# **CORRIDORS FOR BORNEAN ELEPHANTS:**

A Suitability and Connectivity Analysis in Sabah, Malaysia

# BACKGROUND

The Bornean elephant *(Elephas maximus borneensis)* is an Asian elephant subspecies that is now thought to be indigenous to Borneo. This species is currently found in the northeast corner of the island, with a majority of the population's range within the Malaysian state of Sabah. Much of the elephant range falls within protected forest areas, and there has been increasing focus on elephant conservation as ecotourism makes up a majority of the tourism profit in Sabah.

Despite these conservation measures, the Bornean elephant population is decreasing and classified as "endangered" by the IUCN. This pattern can be attributed

to a multitude of factors, mainly relating to the overall risk of the small population size and an increase in human-wildlife conflicts. Some of the most dire causes of these issues are the increase in habitat fragmentation and the spread of agriculture, specifically palm oil plantations.

#### Habitat Fragmentation

Sabah's protected areas are divided by land used for agriculture, separating elephant habitat into isolated fragments. With an approximate total population of 1000 individuals, including only 400 breeding adults, dividing the population means a significant loss in genetic diversity. Genetic data suggests that the populations in forest fragments are undergoing genetic drift, increasing the risk for inbreeding depression.

#### **Palm Oil Plantations**

Palm oil plantations make up an increasing amount of the agricultural land that separates protected areas.
Elephants have been observed using palm oil plantations as corridors to protected forests, a dependence that increases the chance of human-wildlife conflicts. Farmers in these areas may use aggressive and sometimes fatal measures to prevent elephants from destroying crops.



Need for Corridors

KALIMANTAN (INDONESIA)

> The goal of this project is to identify the most suitable areas to create corridors to bridge isolated populations and keep elephants out of palm oil plantations.

## METHODS

#### 1. Suitability Analysis

Factors impacting the quality of Bornean elephant habitat were identified in scientific literature. Relevant data was inputted into ArcGis Pro, then Spatial Analyst tools were used to create a weighted analysis of these factors using the criteria listed below.

#### 2. Corridor Analysis

The generated suitability analysis raster and the Least Cost Path tool were used to identify the best path for corridors to connect the edges of each isolated range.

Factors	Distance From Protected Areas	Distance From Palm Oil Plantations	Land Use	Distance From Roads	Human Population Density	Forest Canopy Height	Elevation	Slope
Weight	25%	25%	10%	5%	15%	10%	5%	5%
<b>1</b> (Highest Suitability)	0-0.1 km	>5 km	Evergreen Broadleaf Forests	>7.5 km	0-50	10-16 m	-41-100 m	0-10%
2 (High Suitability)	0.1-1 km	2-5 km	Mixed Forests	50-75 km	50-500	5-10 m	100-500 m	10-20%
3 (Average Suitability)	1-2 km	1-2 km	Savannas, Grasslands	25-50 km	500-1000	16-25 m	500-1000 m	20-30%
4 (Low Suitability)	2-3 km	0.1-1 km	Wetlands, Cropland-Natural Vegetation	6.25-25 km	1000-5000	0-5 m	1000-2000m	30-40%
5 (Lowest Suitability)	>3 km	0-0.1 km	Urban, Croplands	0-6.25 km	>5000	>25 m	>2000 m	>40%

## RESULTS

The recorded range of Bornean elephants spans over both high and low suitability habitats, possibly pointing to the mix of forest habitat quality in Protected Areas. Using the Least Cost Path tool, three potential corridors were identified that would connect an end point of each of the three isolated elephant populations. Each of the proposed corridors mainly pass through areas of high suitability, however each intersects some amount of low suitability habitat. Two of the proposed corridors pass over a main road, a factor that is classified as low suitability.

## DISCUSSION

Creating the three proposed wildlife corridors would serve as bridges between the three isolated populations and facilitate gene flow. This would decrease the chance of inbreeding depression and increase the population's ability to adapt. The presence of these wildlife crossings would hopefully minimize the time that elephants spent in or around palm oil plantations, and therefore decrease human-wildlife conflicts. However, two of the corridors pass over the main road. Creating corridors across the road may actually increase human-wildlife conflicts by funneling the elephants towards vehicles on the road. Overall, identifying these areas informs conservationists on the most optimal path to connect the three elephant populations and highlights areas of low suitability habitat along these corridors where conservation efforts should be concentrated. More research is needed to identify the most efficient way to create these three corridors and examine the implications of creating these corridors across roads and the effect such actions would have on human-wildlife conflicts.

## **SUITABILITY FACTORS**

Land Use Suitability



Protected Areas make up a majority of the identified Bornean elephant range. These areas may provide the elephants with food sources and minimize the chance of interaction with humans and subsequent conflicts. This map shows established Protected Areas in Sabah as reported by Global Forest Watch. This merged layer includes areas classified as strict nature reserves, wilderness areas, national parks, and habitat and species management areas.

### Land Use

One of the primary threats to the Bornean elephant population is the impact of habitat fragmentation due to deforestation for agriculture. This map shows the suitability of habitat in relation to land use. The Raster Calculator tool was used with reclassified rasters for distance from Protected Areas (35% weight), distance from palm oil plantations (35% weight) and general land use (30% weight). The forest categories of general land use were ranked as most suitable due to the recorded preference of degraded forests, with urban areas and croplands ranked least suitable due to chance for human-wildlife conflict.

### Human Impact

**Habitat Suitability** 

One of the primary threats to the Bornean elephant population is the increase of human-wildlife conflicts. As the human population in Sabah grows and more forests are converted for agriculture, interactions between elephants and humans are expected to increase. This map shows the suitability of habitat in relation to human impact. The Raster Calculator tool was used with reclassified rasters for human population density (80% weight) and distance to major roads (20%). Distance to major roads was weighted less because some elephants have been observed crossing roads regularly, but the population as a whole avoids urban areas.



**Forest Habitat** 

While much of the observed Bornean elephant range falls within Protected Areas, these sections of protected forest may not necessarily provide quality elephant habitat. Bornean elephants have been observed to prefer degraded forests, mainly occurring below 2000 meter elevation, on flatter slopes, with an optimal tree height of 13 meters. This map shows the suitability of forest habitat in Sabah using the Raster Calculator tool with reclassified rasters for tree canopy height (40% weight), elevation (30% weight), and slope (30% weight). Tree canopy height was the factor used in scientific literature to identify degraded forests, so this factor was weighted the highest.

