Save the Sloths! A Look at Forest Canopy Loss in Redenção - State of Pará, Brazil

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Abstract

Sloths, those slow-moving rainforest mammals with a permanent smile on their face have been some of the most popular rainforest creatures for people around the world. However, these gentle creatures face a growing threat from the humans that seemingly love them, as their unique endemic habitats butt up against the drives of human development. Growing demand for new sources of wood products, increased farmland, and cattle ranching is leading to increased deforestation in Central America and South America that leaves sloths with dwindling habitat. With behavior and diets that are incredibly slow to adapt to a changing environment, the loss of humid tropical rainforest in Brazil means that even species of sloth not currently listed as vulnerable or endangered such as the three-toed brown-throated sloth (*Bradypus variegatus*) face threats that could lead to the species loss that cannot be recovered from. This report aims to identify rates of deforestation to human development in the Neotropical rainforests in Northern Brazil in the territory of *Bradypus variegatus.*

Background

Sloths live in the canopy of tropical forests, eating, sleeping, and rearing young almost exclusively off the ground, sparsely travelling to the forest floor mostly for the purpose of defecation. This requirement of a habitat offering continuous tree canopy means they can be acutely impacted by reduced tree canopy coverage in their habitat range (Lara-Ruiz, Chiarello, & Santos, 2008). In addition to needing tree canopy for both protection and a source of food for their herbivorous diet, sloths will seek naturally occurring minerals found in soils near rivers and streams as a source of vital minerals, making forest canopy near rivers the most ideal habitat for sloths (Vaughan, 2007). This can be at odds with human development which may seek land near rivers for irrigation of crops, water for livestock, or transportation for logging products or other natural resource extraction. As countries like Brazil seek to grow their economy at a rapid pace, ecological conservation efforts may take a back seat to natural resource exploitation and agriculture. While it is understandable that a country seeks to enrich its people by utilizing the resources within their territory, care needs to be taken that species like sloths do not spiral into an extinction vortex at which point the species cannot recover.

Deforestation and habitat loss for sloths not only lowers species population, but also leads to lack of genetic diversity. Lower genetic diversity leaves species more vulnerable to disease and negative genetic traits that are compounded by inbreeding. While the species itself is important for the ecological cycle of tropical forests, it thrives best in biodiverse habitats and is a bellwether for overall loss of biodiversity. In addition to deforestation and loss of habitat having a negative impact on sloths, loss of tropical forests directly impacts the uptake of Carbon Dioxide in the atmosphere, leading to higher levels of greenhouse gases that can contribute to global climate change (Sheikh, 2023). We should seek to limit deforestation and monitor the loss of tropical forest canopy not just to save the sloths but possibly to ensure we all have a livable future.

Selection of Brazil as area of study was driven by the Global Forest Watch and their reports on primary forest loss in South America pointing to some of the highest total tree cover loss over the last 20 years. They report from 2002-2022, Brazil lost almost 30 million hectares of humid primary forest (fig.1), accounting for an 8.6% decrease in total humid primary forest in the country (Global Forest Watch, 2022).
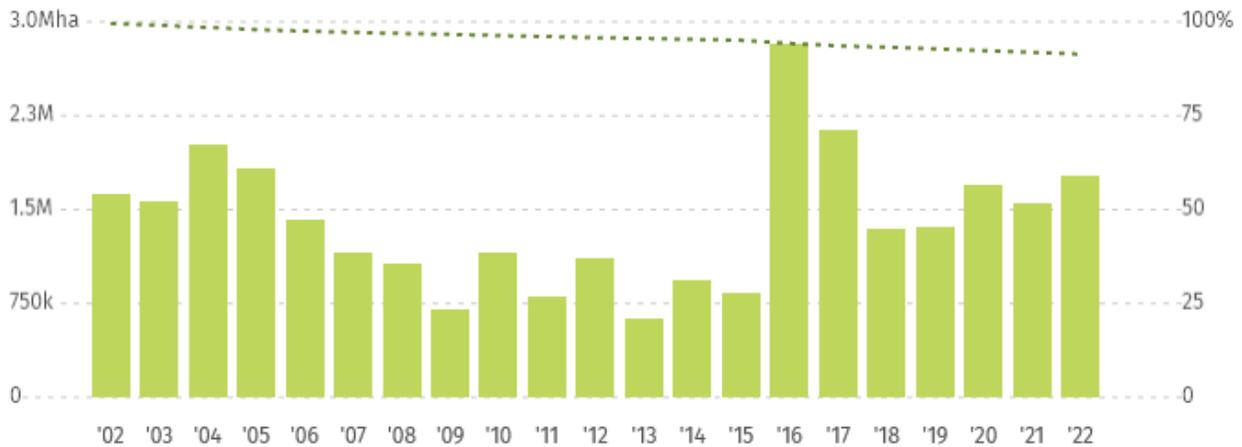

Figure 1 Primary Forest Canopy Loss in Mha Source: Global Forest Watch

Additionally, Global Forest Watch pointed to shifting agricultural needs as one of the most significant drivers of this loss of tree canopy. Global Forest Watch identified the state of Pará as the region with the highest amount of forest change, with loss of 10.3 Mha of primary humid forest loss from 2002 to 2022 (Global Forest Watch, 2022). As this region is overlayed by range where *Bradypus variegatus* is found, this makes it the ideal region for identification of areas of deforestation and habitat loss. Areas showing deforestation can be targeted for efforts to encourage reforestation or guide harm reduction towards remaining sloths in the region.

Data Source and Selection

Because loss of forest canopy can be easily discerned from true color or near infrared band composites, Landsat 8 OLI satellite imagery was selected due to its high resolution and availability over a wide range of dates. While Sentinel-2 imagery is even higher resolution, a more narrow range of dates was available and Landsat 30m resolution was acceptable for classification analysis. Study Area selection was made following two criteria: less than 10% cloud cover with the longest time interval between images to capture greatest amount of change. Due to this, an area in Redenção in the southeast of the State of Pará was chosen. While this area has not been identified as having a well known or previously studied group of sloths, the rates of deforestation and loss of biodiversity mean an overall loss of available habitat for any sloth population, current or future.

Data Sources Used

2014 Data:

- Satellite: Landsat 8
- Instrument: Operational Land Imager
- Spatial Resolution: 30m (Bands 2,3,4) 15m (Band 8)
- Radiometric Resolution: 12 bits
- Date Acquired: 06/03/2014
- Date Downloaded: 12/10/2023
- Path/Row: 224/065
- Scene ID: LC82240652014154LGN01
- Data Provider: NASA

2023 Data:

- Satellite: Landsat 8
- Instrument: Operational Land Imager
- Spatial Resolution: 30m (Bands 2,3,4) 15m (Band 8)
- Radiometric Resolution: 12 bits
- Date Acquired: 06/28/2023
- Date Downloaded: 12/10/2023
- Path/Row: 224/065
- Scene ID: LC82240652023179LGN00
- Data Provider: NASA

Methods

After acquiring data from NASA Earthdata website Semi-Automatic Classification Plugin (SCP) was utilized in QGIS Desktop to preprocess and classify data. First Landsat 8 OLI bands 2, 3, and 4 were atmospherically corrected to remove haze and aerosols using the DOS1 atmospheric correction. Utilizing the higher resolution band 8, panchromatic sharpening was done at the same time. Panchromatically sharpened and atmospherically corrected bands were merged into composite raster using the QGIS raster toolset to create a True Color composite. Cumulative Cut Stretch utilizing entire dataset was applied to increase contrast and brightness of images to use for classification.

SCP was used to create training polygons for classification for each True Color raster using four basic classes: forest canopy, bare soil/scrabble, agricultural fields/pasture, and dirt roads. In order to get more accurate classification, roughly 15-20 training polygons were generated for each meta class. After creating training polygons, classification was run to generate classification raster for each year. Due to roads being mostly unpaved and having similar reflectance to bare soil/scrabble means that classification of these areas was less accurate but acceptable as forest canopy was classified more clearly.

Final Products

Final products show clear difference in forest canopy class in both images that aligns with composite raster satellite images.

Land Cover in Redenção - State of Pará, Brazil
June, 03 2014

Classified

LandSat 8 True Color

Classes
- Forest
- Soil/Scrabble
- Agriculture/Pasture
- Roads

N

0 1 2 3 4 km
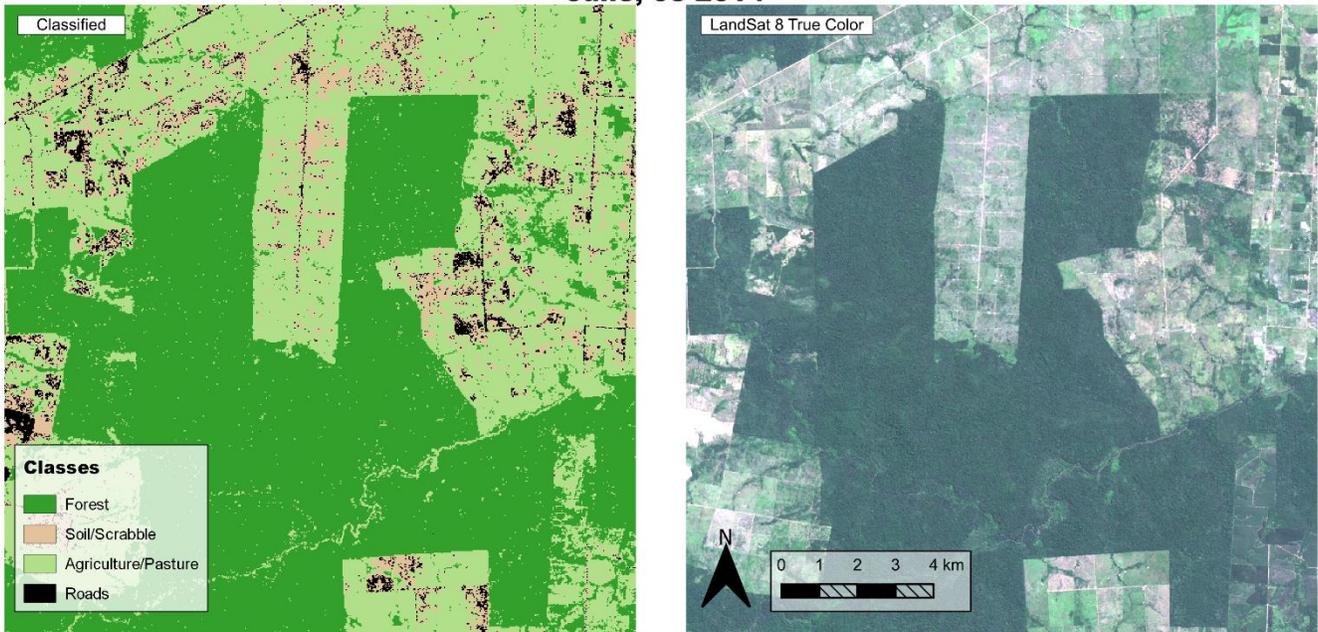
Class	Pixel Sum	Percentage	Area (Square Meters)
1 Forest	870125	47.36	195778125
2 Soil/Scrabble	147039	8.00	33083775
3 Agriculture/Pasture	698969	38.05	157268025
4 Roads	59355	3.23	13354875

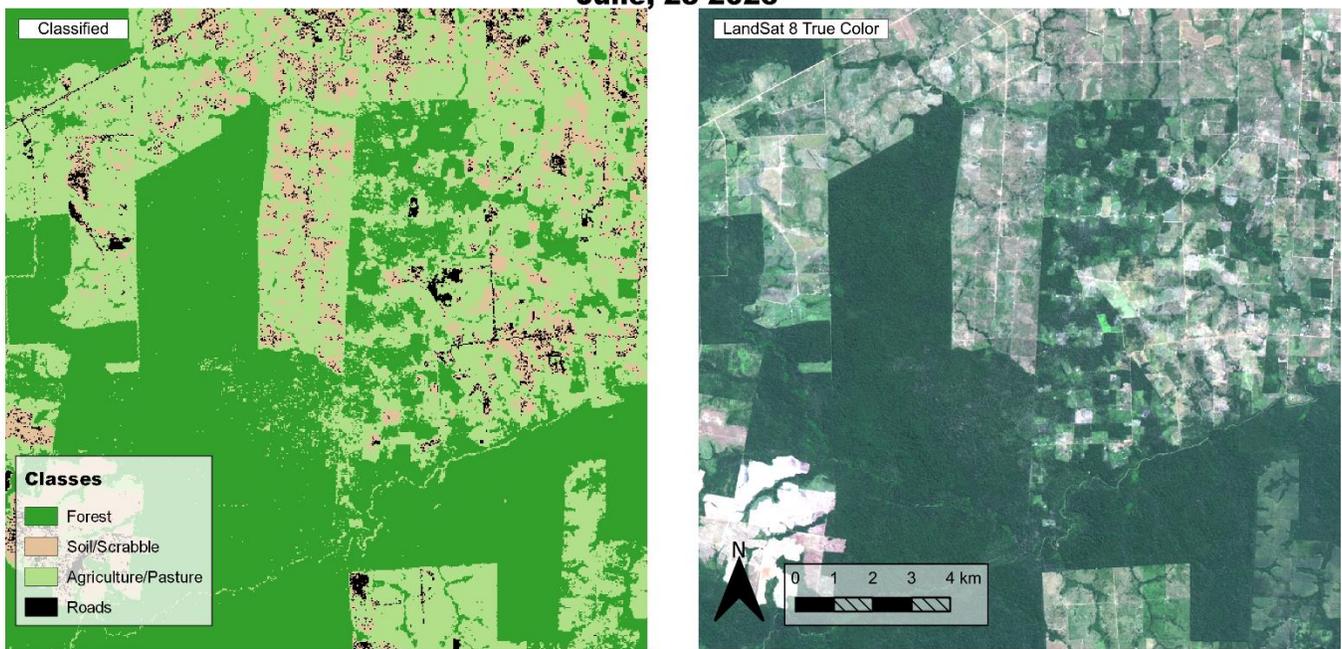Atlantic Ocean

Study Area

Brazil

0 300 600 km
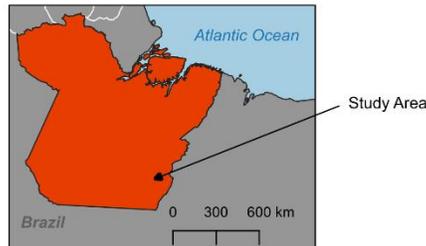
Skylar Bohan
Data Source: Landsat 8 OLI June 3, 2014
Row/Path: 224/065
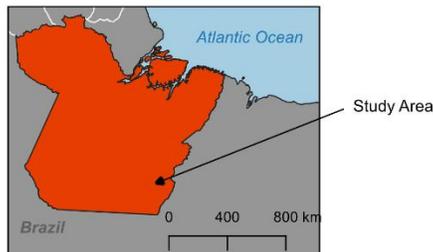Projection: WGS84 UTM 22N
December 12, 2023

Figure 2 2014 Land Cover

In 2014, roughly 47.36% of the study area representing about 195,778 km^2 was forest canopy, with 38% of the area or 157,268 km^2 covered in non-canopy fields likely for agriculture or pastures for livestock. While there is some encroachment into the forest, there are clear uninterrupted tracts of forest canopy for almost half of the area.

In 2023, it is clear deforestation has occurred in the eastern central area of the forest canopy of the study area. After classification was completed forest canopy now represents 46.64 % of the study area a loss of forest canopy or 192,782 km^2, a loss of 299,600 Hectares of forest canopy. Classification points to decrease in agricultural or pastureland, however classification found higher amounts of bare soil and roads in 2023 classification, so overall deforestation for purpose of agriculture or pasture land may have occurred even if crops are not currently being grown.

**Land Cover in Redenção - State of Pará, Brazil**
June, 28 2023

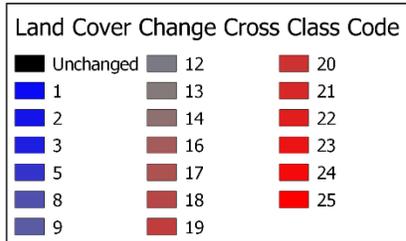| Class	PixelSum	Percentage %	Area (Square Meters)
1 Forest	856810	46.64	192782250
2 Soil/Scrabble	190461	10.37	42853725
3 Agriculture/Pasture	667512	36.33	150190200
4 Roads	60715	3.30	13660875

Skylar Bohan
Data Source: Landsat 8 OLI June 28, 2023
Row/Path: 224/065
Projection: WGS84 UTM 22N
December 12, 2023

Figure 3 2023 Land Cover
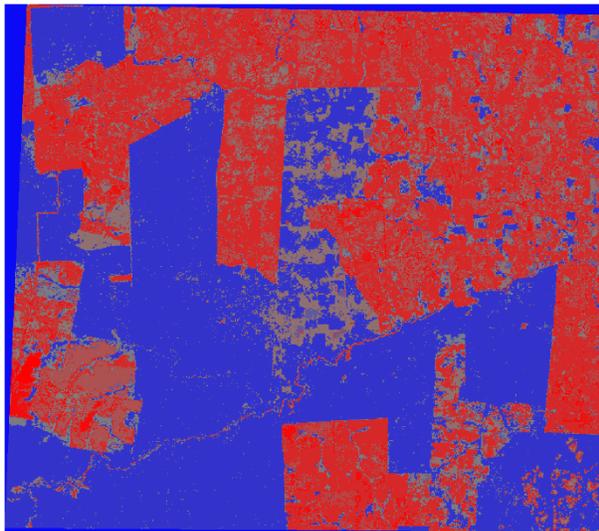
CrossClassCode	NewClass	ReferenceClass	PixelSum	Area (Square Meters)
1	0.0	0.0	61609.0	13862025.0
2	0.0	1.0	1.0	225.0
3	1.0	0.0	11.0	2475.0
5	1.0	1.0	761355.0	171304875.0
8	1.0	2.0	2042.0	459450.0
12	1.0	3.0	92802.0	20880450.0
16	1.0	4.0	600.0	135000.0
9	2.0	1.0	6926.0	1558350.0
13	2.0	2.0	43226.0	9725850.0
17	2.0	3.0	122236.0	27503100.0
20	2.0	4.0	18073.0	4066425.0
14	3.0	1.0	100235.0	22552875.0
18	3.0	2.0	87541.0	19696725.0
21	3.0	3.0	449771.0	101198475.0
23	3.0	4.0	29965.0	6742125.0
19	4.0	1.0	1608.0	361800.0
22	4.0	2.0	14230.0	3201750.0
24	4.0	3.0	34160.0	7686000.0
25	4.0	4.0	10717.0	2411325.0

Skylar Bohan
Data Source: Landsat 8 OLI
Row/Path: 224/065
Projection: WGS84 UTM 22N
December 12, 2023

0 1 2 3 4 km

Land Cover Change Cross Class Code

Unchanged	12	20
1	13	21
2	14	22
3	16	23
5	17	24
8	18	25
9	19	

Land Cover Change Classification
Redenção - State of Pará, Brazil 2014 - 2023

Figure 4 Land Cover Change Classification

Reviewing the Change Classification in the above figure you can see visually the pattern of change coming from existing deforested areas on the eastern side of the forest moving westward. Likely within the same time frame in 2032 this entire section of forest canopy will be lost if it follows this pattern.

Conclusions

While this is just a small study area, it is clear over the last 10 years forest canopy is decreasing at a measurable pace that can be seen with the naked eye. The Global Forest Watch data clearly shows this is not a isolated pattern in this one small study area (Global Forest Watch, 2022). As more deforestation occurs, this loss of habitat could be tragic for sloth species across Brazil and South America. As mentioned, natural resource exploitation, and growth of agriculture is a necessary part of economic growth and human activity in this region, but steps can be taken to reduce its negative impact on sloths and other tropical forest species. While not a cure-all for all habitat loss, reforestation and focusing on planting cacao trees is one method to combat the negative effects of shifting agricultural demands (Vaughan, 2007). Cacao trees provide tree canopy and food sources for sloths, while providing economically desirable agriculture products for farmers, and as a species already adapted to growth in humid tropical, can be less resource intensive to grow and cultivate. I hope with this increased

awareness of deforestation and habitat loss occurring in Brazil as shown with this map demonstrates how important it is to start addressing this issue now before we lose the chance to still see the gentle sloth serenely traversing the forest canopy.

References

Global Forest Watch. (2022). *Brazil Deforestation Rates & Statistics | GFW*. Retrieved December 10, 2023, from Forest Monitoring, Land Use, & Deforestation Trends | Global Forest Watch: https://www.globalforestwatch.org/dashboards/country/BRA/?category=forest-change&location=WyJjb3VudHJ5IiwiQlJBIl0%3D&map=eyJjYW5Cb3VuZCI6dHJ1ZX0%3D

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Vaughan, C. R. (2007). Spatial ecology and conservation of two sloth species in a cacao landscape in Limón, Costa Rica. *Journal of Biodiversity and Conservation*, 16-18.