Cacao for Corridors:

A Suitability Analysis Of Shade-grown Cacao Corridors for Black Howler Monkeys in Izabal, Guatemala

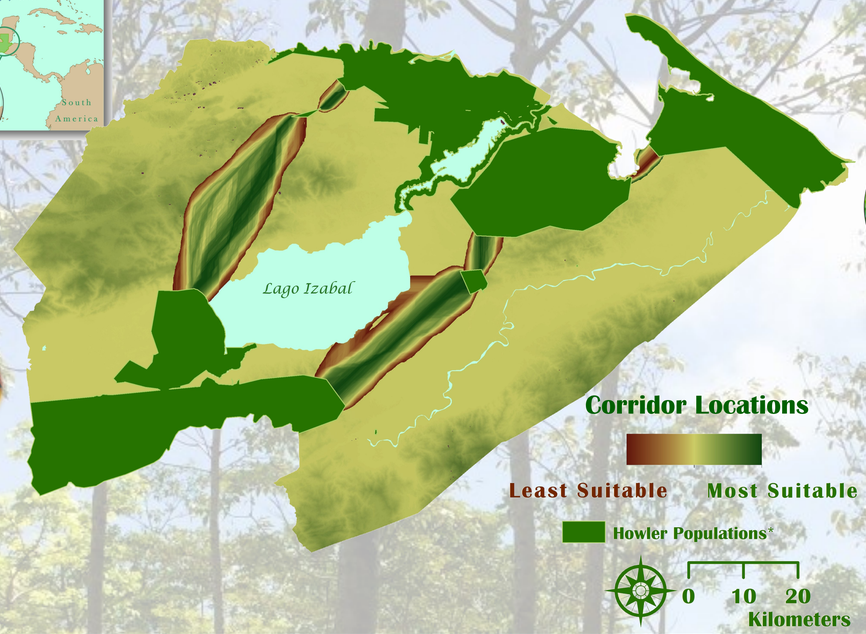
Lago Izabal

Habitat fragmentation is an escalating issue in tropical forests, particularly in developing countries such as Guatemala. Considered a region of high biodiversity, Guatemala is home to several endangered species, including the black howler monkey (*Alouatta pigra*). Although this species plays a critical role in seed dispersal and forest regeneration local ecosystems, population numbers are declining rapidly in response to substantial deforestation of natural habitat.

The land surrounding Lake Izabal was once covered in dense forest and home to a large population of howlers as well as ancient Mayan descendants. Agricultural development, nickel mining, and urbanization has since led to the deforestation of surrounding habitat, aside from a few distinct reserves. Although these small forest reserves retain a few populations of howlers, they most likely will not persist without gene flow between troops from other habitats, as well as sufficient food resources and territory availability.

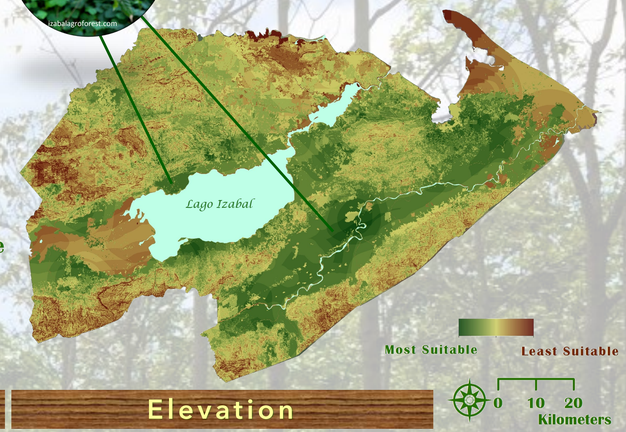
The establishment of wildlife corridors could aid in the mitigation of habitat fragmentation. To achieve this, land must be reforested in a corridor that allows howlers to travel between habitat fragments. As much of the land required is dedicated to agriculture, reforestation of Izabal proves as a significant challenge. A plausible solution is the establishment of shade-grown cacao plantations near populations of native Maya. As these natives are actively being pushed off their land by miners and government officials, successful cacao farms could provide them with successful livelihoods that are characteristic of ancient Mayan culture. As shade-grown cacao utilizes natural or planted forest canopy to produce high quality crop, farms established between habitats could create natural corridors for howlers to travel within. This type of agroforestry has been considered successful in the past in providing habitat and increasing biodiversity, and I believe it will prove as a valuable solution .

Potential Corridors



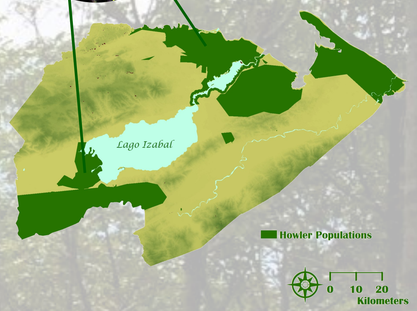
Cacao Suitability

Results from the weighted suitability analysis reveal large areas in Izabal that may be potential locations for reforestation utilizing shade-grown cacao farms. Areas to the southeast of Lago Izabal appear to be especially favorable as locations that could eventually provide connectivity between several protected habitats.



Howler Habitat

Black howler monkey populations historically inhabited the dense forest and mangroves surrounding Lago Izabal. Currently considered endangered, these herbivorous primates cling to the few remaining fragments of protected forest in the area.



Methods

Suitability Factors: Factors for shade-grown cacao locations were determined based on peer-reviewed literature, including land use, rainfall, elevation, slope, Maya population density, and distance to roads.

Suitability Analysis: Suitability factors were weighted based on review of literature. Raster calculator was utilized to complete a suitability analysis based on the weights listed in the table below.

Corridor Analysis: Corridor tool was utilized to determine the most suitable route between each habitat fragment surrounding Lago Izabal based on suitable shade-grown cacao locations.

Table 1: Suitability Factors

	Land Use	*Rainfall (mm/year)*	*Slope*	*Elevation (meters)*	*Maya Population Density (#/km²)*	*Distance to Roads (meters)*
Weight	25%	20%	20%	15%	10%	10%
1 Least Suitable	Wetland, Mangrove, Water, Beach	<1,250 <4,000	>40°	>1000 , <0	0-.02	>12,000
2	Populated places	3500-4000	30-40°	800-1000	.02-.05	8,000-12,000
3	Shrub land, Industrial land	3250 -3500	25-30°	600-800	.05-.08	5,000-8,000
4	Natural Forest	1,250-1,500 3000-3250	15-25°	400-600	.08-.10	2,000-5,000
5 Most Suitable	Cropland, Pasture	1,500-3,000	0-15°	0-400	.10-.20	0-2,000

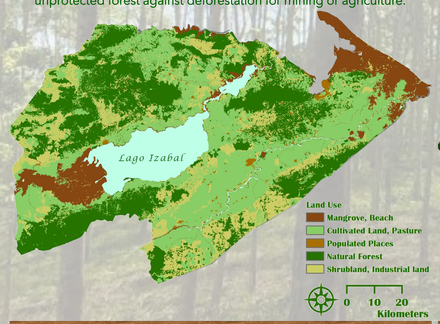
Data sources: IUCN, UNEP-WCMC, USGS, NGA, NASA, GADM, ESRI, MAGA

Projection: NAD_1983_2011_UTM_Zone_16N

Background: Izabalagroforest.com

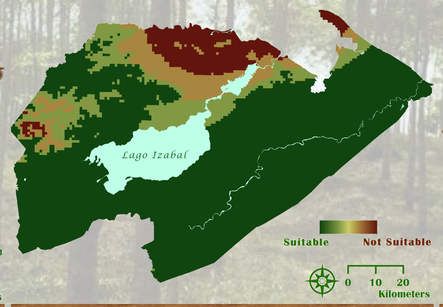
Land Use

Land use type is critical in determining suitable locations for shade-grown cacao, as areas such as mangrove are unsuitable for this type of agroforestry. Cropland or pasture are ideal, and allow for the opportunity to reforest areas that were previously cleared for agricultural use. Existing forest is the next choice for cacao agroforestry, as it safeguards unprotected forest against deforestation for mining or agriculture.



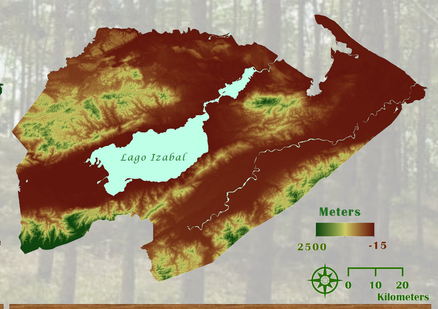
Rainfall

Cacao growth is significantly dependent on rainfall. For optimal growth, 1,500– 2,000 mm of rainfall on average annually is preferred. Cacao can tolerate a range of about 1,250-4,000 mm of annual rainfall. Average annual rainfall was reclassified based on literature from the International Cocoa Foundation, as shown in table 1.



Elevation

Cacao grows best at elevations between 0 and 300 meters, however, can grow up to 1,000 meters depending on additional environmental and geographic factors. The area surrounding Lago Izabal ranges significantly in elevation, with peaks as high as 2,500 meters.

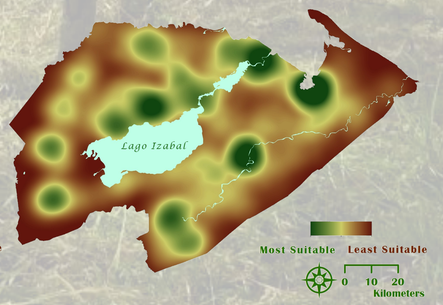


Slope

Slope of terrain must be taken into consideration when growing cacao in order to avoid excessive soil erosion. Although canopy trees utilized in agroforestry assist in buffering erosion, cacao should not be planted on slopes steeper than 40°, with 0-15° ideal. Slope was reclassified based on literature from the World Bank Group, as shown in table 1.

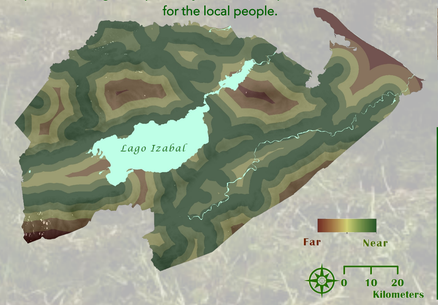
Maya Population Density

As the Maya population is valuable in the establishment of shade-grown cacao farms, population density was taken into consideration in the suitability analysis. Population density was reclassified based on kernel density, as shown in table 1.



Distance to Roads

In the case of agroforestry, reasonable proximity to roads is necessary in order for farmers to gain access to cacao farms. This factor was weighted the least in order to ensure that potential corridors are not placed in dangerous proximity to roads, but provide sufficient access for the local people.



Conclusions

The results of the initial stage of this analysis indicate that several areas in Izabal, Guatemala may be promising locations for shade-grown cacao farms. As these farms are established, canopy trees that are planted will allow for reforestation of previously cleared cropland. Farms established in existing portions of natural forest will ideally prevent these areas from being cleared for commercial agriculture. As these establishments flourish, natural corridors can begin to form in which black howler monkeys, as well as other local species, will be able to regain movement between several habitats.

The corridor stage of this analysis does reveal potential routes that could be connected between multiple protected areas of forest. With proper management by the local people, means of sustainable livelihoods could replace areas devastated by deforestation. This could ultimately encourage return of biodiversity as well as free movement of wildlife populations.

Projects of this magnitude and complexity are a familiar challenge in the conservation field. It is critical to continue to innovate solutions that meet the needs of both human and wildlife populations as the Anthropocene persists. Hope still remains in these beautifully biodiverse corners of the earth.

Acknowledgements

I'd like to thank Carolyn Talmadge and Catherine Ressijac for their unwavering attentiveness and dedication throughout this project!!

Cartographer: Meghan MacGregor
Masters of Conservation Medicine Candidate '18
MCM 591: GIS for Conservation Medicine
15 December 2017
Tufts UNIVERSITY | Cummings School of Veterinary Medicine