What is Natural?
Remote sensing of terra preta in Amazonia

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How many people, an ultimate sustainability question?

If there were large populations this would mean a few things

- Forest is resilient
- Forest was managed sustainably
- Ecological research needs to be framed in a new context – not in a pristine forest
Lack of archaeological evidence

Bone, wood, tusk, and other organic substances tend to decay easily, especially in the humid tropics.

Little stone in Amazonia

Leads anthropologists to examine other sources of data such as linguistics, ceramics, and comparison with contemporary indigenous cultures.

A prime source used in reconstruction of Amazonian societies are Amazonian black earths (ABE) or in Portuguese, *terra preta* soils (Smith 1980, Petersen, et al. 2001).
What is terra preta?

Anthrosols characterized by

- high levels of organic matter
- charcoal
- nutrient elements
- frequently associated with large accumulations of potsherds and other artifacts of human origin

Archaeological excavation of terra preta sites in Brazil. Courtesy of Eduardo Neves
Work with Meghan Howey, Rob Braswell, Steve Hagen, Christina Czarnecki
Seasonal cycle of lake total freeze-thaw. The yellow line indicates the total number of lakes that are completely frozen. The red line shows the total number of lakes that are partially frozen. Note that neither line is normalized for clouds.
PALEOECOLOGY WORK

Hired Crystal McMichael as a post-doc to continue this work, setup a charcoal and phytolith lab, work two pending proposals if they are awarded, and develop new proposals.

Papers


Proposals

Collaborative Research: Using stochastic biogeographical models to link regional processes with continental patterns and the past with the future (w/ R. Cowell, UConn – PI, Palace, UNH -PI) – NSF Macroscale Biology

Collaborative Research: Long-term Anthropogenic Influences on the Crater Lake Environmental Landscape of Western Uganda (w/ M. Howey - PI) – NSF Archaeology
Deaths from vector-borne disease

VBD Deaths/million
- 0 - 1
- 1 - 20
- 20 - 50
- 50 - 200
- 200 - 500
- 500 - 1900
- No Data

Estimates by WHO sub-region for 2002 (WHO World Health Report, 2004). The boundaries shown on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement. © WHO 2005. All rights reserved.
Chagas disease

Chagas disease is caused by *Trypanosoma cruzi*, a parasite related to the African trypanosome that causes sleeping sickness.

It is spread by reduvid bugs and is one of the major health problems in South America.

Not present in the US

Harder to detect and does not kill outright
Symptoms

**Acute Phase**
- Fever
- General ill feeling (malaise)
- Swelling of one eye
- Swollen red area at site of insect bite

**Chronic Phase**
- Constipation
- Digestive problems
- Pain in the abdomen
- Swallowing difficulties

**Complications**
- Cardiomyopathy
- Enlargement of the colon (megacolon)
- Enlargement of the esophagus (megaesophagus) with swallowing difficulty
- Heart disease
- Heart failure
- Malnutrition
INTRODUCTION: Palm is an ecotype of the vector of Chagas Disease in Amazon

Work of Julia Shimbo
University of Brasilia
PhD. candidate
Some palm species are often abundant near **human habitations**, in **pastures** and **deforested areas**, because selective deforestation favors tree palms and some palms are pioneer species in secondary forests.
METHODS: Field data

First fieldwork:
13 TRANSECTS (250m x 20m each) - 0.5 ha each - total of 6.5 ha
METHODS: Mapping palms in the forest

Develop and compare of high-resolution remote sensing analysis techniques (automatically, manually and fieldwork) to identify and map palm in the terra firme forest.
Examining the Spatial and Temporal Ecology of Vector-Borne Lyme Disease in New Hampshire

Michael Palace

Christina Czarnecki, Ernst Linder, Peter Ingraham, Zhaoyu Yin, William Salas, Nathan Torbick, Michael Routhier, Rosemary Caron, Chengwei Yuan, David Bartlett, Xiangming Xiao

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• Lyme disease is a vector-borne and emergent disease

• Lyme disease is the most common tick-borne disease in the world (CDC 1996, Barbour et al. 1993).

• Lyme disease, the most prevalent vector-borne disease in the U.S. with nearly 18,000 cases annually, was not recognized until the early 1980’s. (Edman 2005).
• In the northeast United States, *Ixodes scapularis* (black-legged tick or deer tick) is the most common cause of transmission for Lyme disease.

• *I. scapularis* has a complex, two-year life cycle with four stages: egg, larvae, nymph, and adult (Stafford 2001).

• Once hatched, the tick will feed on the blood of only one host before molting into its next life stage.
List of landscape level parameters derived from landuse cover and FRAGSTATS

Parameters were derived for each site at 1 km, 5 km and 10 km radius and watershed

- site area in hectares
- patch density
- perimeter-area fractal dimension
- interspersion and juxtaposition index
- division
- patch richness density
- forested patch density
- forested largest patch index
- forested edge density
- forested patch cohesion

Parameters for unfragmented blocks around a site were also determined.
- Number of Unfragmented Blocks
- Average Block Area (HA)
- Largest Block (HA)
- Size of Site's Block (HA)
Poisson regression of Tick Abundance by Site

A Poisson regression of all ticks found adjusted for number of site visits resulted in a number of significant remotely sensed landscape characteristics as explanatory variables.

An optimal model after variable selection explained over 90% of the variability.

The most important were:
- forest edge density (10 km radius)
- forest patch cohesion (10 km radius)
- patch richness density (5 and 10 km radius)

Lesser degree a negative effect of moisture (either as soil moisture, barometer minimum or dewpoint) which is explained by the excessive wetness.
Zero-Inflated Poisson Regression

Such a model incorporates the occurrence of excess zeros
Considered a two-component mixture model, one component looking at zeros
After including a Land Cover type and looking at combination for a low AIC

Population Model had ten variables that were significant
- Patch Fraction at 5 km
- Patch Fraction at 10 km
- Division at 10 km
- Patch Richness Density at Watershed
- Patch Richness Density at 5 km

Zero Structural Model had five variables that were significant
- Average Humidity
- Interspersion and Juxtaposition index at Watershed
- Forest Edge at 10 km
- Julian Day
Introduction

- We are investigating the potential for pre-decimated forest cover types (which dominate area east of the Appalachian Ridge ORV Zone) to serve as an impediment to the movement of raccoon (Procyon lotor) variant rabies. A resulting risk model will form the basis for future scenarios modeling the spread of different strains.
- As a first step, we assessed the level of agreement between ground-level and spatially explicit ETM+ (15m spatial resolution) habitat data currently used in ORV planning.

Methods

- We compared Landsat-7 satellite imagery to ground-based habitat types in terms of the accuracy of classification matching on Cape Cod, Massachusetts and in Arkansas to Landsat ETM+ satellite imagery. This study assessed ground assessments are accurate and replicable.

Results

- Field Observations VS NLCD ETM+-

| Relative raccoon density (year at latitude) | Percent classification agreement (NLCD ETM+)
|----------------|-------------------|
| 3.80km² (2009) | 39% (95)
| 0.71km² (2007) | 15% (75)
| 0.71km² (2007) | 15% (75)

Source: Aron et al. 2007, Brookland pots core.

Conclusions

- Agreement between ground level and ETM+ based habitat values was low, and variable between types. The greatest level of agreement was noted for deciduous forests. The least agreement was noted for shrubland, mixed forests, and woody wetlands.
- Quickbird/Worldview imagery is available at relatively higher spatial (2 m) resolution than in ETM+ imagery (30 m), and may provide increased benefits for ORV planning.

Other models of dispersal distances despite combined categories of deciduous trees could potentially aid in raccoon rabies risk modeling due to this habitat type's importance.
- Assumptions about the accuracy and validity in ground observations would be limited before models and scenarios may be made about any imagery's utility for raccoon variant rabies modeling.
Future work

- Lyme disease and human babesiosis- NSF Ecology and Evolution of Infectious Disease
- Chagas Disease, land cover change and sustainable management in Amazonia- NSF Ecology and Evolution of Infectious Disease
- Possible funding to examine rabies and modeling
Future work

Coupled Human Natural Systems and/or PIRE at NSF for Africa work

Senior Research Proposal in Archaeology at NSF for Michigan work

CREATIV grant – on the explosion of palm distribution 3000 years ago in Amazonia

NSF Archaeology proposal – Geoglyphs in Amazonia

Use of lake freezing thawing to look at methane production in lakes above the arctic circle

Use of search algorithm to look at animal movement, search and turning angle in primates