Vegetation Change and Migration in Protected Areas and Biological Corridors under Climate Change Scenarios in Mesoamerica

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Climate change, species migration, and landscapes

- Future distribution of ecosystems depends on the ability of plants to migrate (Pitelka et al., 1997; Kirilenko et al., 2000)
  - Many studies on CC and ecosystems consider unlimited dispersal or no dispersal (Pearson, 2006)
- Landscape alteration may reduce migration capacity (Pitelka, 1997)
  - Altering dispersal rate
  - Reducing suitable habitat for successful colonization
- Biological corridors can facilitate migration between valuable vegetation areas (e.g., protected areas)
- Need for fine-scale modeling approaches for understanding the role of corridors, combining bioclimatic models and simulation of migration across landscapes (Pearson, 2006)

![Diagram showing protected areas and corridors affected by climate change](image)
Objective

- To assess the role of corridors in facilitating plant migration between protected areas under different climate change scenarios in Mesoamerica.
THINKING beyond the canopy

Study Area

Mesoamerica
(South of Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama)

The Mesoamerican Biological Corridor (MBC)
- Regional initiative
- Conceptualized and agreed upon in 1997
- Under progressive implementation

“Increasing isolation of protected areas may prevent them from functioning as an effective network” (Sánchez-Azofeifa et al., 2003)
**Approach**

- **Cellular automaton**
  - Spatially-explicit dynamic model
  - Resolution: 2.5’ (~5km). From 1990 to 2050.

- CC modifies location of suitable environments for ecosystems

- Each ecosystem type is composed of different species with different migration capacities (from 50 to 1000 m/yr)

- Various simulations:
  - Four climate change scenarios
    - HADCM3 & CCCMA, A2A & B2A (WorldClim, Hijmans et al., 2005)
  - Three policy scenarios
    - Enhanced corridors, status quo, degraded corridors
  - Several representations of vegetation change and migration
    - Two ecosystem models + different migration rates
Ecosystem Models

Holdridge bioclimatic classification

Process-based model:
Mapped Atmosphere-Plant-Soil System (MAPSS)

Climate + elevation data
Climate + Soil data
Results

CC impact index = Impact of CC on the vegetation of protected areas (0= “Eden”, 1= No migration)

Impacts depend on:
Policy scenarios (p<0.001)
Climate scenarios (p=0.007)
Ecosystem model (p=0.04)
**THINKING beyond the canopy**

Impact of climate change is higher on:
- lowlands (p=0.02)
- dry areas (p<0.01)
- areas with high future increase in temperature (p=0.02).

**Wet areas**

Protected areas benefit more from corridors if:
- they are more impacted by CC (p<0.01)
- they are smaller (p<0.01)

**Mountains**

Large, altitudinal protected areas benefit more from corridors.

**Small increase in temperature**

Not altitudinal protected areas.

**High**

Effect of corridors in reducing impacts on the protected area.

**Impact of climate change**

on the protected area without corridors.

**Importance of corridors**

for migration between protected areas.

**High**

Blue and green protected areas benefit more from corridors.

**Low**

Black or blue protected areas benefit more from corridors.

**Pacific Ocean**

**Caribbean Sea**

**Costa Rica**

**Panama**

**El Salvador**

**Guatemala**

**Belize**

**Honduras**

**Nicaragua**

**Central America**

Corridors are useful if:
- they are large (p<0.01)
- they are altitudinal (p<0.01)
Conclusion

- Vulnerability of protected areas
  - Especially in dry and lowland areas

- Role of corridors for reducing vulnerability
  - Altitudinal
  - Connecting small protected areas

- Useful tool and scale for identifying vulnerable protected areas and prioritizing corridors in a context of CC
¡Gracias!

Terima Kasih!

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