Modeling Potential Tiger Habitat in Hupingshan-Houhe and Mangshan-Nanling National Nature Reserves, China

Charles J.W. Carroll and Courtney L. Larson
ES 212: Introduction to GIS and Remote Sensing
Environmental Studies Program
Colby College, Waterville, Maine

Abstract

The South China tiger (*Panthera tigris amoyensis*) one of the world's most endangered carnivore species, and is now thought to be extinct in the wild. However, there is some hope of reintroduction, with Hupingshan-Houhe and Mangshan-Nanling National Nature Reserves in southern China seeming to hold the most promise. Our study used slope, elevation, vegetation, and landcover variables to construct a rough habitat suitability index for tigers in these two parks. According to our model, there are areas of suitable habitat within both parks. However, there are some important variables that we were unable to include in our model, such as human population density and prey availability. Considerable in-depth field research will be necessary to evaluate the suitability of these locations before reintroduction is considered.

Introduction

The South China tiger (*Panthera tigris amoyensis*) is currently critically endangered (IUCN Red List, 2007). There were an estimated 4,000 wild tigers in China in the early 1950s, but this number fell to an estimated 150-200 in 1982. The main reasons for this decline are a government-sponsored eradication campaign, hunting, deforestation, and habitat fragmentation (Tilson and Nyhus in press). A 2004 field study (Tilson et al. 2004) concluded that the South China tiger is most likely extinct in the wild.

There are currently about 70 South China tigers living in captivity, of which some could possibly be reintroduced to the wild (Tilson and Nyhus in press). However, it is not known if there is suitable remaining habitat large enough to sustain viable tiger populations. The two promising locations, based primarily on size, are Hupingshan-Houhe and Mangshan-Nanling National Nature Reserves (Tilson and Nyhus in press).

In this study, we use Geographic Information System (GIS) modeling to investigate potential tiger habitat within the two locations by creating a habitat suitability index. This is an unofficial draft model and is not intended to reflect a final tiger habitat analysis of the two sites, but rather to provide a preliminary draft guide for more detailed studies in the future.

Methods

Our habitat suitability index (HSI) combined four variables in a multiplicative model: elevation, slope, landcover, and vegetation, as measured by a Transformed Normalized Difference Vegetation Index (TNDVI) (see Data Sources for source information). Slope was calculated from the elevation data. To make the HSI, we normalized all the values on a scale from zero to one, where 0 is the least suitable and 1 is the most suitable. Based on a prior iteration of the model, we knew that elevation had a disproportionate impact on the HSI, so we modified the elevation layer to range from 0.8 to 1, using the equation below (where E_i is the elevation grid) to transform each pixel. This meant that the points with the highest elevation would still have a value of 0.8, so that they would not have a large impact on the overall HSI value.

$$E_i = \frac{\left(\frac{x_i - x_{\min}}{x_{\max} - x_{\min}}\right)}{5} + 0.8$$

In our model, elevation was weighted 0.1, slope and vegetation were both weighted 0.25, and landcover was weighted 0.4. This is because elevation is less important for tiger habitat than the other variables, and landcover is especially important because human-impacted areas are the least suitable for tigers. The resulting map layer shows habitat potential, calculated using the equation below. We then re-scaled the resulting layer to range from 0 (least suitable) to 1 (most suitable) to make comparisons easier.

HSI = (0.4)(Landcover) * (0.25)(Slope) * (0.25)(TNDVI) * (0.1)(Elevation)

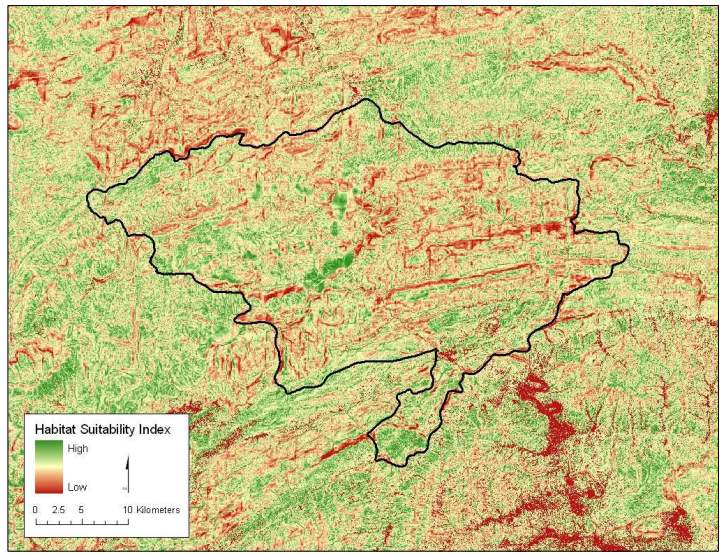


Figure 9. Habitat Suitability Index for Hupingshan-Houhe NNR

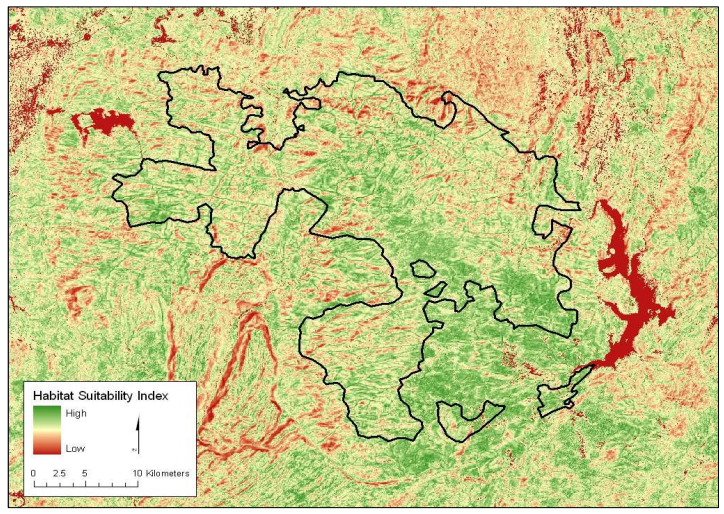
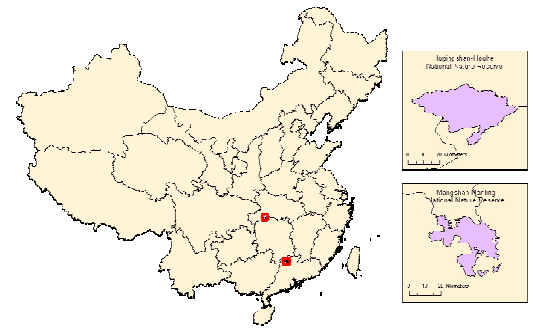


Figure 10. Habitat Suitability Index for Mangshan-Nanling NNR



Results

The mean HSI value for Hupingshan-Houhe NNR was 0.5213 ± .0001. Within the site, which is approximately 1,636 km^2 in total, 87.8 km^2 had an HSI value ranging from 0.75-1, the best habitat class; 822 km^2 had a value ranging from 0.50-0.75; 684.3 km^2 had a value of 0.25-0.50; and 42.3 km^2 had a value between 0 and 0.25, the least suitable habitat (Figure 11). The most suitable habitat is clustered in the western half of the site and in the southeastern peninsula.

In Mangshan-Nanling NNR the mean HSI value was nearly the same, 0.5372 ± .0001. The total area of the site is approximately 1,155 km^2. Of this area, 18.6 km^2 was in the best habitat class, with values ranging from 0.75-1; 722.3 km^2 ranged from 0.50-0.75; 403.4 km^2 had a value between 0.25 and 0.50; and 11.5 km^2 was in the least suitable habitat class, with values ranging from 0-0.25 (Figure 11). The main core area of the site is quite favorable, with suitable habitat continuing south beyond the main boundary and including the small isolated park fragments.

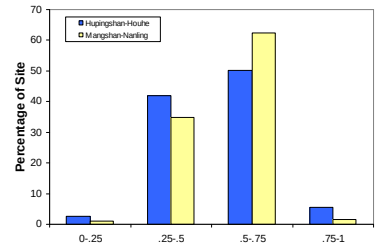


Figure 11. Percent of site area in four habitat classes

Discussion

These two sites in China are some of the largest that are available for potential tiger reintroduction in the future, collectively encompassing 2,791 km^2. Our findings show that there is very little high quality tiger habitat in either park. However, there is even less highly unsuitable habitat in either of the parks; nearly all of the total area fell into the middle quartiles of the HSI values. This indicates that significant improvements would be necessary if reintroduction is to occur in either of these parks.

The southeastern peninsula of Hupingshan-Houhe NNR looks relatively favorable based on this analysis, but due to its proximity to the city, we are uncertain of its actual suitability. Based on our analysis, we suggest that future field studies be done in the western half of the park since this area seems to be the most suitable.

Mangshan-Nanling NNR has approximately the same mean level of suitability as Hupingshan-Houhe NNR, based on this model. However, it seems likely that if the area south of the site's main border and north of the park fragments (which are not actually in the parks proper) could be included in a possible tiger reintroduction site, there could be a relatively large amount of suitable, contiguous habitat in that area. However, there does appear to be some agriculture in this area, which could complicate a future reintroduction.

In the future, more detailed habitat suitability models could take into account additional variables such as human population density, distance from human development, prey density, and microclimatic conditions. However, although our models are fairly rough, they are nevertheless useful in guiding future research on tiger habitat in these two parks. It appears that there is some remaining habitat that is fairly suitable for tigers, which indicates that reintroduction of the South China tiger remains a possibility worth exploring.

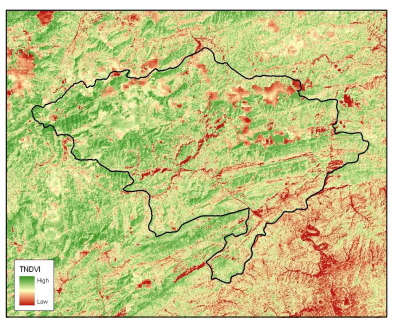


Figure 1. TNDVI in Hupingshan-Houhe NNR

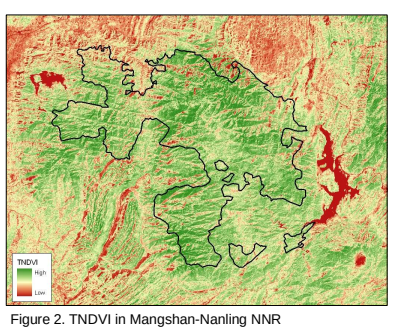


Figure 2. TNDVI in Mangshan-Nanling NNR

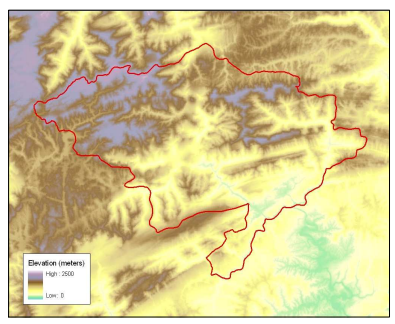


Figure 3. Elevation in Hupingshan-Houhe NNR

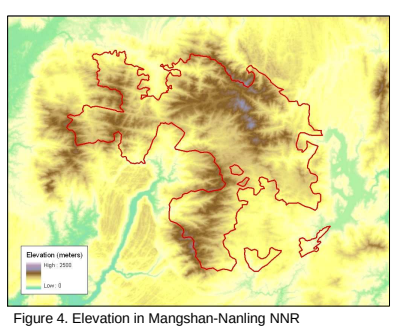


Figure 4. Elevation in Mangshan-Nanling NNR

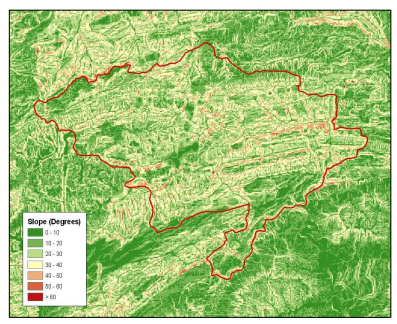


Figure 5. Slope in Hupingshan-Houhe NNR

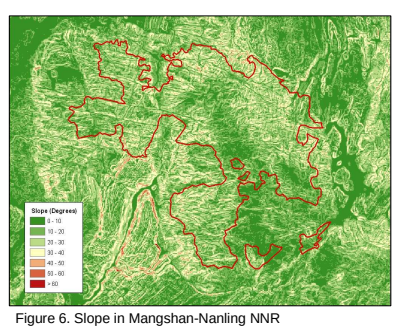


Figure 6. Slope in Mangshan-Nanling NNR

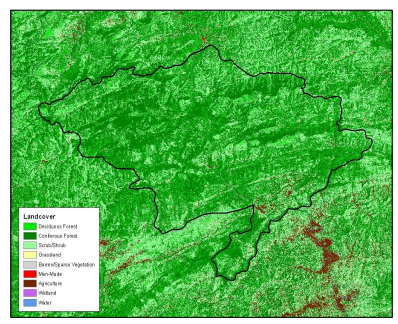


Figure 7. Landcover in Hupingshan-Houhe NNR

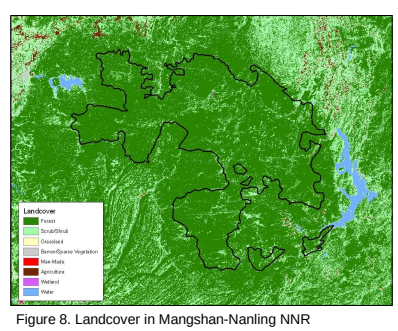


Figure 8. Landcover in Mangshan-Nanling NNR

Literature Cited

IUCN. 2007. 2007 IUCN Red List of Threatened Species. Available from http://www.iucnredlist.org/.
Tilson, R., H. Defu, J. Muntifering, and P.J. Nyhus. 2004. Dramatic decline of wild South China tigers *Panthera tigris amoyensis*: field survey of priority tiger reserves. *Oryx* 38(1): 40-47.
Tilson, R., and P.J. Nyhus. 2009. Yin and Yang of Tiger Conservation in China. In *Tigers of the World: The Biology, Politics, and Conservation of* Panthera tigris. New York: William Andrew Press (in press).

Data Sources

TNDVI: European Space Agency Ionia Globcover Portal. www.esa.int/due/ionia/globcover
Elevation: U.S. Geological Survey. EROS Data Center.
Land Cover: MDA Federal. EarthSat GeoCover LC. www.mdafederal.com
Maps were projected using Universal Transverse Mercator Zone 49N

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