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Optimum Land Allocation for Species Protection and Military Training on DoD Installations

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1. Introduction

Mathematical programming models can design an optimum landscape for conservation and military needs.

Increasing military needs require more land. Need to identify management areas to accommodate training needs. Need to identify training areas and habitat areas to relocate GTs.

Why?

Conservation and the Military

But

Increasing military needs require more land

How?

Mathematical programming models can design an optimum landscape for conservation and military needs

Suitable habitats for many endangered species are located on DoD lands.

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2. The Research Problem

Identify conservation management areas (CMAs) to manage endangered and threatened species given the military training needs.

Spatial Considerations

Compact CMAs - GTs are a ground-bound species.

Movement distances - Minimize relocation distances.

Meta-clustering - Multiple populations can interact.

Cluster distances - Locate military areas and CMAs apart.

Joint Management Considerations

Joint management is more efficient.

GFs rely on burrows and need ponds.

Simultaneously identify military areas and CMAs.

3. Methods

We develop six linear mixed-integer multi-objective programming models:

1. Base relocation model for Ft. Benning
2. Minimum distance relocation model for Ft. Benning
3. Meta-clustering relocation model for Ft. Benning
4. Clustered habitat selection model for Ft. Stewart
5. Multiple species habitat selection model for Ft. Stewart
6. Multiple land use model for Ft. Benning

The models are solved using GAMS/CPLEX.

4. Results

The minimum distance relocation model places the CMAs closer to original habitat sites (in red) compared to the base model.

Selected CMAs are meta-clustered.

Smaller meta-cluster distances result in one cluster.

The model selects clustered CMAs.

The model selects GT CMAs that are also close to ponds (The ponds are shown in dark blue).

Optimization models can be used to identify land for conservation given military land use.

Spatial and ecological criteria can be incorporated into integer programming models.

Multiple land uses, both conservation and military, can be solved simultaneously.

Adding spatial requirements can lead to:

- CMAs made up from less suitable parcels
- Larger CMAs to meet the minimum population
- Complex models that are computationally harder to solve

5. Conclusions

An Example: Ft. Benning, GA

(a) Current Locations of military land use

(b) Future Locations of military land use

- Covers 182,000 acres
- US Army Armor Center and Schofield will be relocated
- New firing ranges and maneuver areas are being built on lands that have large Gopher Tortoise populations.

Gopher Tortoise (GT)

- Species at Risk
- Essential for survival of more than 200 species
- Social species, community integrity must be maintained.

Ft. Stewart has a significant population of Gopher Frogs (GF).

- Near Threatened Species
- Rely on GT burrows for shelter

An Example: Ft. Stewart, GA

(a) Military ranges

(b) SUItability index for GT

(c) Location of ponds

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