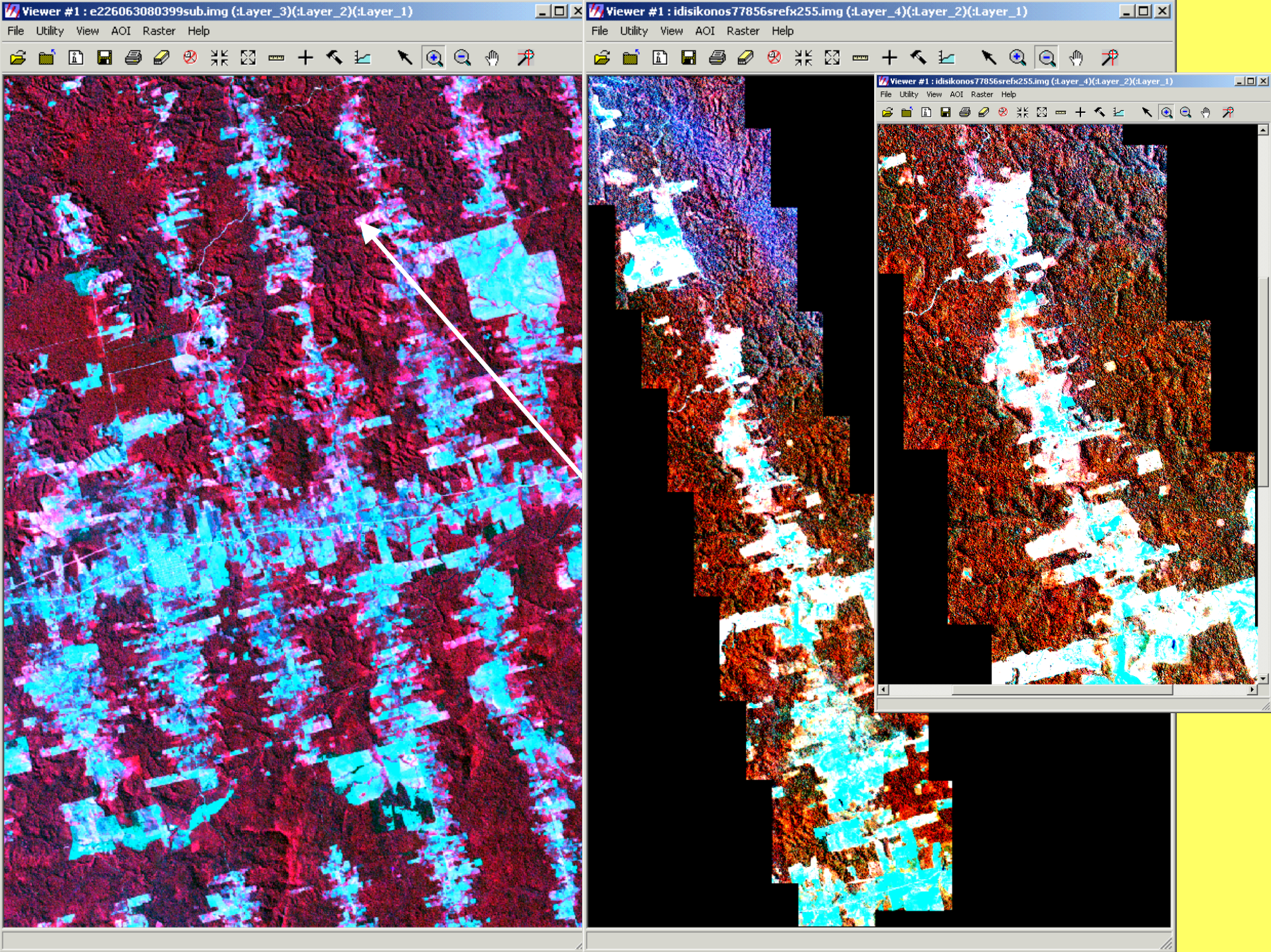

Road
Result after 40 steps
Large lots
Lots



ETM+ Subset 1999



Fractional Cover 1999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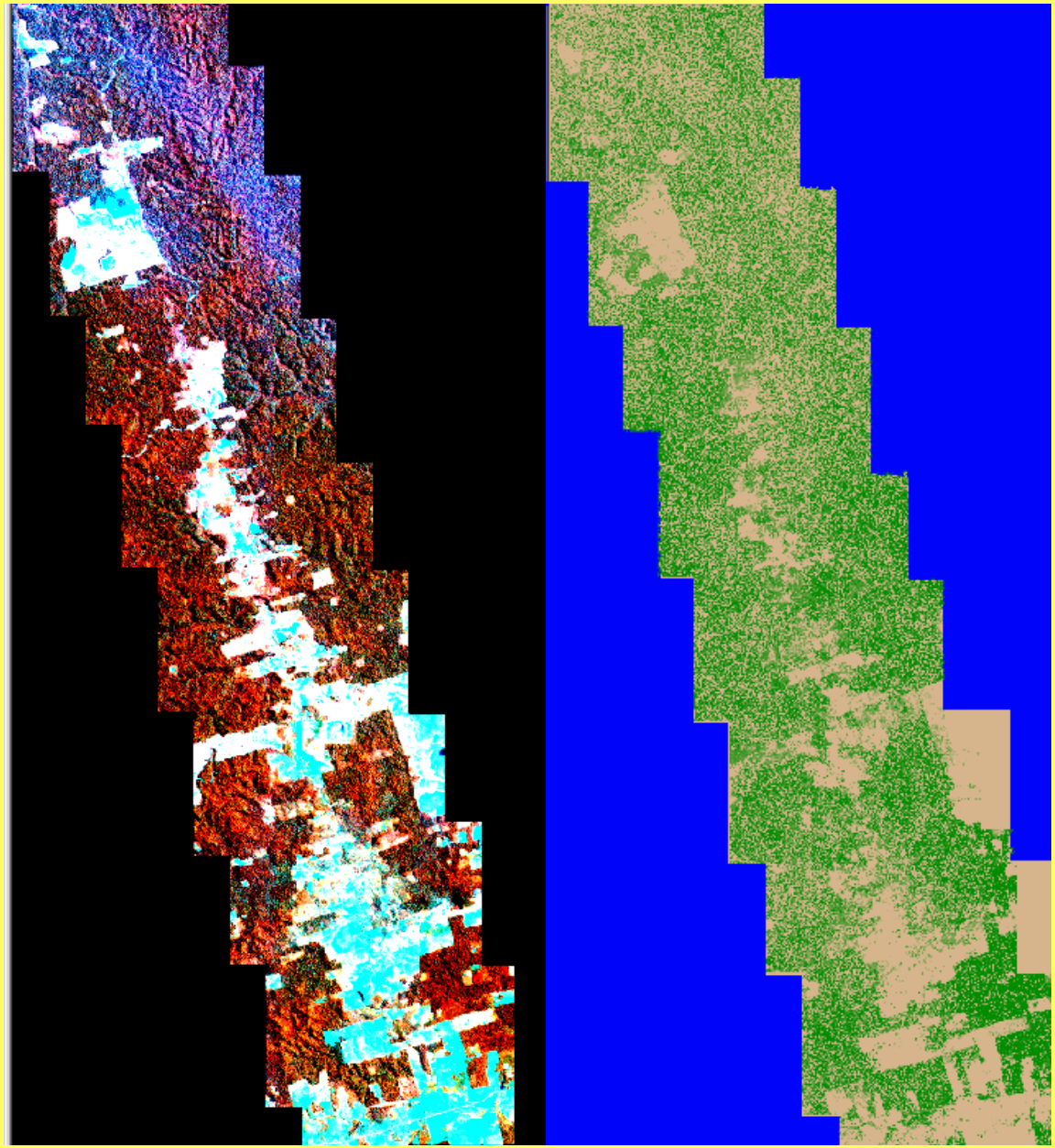
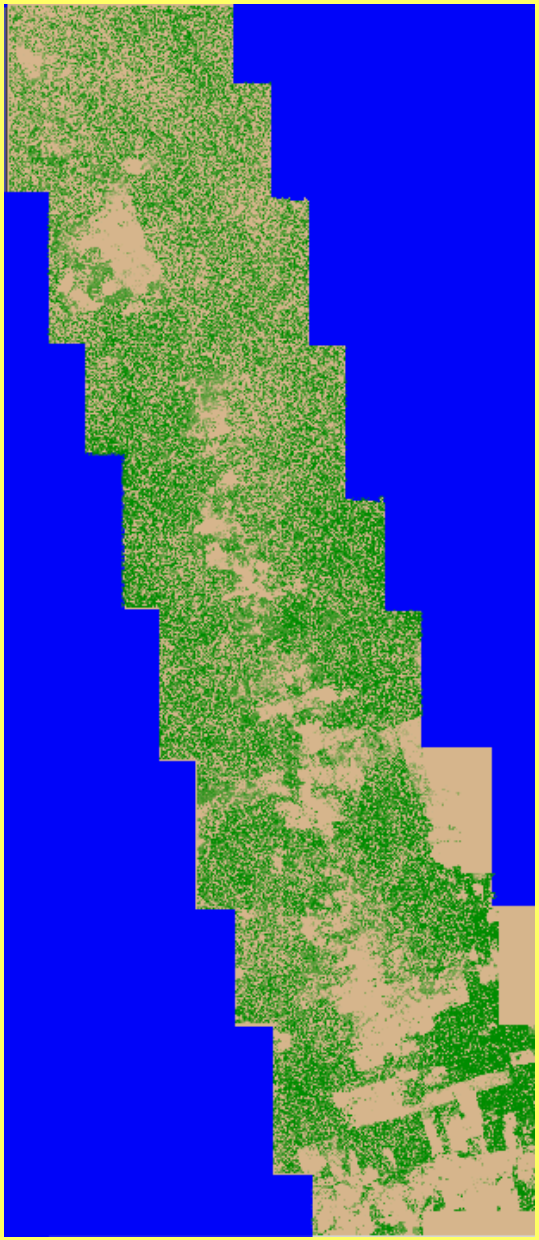
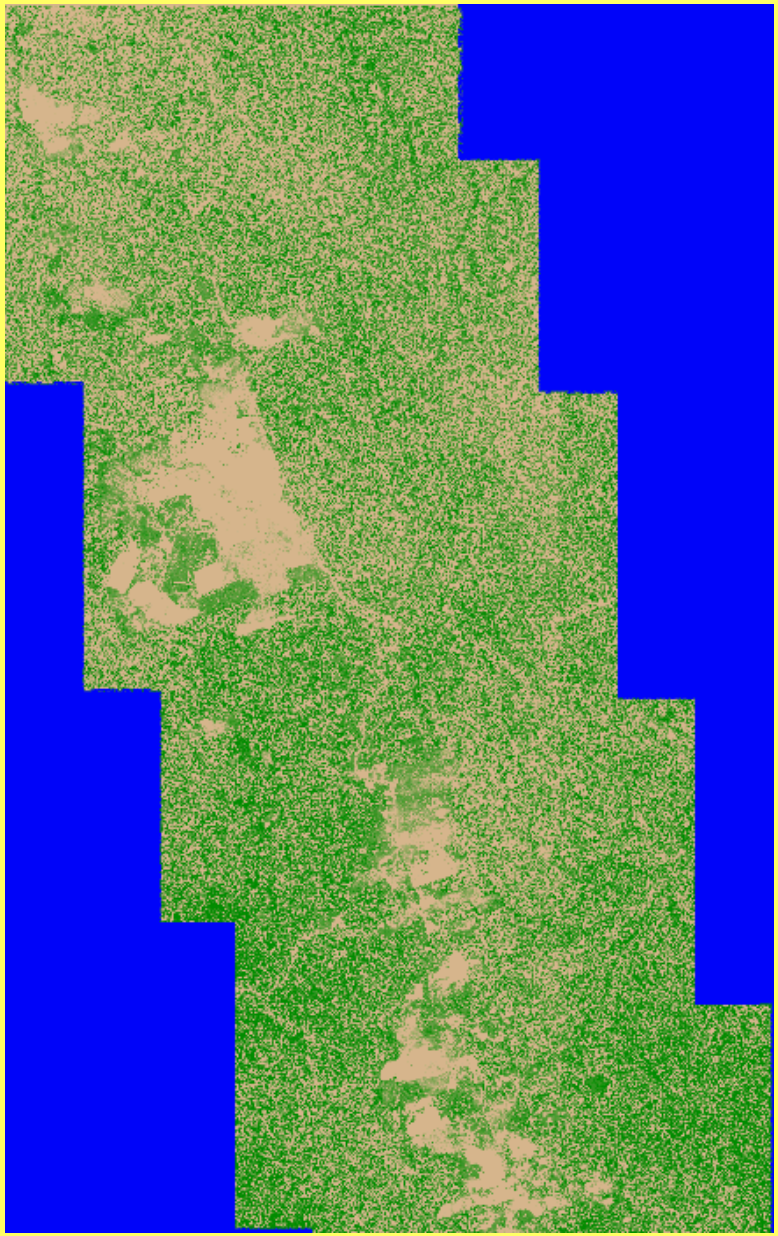
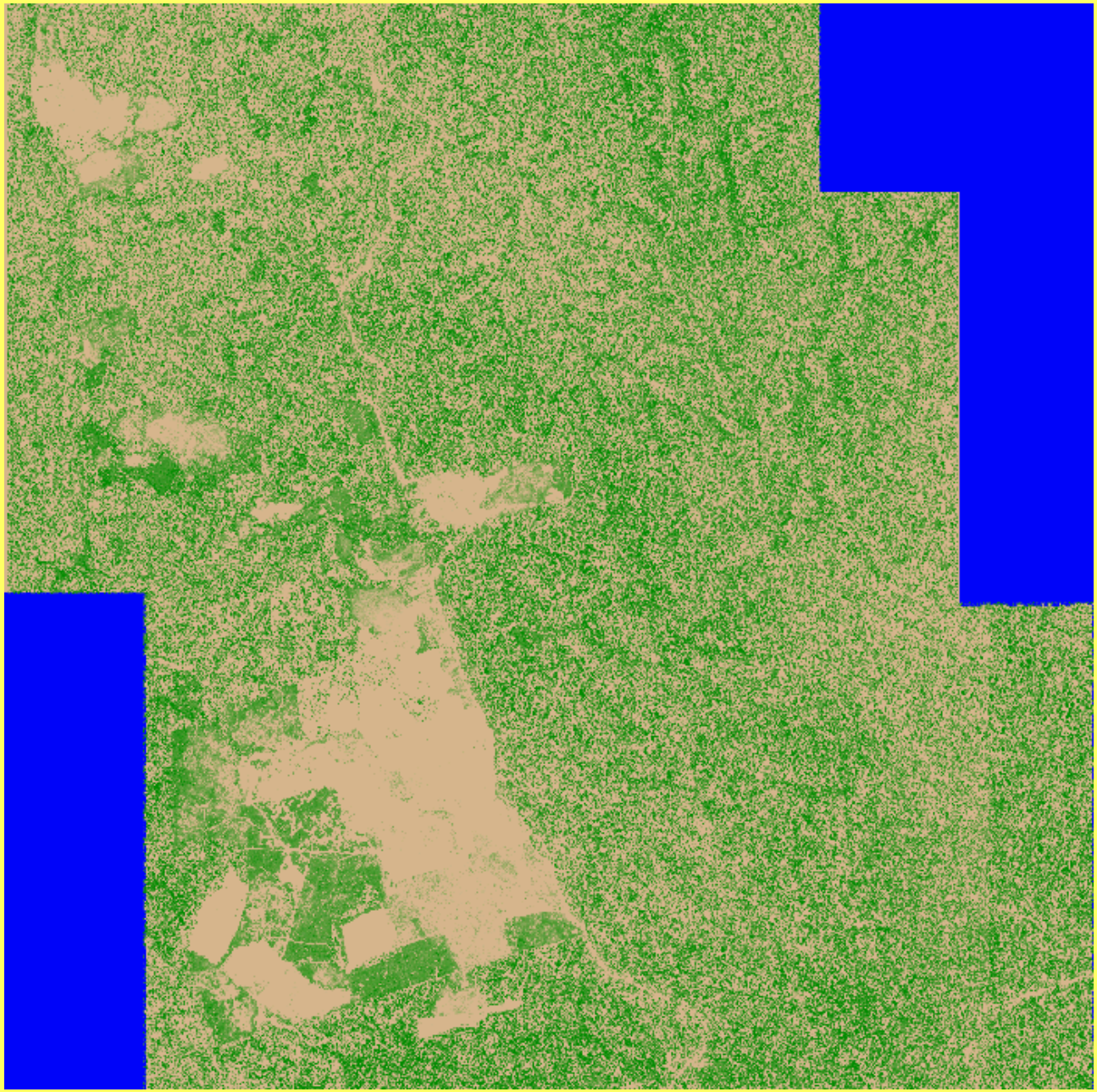
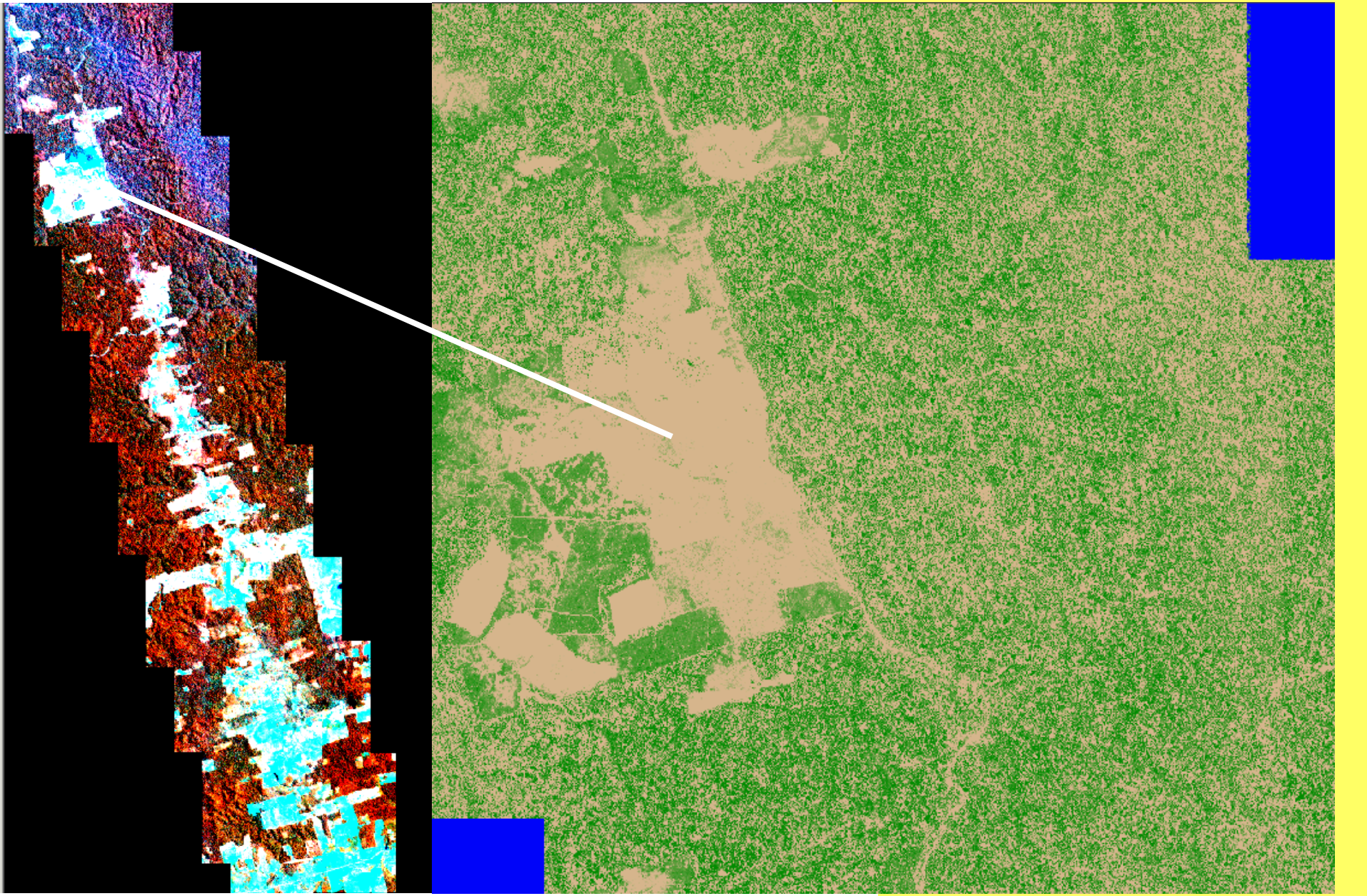
File Utility View AOI Raster Help
Viewer #1 : idisikonos77856srefx255.img (:Layer_4)(:Layer_2)(:Layer_1)
File Utility View AOI Raster Help
Viewer #1 : idisikonos77856srefx255.img (:Layer_4)(:Layer_2)(:Layer_1)
File Utility View AOI Raster Help







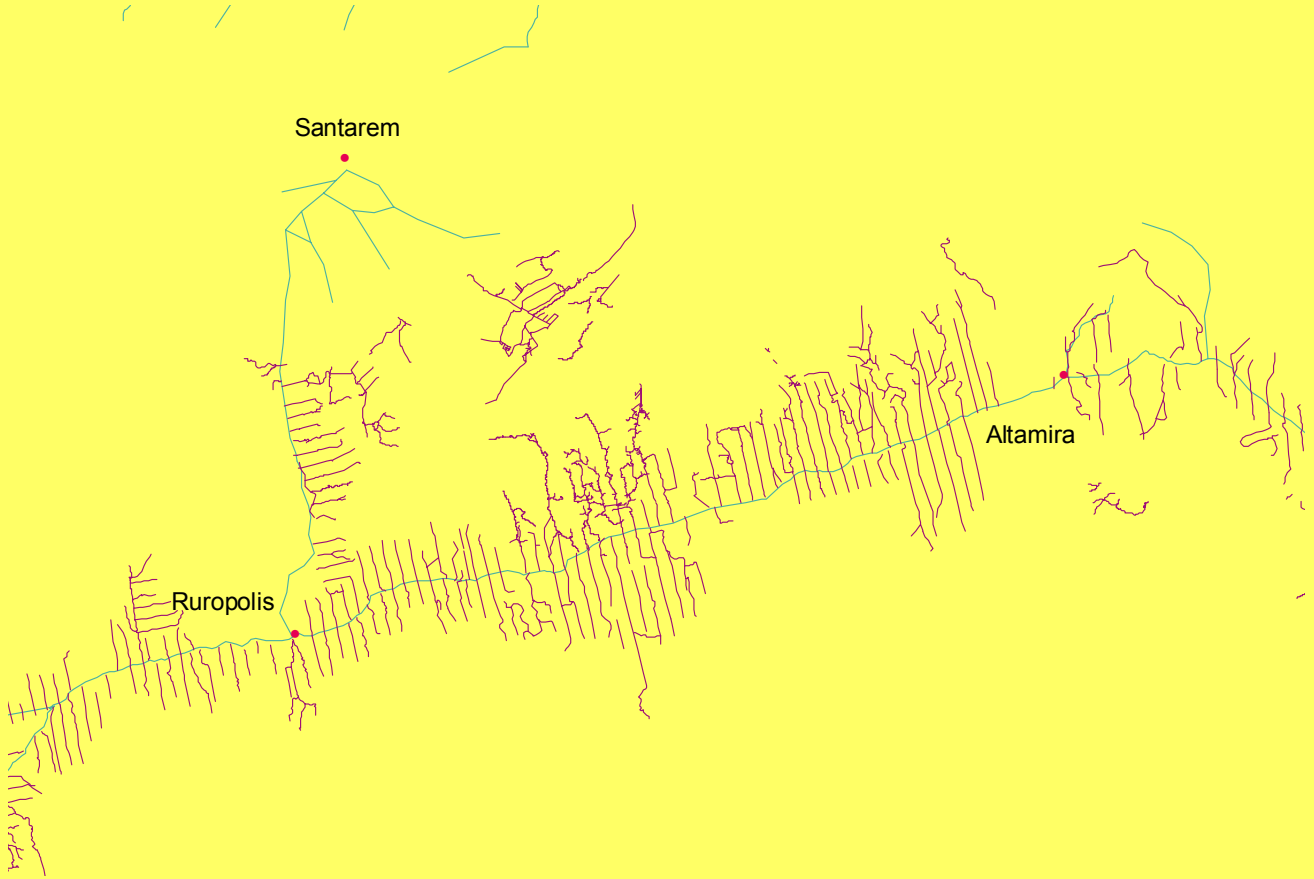




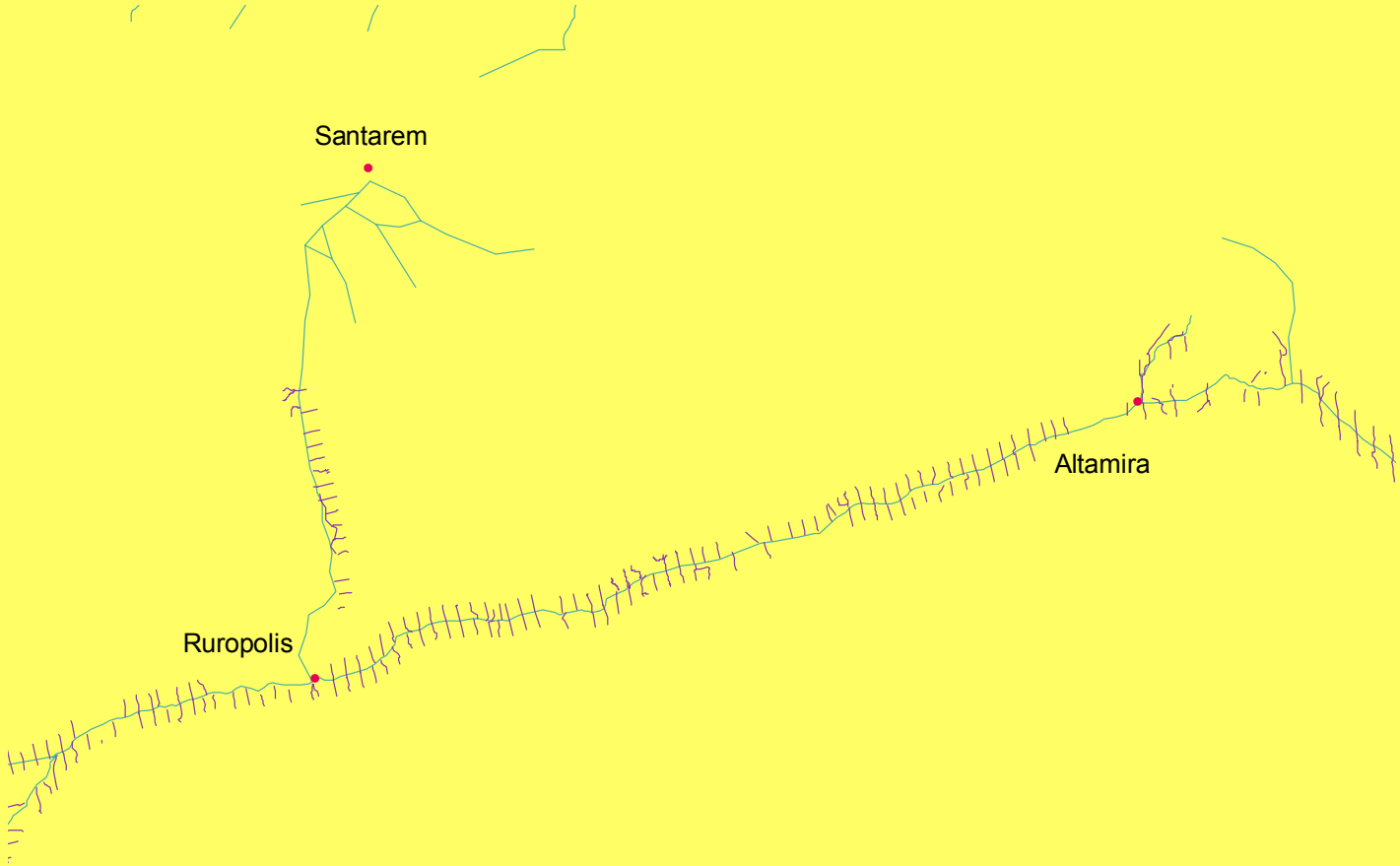
- A “farm level model”
- Highway pattern exogenously given
- What about ……

HIGHWAYS AND ROADS ???

Settlement Roads 1998

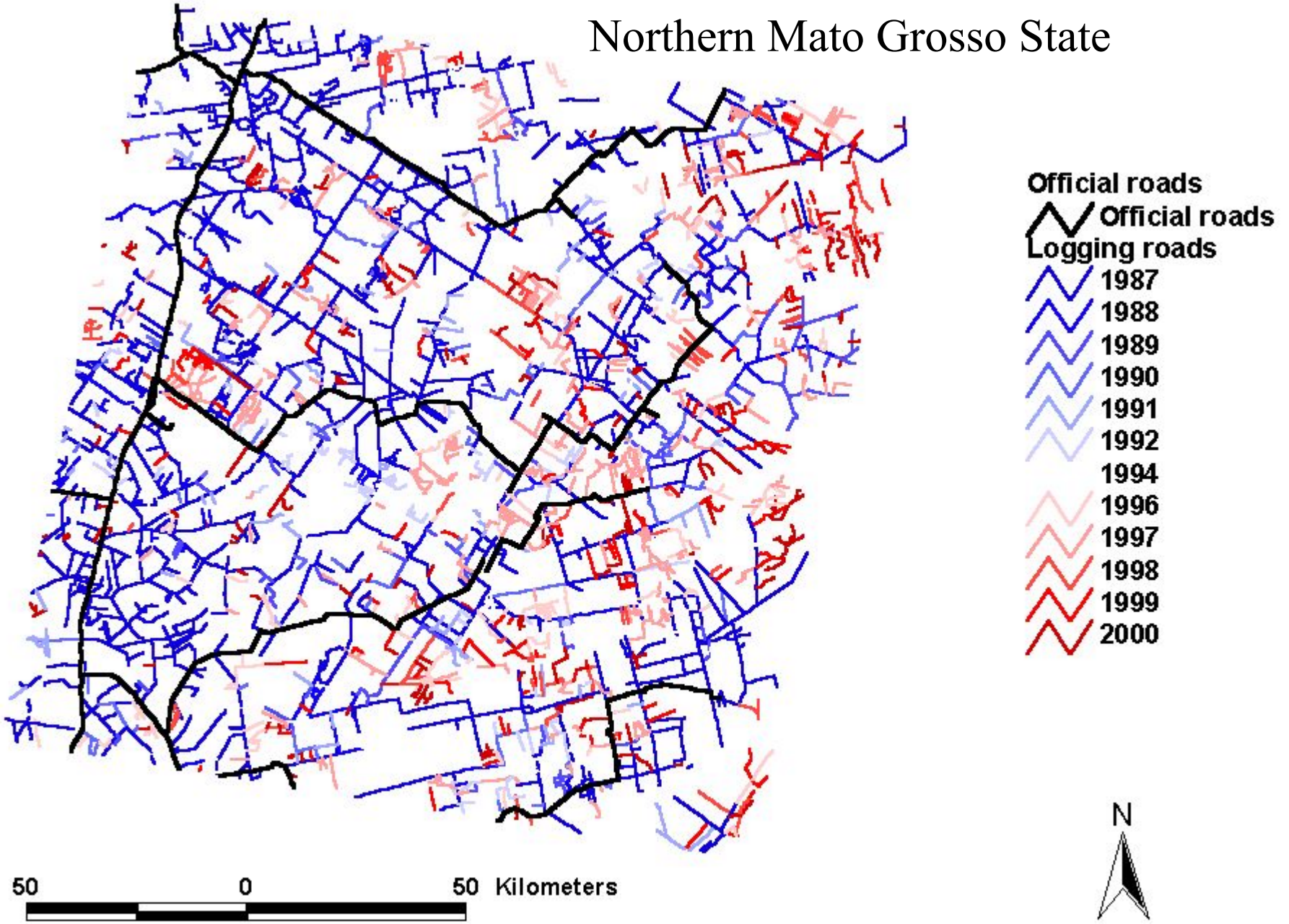


Settlement Roads 1970s



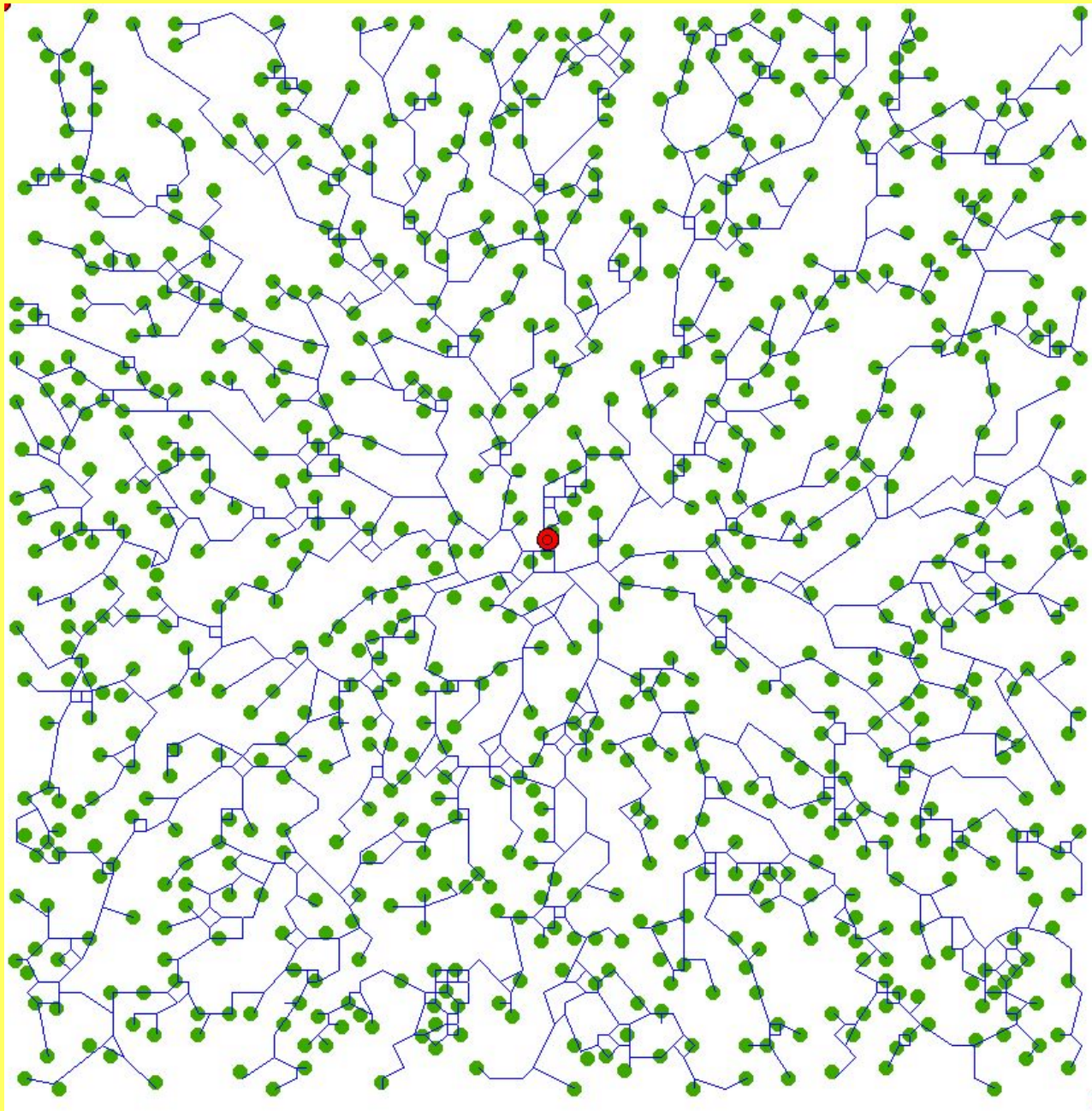
Growth in Settlement Roads

Northern Mato Grosso State



Source: Monteiro and Souza, 2001

Simulation: randomized distribution of trees



Next steps for the Human Driver Model

Initiate Error Assessment of Model

Add a road extension component to the simulation, to reflect the logger's

"decision-making calculus"

The *Biodiversity Component* of the project:

developing statistical models to predict

species richness (of birds)

in varied landscapes including differing amounts

…..and **configurations**

of forest, pasture, and coffee plantations.

The so-called *Biodiversity impacts of land cover change*

The project is developing separate models to predict richness of particular groups of species

Some are likely to be ***negatively*** affected by deforestation

(in the families Formicariidae and Thamnophilidae, the antbirds)

Others are likely to be positively affected (in the family Emberizidae),

The sparrows and finches (seedeaters)

The data to be used……

were successfully collected last winter (2000-2001)

They come from 37, 3-km long routes,

southern Costa Rica (Coto Brus).

Sampling of bird species: 15 points along each route,

yielding a total of 555 sample points

A test site for model verification is presently being added to the sample in central Costa Rica.

the Monteverde area

Data are being collected for 8 routes. The general applicability of the models developed for southern Costa Rica will be tested using these additional data.

TO DATE……..

FOR ALL 37 routes in the South…….

1) database has been developed

2) overall species richness, estimated

3) richness of several subsets of species, estimated (seedeaters and antbirds)

4) Landscape analyses for each route, initiated.


Monteverde
study area
Costa Rica
Coto Brus
study area

The following slide gives estimated species richnesses for ALL 37 routes in the Coto Brus study site

Route	Species richness estimate (standard error)	Route	Species richness estimate (standard error)
San Isidro, Altamira	134 (14.9)	Canas Gordas	112 (13.0)
Below Altamira	137 (15.0)	Cerro Paraguas	129 (15.6)
Valle del Silencio	167 (17.7)	Gamboa	66 (9.7)
El Alto	95 (12.0)	Linda Vista 1	92 (10.1)
Gutierrez-Braun	118 (14.4)	Linda Vista 2	96 (12.6)
Roble 1	97 (11.8)	New Fila	88 (12.4)
Roble 2	64 (6.3)	New Tutilama	140 (16.4)
San Carlos	117 (14.0)	Pepe	66 (5.7)
El Salto	98 (12.4)	San Antonio	92 (11.9)
New Mellizas	79 (10.1)	San Francisco	51 (4.8)
Red Gate	77 (6.7)	Santo Domingo	56 (5.6)
Sin Nombre	86 (11.8)	Valle Azul	130 (15.2)
Coton	147 (16.6)	Wilson	124 (14.7)
Echandi	83 (9.0)	Lucha	77 (8.0)
Flor del Roble	94 (11.4)	New Rio Negro	88 (9.6)
Lecheria	124 (14.9)	Progreso	60 (7.2)
Madeline	73 (7.5)	San Miguel	65 (8.0)
Third Gate	122 (11.7)	Hospital	113 (13.4)
Campo Tres	88 (11.1)		

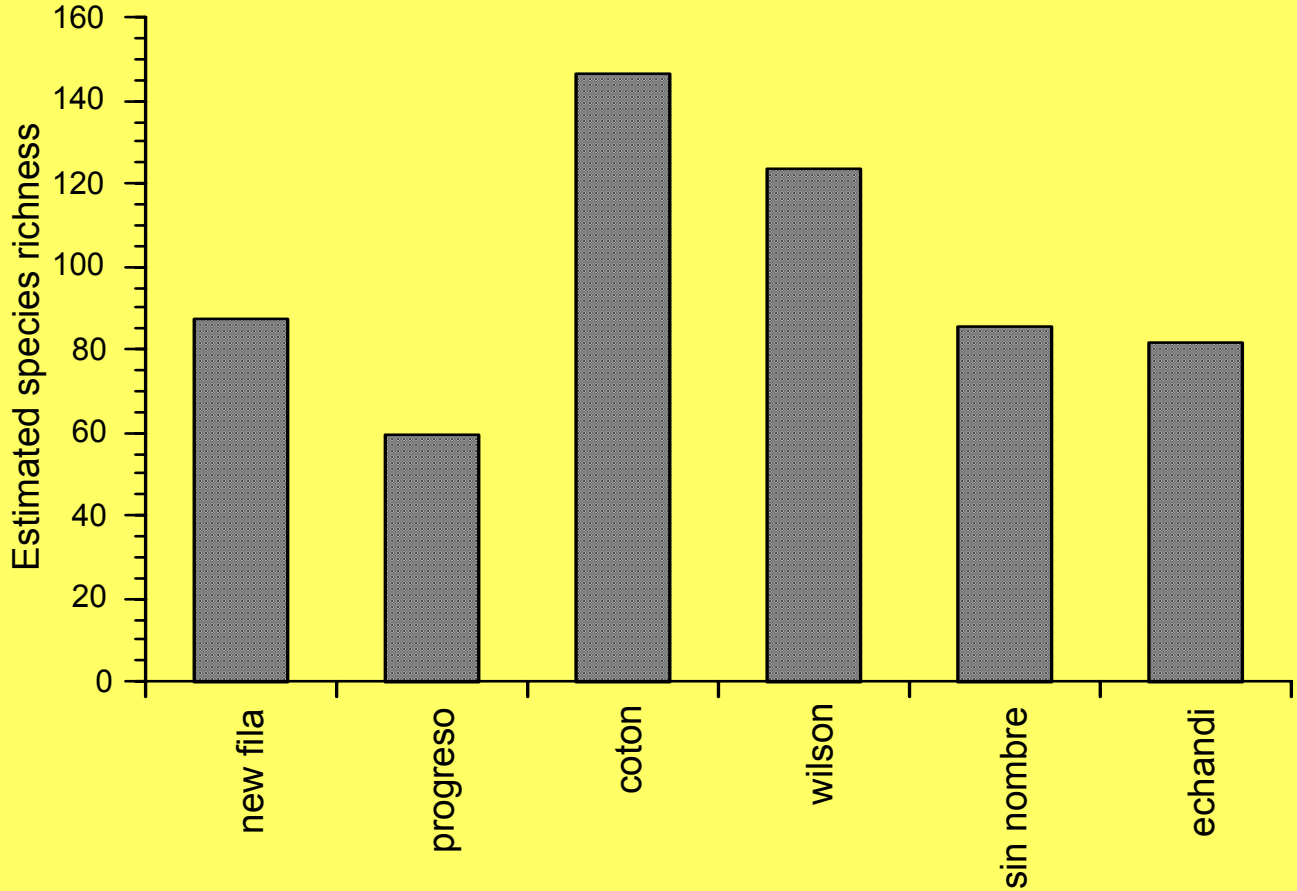
The next slide gives data from a subset of 6 of the 37 routes that could be ordered by direct observation with respect to the amount of forest in the landscape.

The highest species richness is found along routes with

both forested and unforested portions

…….Modelling may demonstrate that the highest biodiversity levels are maintained in mixed landscapes

Estimated species richness for six routes; from left, least to most forested



The next slide breaks out proportions of antbirds and seedeaters.

Seedeaters are most common in the least forested routes.
Antbirds are most common on forested routes.

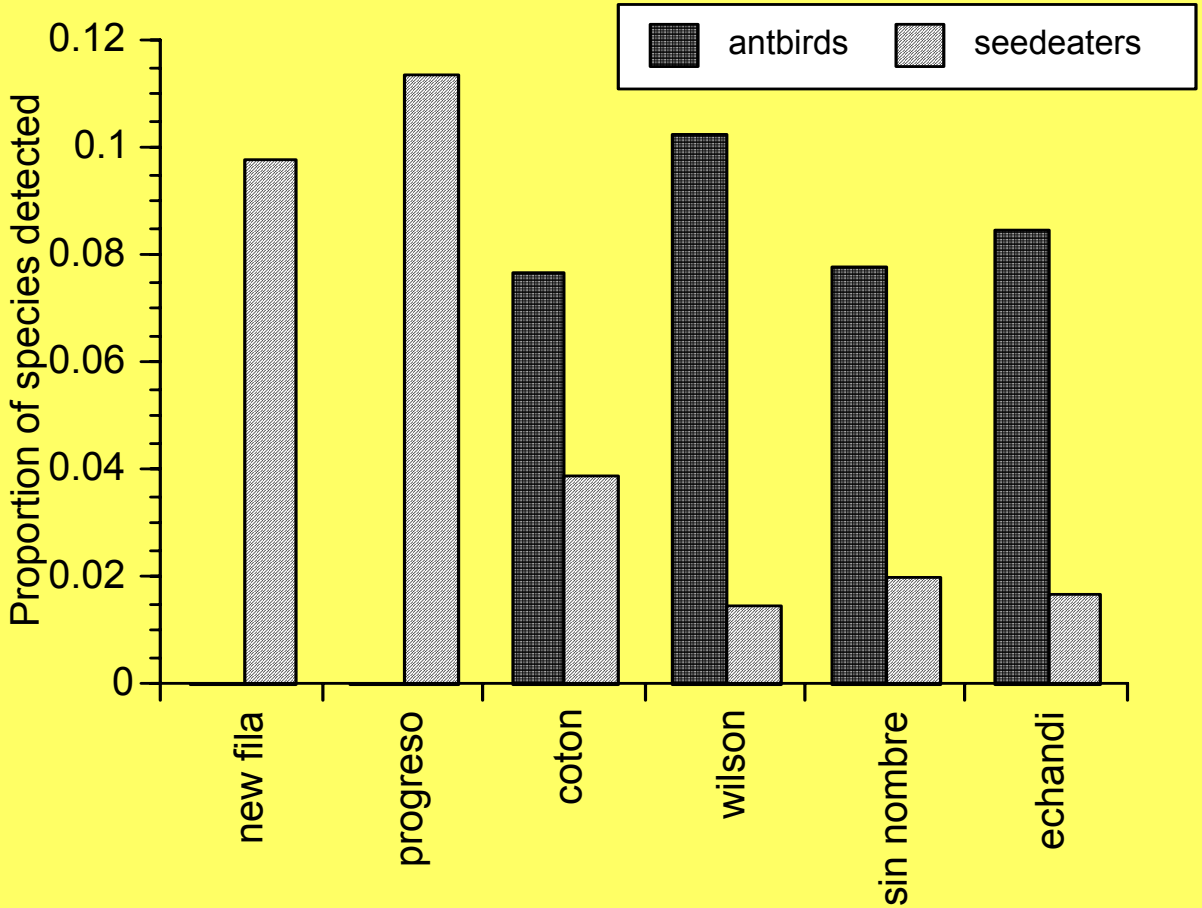
Evidently, groups of birds

vary in their response to deforestation

The richness of certain groups (e.g., antbirds) may be deemed particularly important to conservation goals

Hence, it is important to have separate models linking landscape features to the species richness of particular groups.

Proportions of antbirds and seedeaters for six routes; from left, least to most forested



Next steps for the Biodiversity Analysis

Create a Monteverde data base with new data

Conduct landscape analysis for buffers around routes

Develop statistical models linking landscape with bird species richness estimates for Coto Brus data

Test Coto Brus model against Monteverde data