3D Information-Based Wild Boar Habitat Analysis -A Case Study of Seoul

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The 31st AIM International Workshop

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Introduction

Urbanization has progressively led to the contraction and fragmentation of wildlife habitats. Among affected species, wild boar (*Sus scrofa*) have increasingly ventured into urban areas in response to habitat loss and anthropogenic disturbances, giving rise to a range of issues including crop damage, traffic accidents, and infrastructure degradation (Lee, 2019). By integrating three-dimensional LiDAR-derived canopy and terrain models, large-bodied mammals such as wild boar exhibit adaptive behaviors in urban environments, selecting movement corridors and habitat patches according to landscape connectivity and environmental attributes. Consequently, identifying the key habitat characteristics and preference factors that drive wild boar occurrence in urban settings is essential for mitigating human–wildlife conflicts. In this study, we analyze habitat suitability for wild boar within Ansan Urban Park using detailed 3D structural variables, to elucidate the principal environmental determinants of habitat selection and to provide baseline data for the development of urban wild boar management and conservation strategies. Specifically, we evaluate habitat suitability by modeling the relationship between boar occurrence probability and a suite of three-dimensional environmental variables, and we derive recommendations for securing and managing suitable habitat within metropolitan areas.

Methodology

This study selected Ansan Urban Park in Seodaemun-gu, Seoul, as the study area. Within this park, we obtained 32 wild boar occurrence points through deployment of motion-activated camera traps. The park encompasses a variety of green spaces, walking trails, and ecological corridors, facilitating analysis of boar movement pathways and potential habitat. Each occurrence point was spatially referenced to a 30 m × 30 m grid cell for analysis. We assembled ten environmental variables documented in prior studies as influential for wild boar habitat selection: three vegetation variables (including LiDAR-derived canopy cover (Figure 2) and LiDAR-based Canopy Height Model [CHM] (Figure 3), tree species composition, canopy height and cover, forest cover percentage), three topographic/geological variables (slope gradient, aspect, distance to rock outcrops), and four accessibility variables (distance to unpaved trails, paved walkways, decks, and other park infrastructure). All variables were produced and aligned at 30 m resolution. To avoid multicollinearity, we calculated Pearson correlation coefficients among predictors and removed those pairs with $|r| > 0.7$, retaining the variable with greater ecological relevance. Habitat suitability was modeled using MaxEnt (version 3.4.1), a presence-only machine learning algorithm that estimates the probability of species presence based on environmental covariates. We generated background points randomly across the park extent and evaluated model generality via ten-fold cross-validation. Model performance was assessed using the area under the receiver operating characteristic curve (AUC). Finally, we applied a threshold to distinguish high-probability from low-probability cells and interpreted the characteristic responses of each environmental variable across these classes.

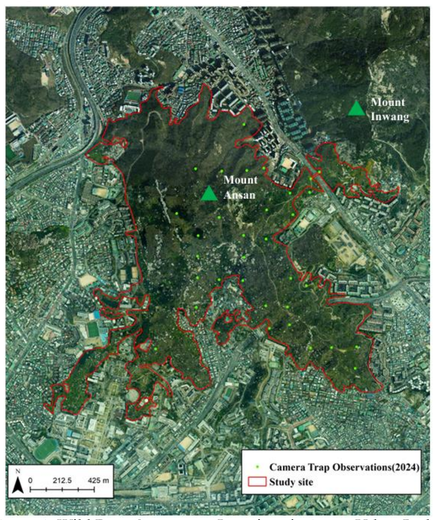

Figure 1. Wild Boar Occurrence Locations in Ansan Urban Park (National Institute of Biological Resources)

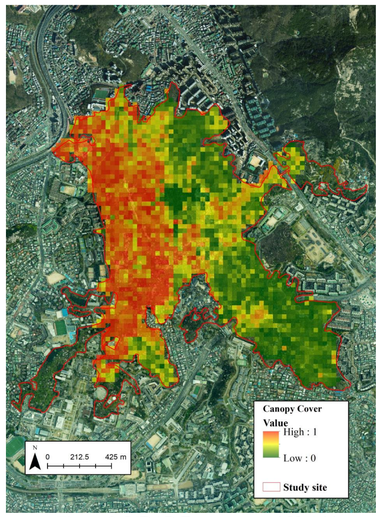

Figure 2. LiDAR Environmental Variable – Canopy Cover (%)

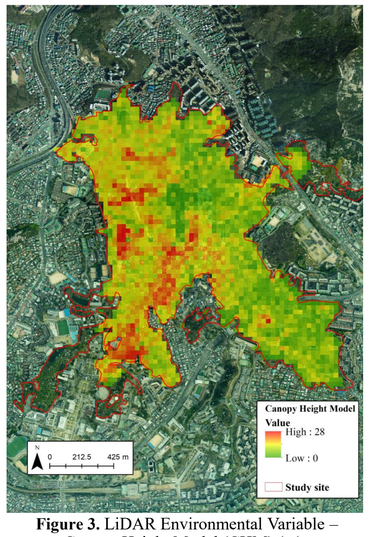

Figure 3. LiDAR Environmental Variable – Canopy Height Model (CHM) (m)

Results & Discussion

The MaxEnt model yielded a test AUC of 0.842, indicating a high level of predictive reliability (Table 1). In the variable contribution analysis, slope and tree species composition accounted for the largest shares, followed by distance to dirt trails, distance to rock outcrops, distance to paved walkways, and distance to decks (Table 2).

The response curves for each environmental variable show that wild boar prefer gentle slopes (5–9 %) as well as moderate slopes (15–45 %), and exhibit highest suitability at canopy heights of 2–12 m and canopy cover of 0–80 %. Additionally, boar occurrence probability peaked at approximately 30 m from dirt trails and 100 m from paved walkways, and suitability also increased near decks—suggesting that the undersides of elevated decks serve as refuge (Table 3). The spatial prediction map revealed that areas classified as “high suitability” (> 0.6) are concentrated along the ecological corridors in the park’s southeast and northeast sectors (the Muakjae Sky Bridge) (Figure 4), a pattern that field verification confirmed coincides with locations characterized by low canopy density and well-developed understory vegetation. These findings demonstrate that slope, tree species composition, and accessibility variables are key drivers of wild boar habitat selection, and that ecological corridors play a critical role in maintaining habitat connectivity. Accordingly, management strategies should include targeted monitoring of high-suitability areas, establishment of buffer zones, and conservation or expansion of ecological corridors.

Table 1. Model Overview

Information	Value
Spatial Resolution	30m × 30m
Model Validation Method	10-fold cross validation
Occurrence Records	32 points
Environmental Variables	10 variables
Model Performance(AUC)	0.842

Table 2. Environmental Variables and Their Contribution to Habitat Analysis

Variable	Description	Type	Contribution (%)	Category
CHM (Canopy Height)	Canopy Height Model derived from LiDAR	Continuous	5.0	Vegetation
Canopy Cover	Percentage of ground area covered by canopy (LiDAR)	Continuous	2.5	
Tree Species Type	Field-surveyed tree species (17 taxa) and their reclassified groups	Categorical	21.1	
Forst Proprtion	Focal-statistics–derived proportion of surrounding area covered by forest	Categorical	2.9	
Slope	Ground slope (%) weighted according to gradient	Categorical	21.7	Terrain & Geology
Aspect	Aspect direction (°)	Continuous	4.9	
Rock Outcrop	Euclidean distance from rock outcrops	Continuous	10.5	
Dirt Trail	Euclidean distance from unpaved trails	Continuous	16.1	
Paved Walkway	Euclidean distance from paved walkways (concrete blocks)	Continuous	10.1	
Deck	Euclidean distance from elevated deck structures	Continuous	5.1	

Table 3. Characteristics of Environmental Variables by Wild Boar Occurrence Probability Thresholds from Habitat Suitability Analysis

Environmental Variable	High Occurrence Probability (Threshold ≥0.387)	Low Occurrence (Threshold ≤0.387)	Interpretation
CHM (Canopy Height)	2–12 m	≤ 2 m	Wild boar prefer areas with canopy height ≥ 2 m, as this provides enough vertical space for understory growth and cover; when canopy < 2 m, understory is too sparse (Tomita et al., 2021).
Canopy Cover	0–80 %	≥ 80 %	Boar favor partially open canopy (≤ 80 % cover) where understory is well developed, rather than dense closed canopy (Smith, 2011).
Tree Species Type	Oaks, fruit trees, conifers	Korean pine, camellias, maples, other broadleaves	Wild boar select tree communities (oaks, fruit-bearing species, conifers) that provide mast and fruits (David et al., 2023).
Forst Proprtion	Interior forest areas	Areas adjacent to non-forest land	Boar prefer habitats surrounded by continuous forest interior rather than edges adjacent to developed land (Jilian, 2012).
Slope	5–9 % and 15–45 %	All other slopes	Moderate (5–9 %) and mid-to-steep (15–45 %) slopes offer cover and reduced human disturbance, and help maintain shade and moisture (Tomita et al., 2022; Bartolomie et al., 2022).
Aspect	Northeast to South (NE–S)	Southwest to North (SW–NW)	Aspects from NE to S provide optimal sunlight and thermal regulation, aiding boar thermoregulation and activity (Francesco et al., 2021).
Distance to Rock Outcrop	> 100 m	≤ 100 m	Boar avoid areas close to bare rock (> 100 m preferred) because outcrops lack forage and water retention (Francesco et al., 2021).
Distance to Dirt Trail	> 30 m	≤ 30 m	Boar tend to avoid trails used by people, exhibiting highest suitability at ~ 30 m away from unpaved paths (Fanny, 2022).
Distance to Paved Walkway	> 100 m	≤ 100 m	Areas more than 100 m from paved sidewalks are preferred, providing sufficient buffer from human foot traffic (Fanny, 2022).
Distance to Deck	0–100 m	> 100 m	Proximity (≤ 100 m) to elevated decks is favored, as boar use the sheltered space beneath decks for refuge (field observation).

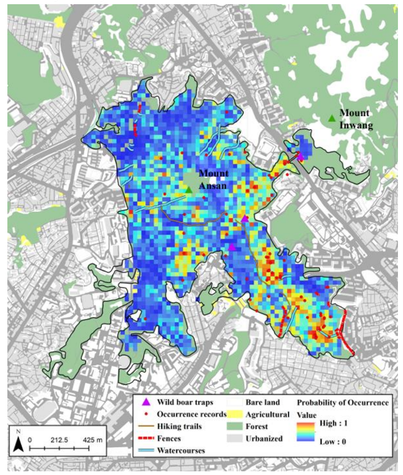

Figure 4. Habitat Suitability Analysis Results for Ansan Urban Park

Conclusion

This study confirmed that wild boar habitat in Ansan Urban Park is influenced by topography, canopy structure, distance from human activity areas, and proximity to ecological corridors, and bsed on these findings, we propose targeted monitoring of high-suitability areas, establishment of buffer zones, and the conservation and expansion of ecological corridors.

Acknowledgment

This study was supported by the National Institute of Biological Resources (NIBR202517102), which is funded by the Ministry of Environment, Republic of Korea.