Development of Ecosystem Impact Assessment Methods for Middle-sized Mammals as the Representative Species

Background

Environmental impact assessment of power plants involves the evaluation of their possible impact on ecosystems. Similarly, environmental impact prediction involves the selection of the species that characterize the ecosystem in terms of top predator species, representative species, and specific species as means to quantitatively understand the possible impacts on ecosystems. However, the procedures for both these approaches are yet to be established.

Objectives

The purpose of this study is to develop methods for quantitative evaluation of possible impacts of development on ecosystems using DNA data and geographic information system (GIS) with focus on the relationship between typical middle-sized mammals (target species) and the ecosystem – satoyama (community-based forest) – inhabited by them.

Principal Results

An ecosystem assessment method has been developed by keeping in view the typical species that inhabit the ecosystem with focus on key factors that characterize the habitats of middle-sized mammals, i.e., foraging, breeding, and behavioral environments (Fig. 1).

1. Estimation of the badger population using DNA data

The badger was considered as the typical target species, and various areas with different types of vegetation in Satsumasendai city (Kagoshima prefecture) were selected as survey areas for collecting badger feces. The results of individual recognition on the basis of fecal DNA analysis indicate that the habitat density of badgers is 0.18/ha in lowland areas (comprising mainly Japanese black pine forest) and 0.30/ha in mountainous areas (comprising broad-leaved evergreen and cedar forests) (Fig. 2).

2. Evaluation of the distribution of food resource using GIS

We analyzed the relationship between food resources and environmental factors by calculating the amount of food resources from wet weights of earthworms, land shellfish, beetles, etc. (those identified in fecal DNA analysis) per unit area of land. The results indicate that the amount of food resource is influenced by the vegetation, soil, and amount of solar radiation in the area. The distribution of food resources was evaluated quantitatively by taking these three environmental factors into account (Fig. 3).

3. Analysis of the suitability of behavioral and breeding environments

A logistic regression model was developed on the basis of vegetation and other environmental variables; feces areas (behavioral environment indicator) and burrow locations (breeding environment indicator) were identified using GIS. The results indicate that badgers prefer broad-leaved evergreen forests and breed even on slopes; the behavioral and breeding environments of badgers were quantitatively evaluated.

4. Comprehensive evaluation of typical target species on the basis of habitat suitability

A habitat suitability map was developed by integrating the data on foraging, breeding, and behavioral environments quantified on the basis of the amount of food resources in the environment from the GIS database (Fig. 4). This habitat suitability map enables comprehensive evaluation of the possible impacts of development on local ecosystems on the basis of the relationship between target species and their habitats.

Future Developments

The ecosystem assessment method along with research findings and examples of ecosystem assessment will be consolidated and analyzed to develop a system for ecosystem assessment that focuses on top predator and representative species in the ecosystem.

Main Researchers: Rikyu Matsuki, Ph. D.[1], Seiya Abe, Ph. D. [2] and Toru Takeuchi, Ph. D. [2]
1) Senior Research Scientist, Bilological Environment Sector, Environmental Science Research Laboratory
2) Research Scientist, Bilological Environment Sector, Environmental Science Research Laboratory

Reference
R. Matsuki, et al., 2009, "Development of ecosystem impact assessment methods for middle-sized mammals as the representative species – Population size estimation of raccoon dog and badger by fecal DNA typing –", CRIEPI Report V08043 (in Japanese)
S. Abe, et al., 2009, "Development of ecosystem impact assessment methods for middle-sized mammals as the representative species – Evaluation of food resource distribution of raccoon dog and badger –", CRIEPI Report V08044 (in Japanese)
T. Takeuchi, et al., 2009, "Development of ecosystem impact assessment methods for middle-sized mammals as the representative species – Habitat suitability analysis for impact evaluation and prediction –", CRIEPI Report V08045 (in Japanese)
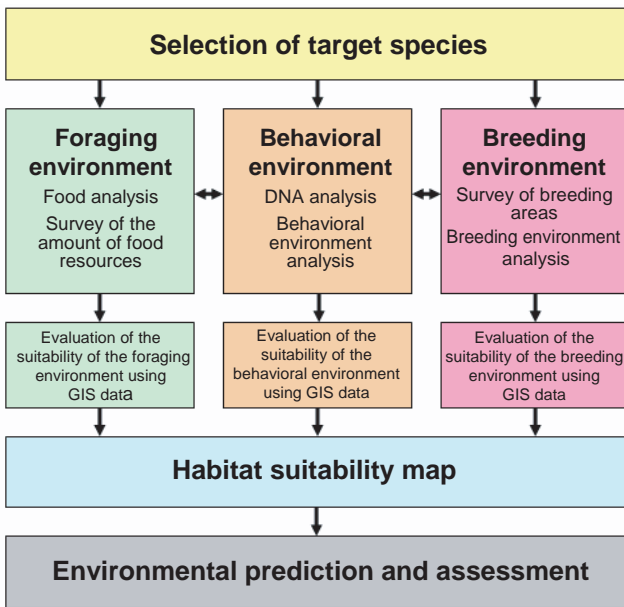
Fig.1 Procedures for Survey and Ecosystem Assessment of Typical Target Species (Middle-sized Mammals)
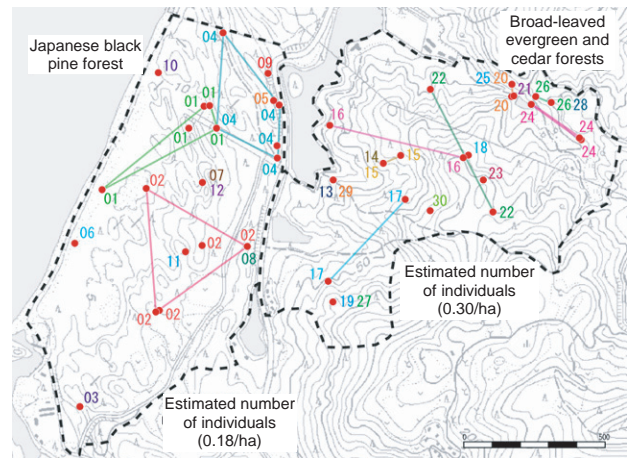

Fig.2 Estimated Number of Badgers on the basis of Fecal DNA Analysis

Dots (locations of feces collection) connected by lines show the movement of each individual.
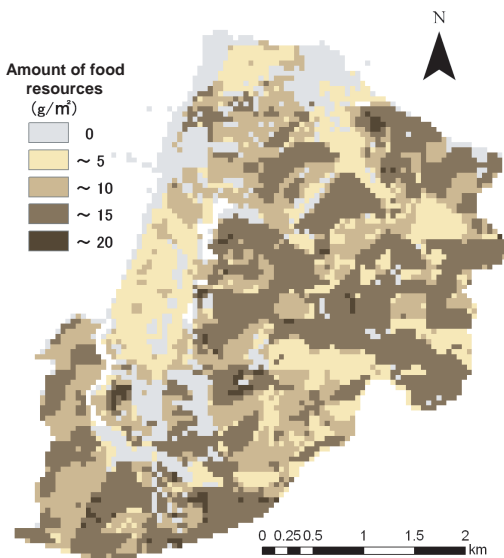

Fig.3 Estimated Distribution of Food Resources

The amount of food resources (g/m^2) refers to the total wet weight (per unit area of land) of earthworms, land shellfish, centipedes, beetles (larvae and imagoes), *Opisthoplatia orientalis*, and soil insects (other than beetle).
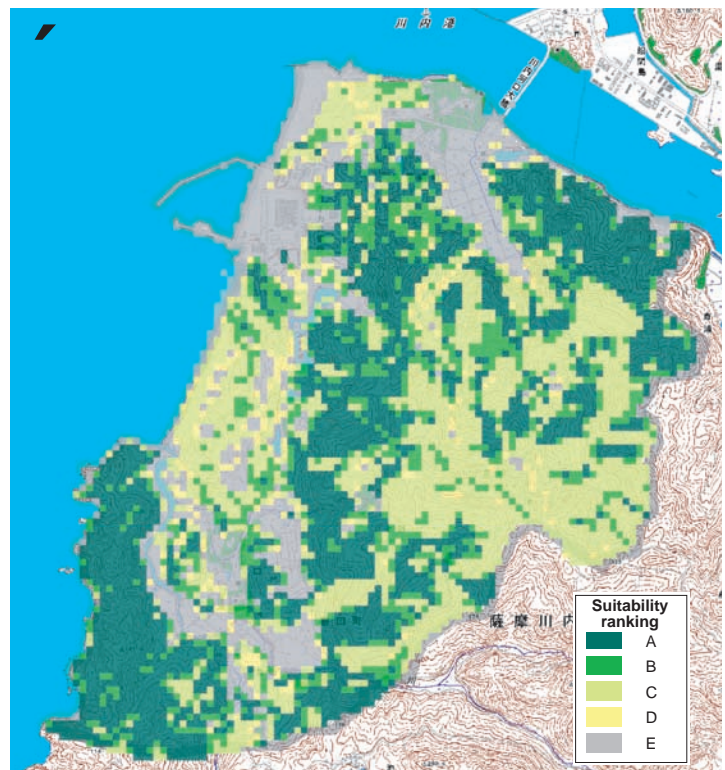

Fig.4 Habitat Distribution of Badgers on the basis of Suitability in Terms of Foraging, Behavioral, and Breeding Environment

The suitability of the habitat decreases in the order of A > B > C > D > E. The impact of habitat suitability on target species can be quantified by superposing a map showing the locations where changes occur.