



THE UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL

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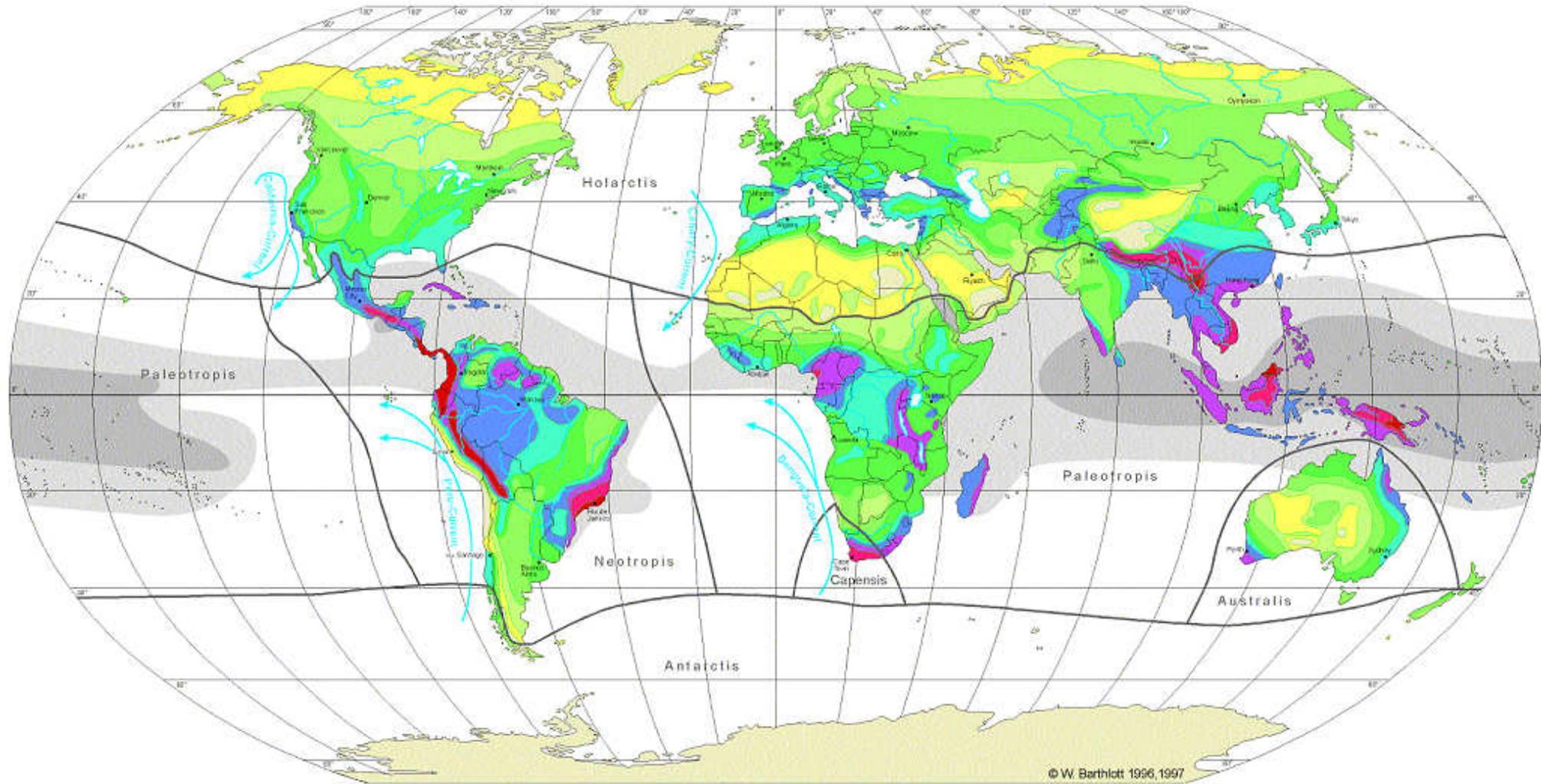
Habitat and Fragmentation Impacts: A Perspective from Landscape Ecology

Presentation Overview

- Introduction to habitat issues
- Habitat loss
- Habitat Fragmentation
- Assessment methods
- Mitigation



GLOBAL BIODIVERSITY: SPECIES NUMBERS OF VASCULAR PLANTS



Robinson Projection
Standard Parallels 36°N und 36°S
Scale 1: 130000000

Diversity Zones (DZ): Number of species per 10.000km²



sea surface temperature



W. Barthlott, N. Biedinger, G. Braun
F. Feig, G. Kier, W. Lauer & J. Mutke 1997
modified after
W. Barthlott, W. Lauer & A. Placke 1996
Department of Botany and Geography
University of Bonn
German Aerospace Research Establishment, Cologne
Cartography: M. Gref
Department of Geography
University of Bonn

Mechanisms of Habitat Loss

- “Land use change”
 - Road construction
 - Urban development
- Agricultural Development
 - Logging
 - Clearing
- Ecosystem modification
 - Non-native species introduction
- Any others?
 - Fire



Why is habitat loss important?

- Early studies have found that many species are threatened by habitat loss
 - 82% of endangered bird species were impacted by habitat loss as of 1986
- UN estimates that 25% of world's mammals face extinction within the next 30 years.
- “Extinction Crisis”: Habitat destruction is the primary cause of biodiversity loss
- What is biodiversity?
 - The term may refer to genetic diversity or diversity of habitats or communities
 - Types of diversity
 - Species count
 - Individual count
 - Importance values: numbers, biomass, productivity.



Why is habitat loss important?

- Little understanding of ecosystem structure and effects of changing it
- No understanding of individual species importance
- Diversity-Stability hypothesis
 - Stable ecosystems tend to be more diverse
- Extinction is Illegal: 1972 Endangered Species Act
 - One of only two federal laws specifically addressing land use
- Biodiversity indices
 - Measures of species diversity
 - Often expressed as ratios between numbers of species and “importance values” of individuals



Example: Shannon index

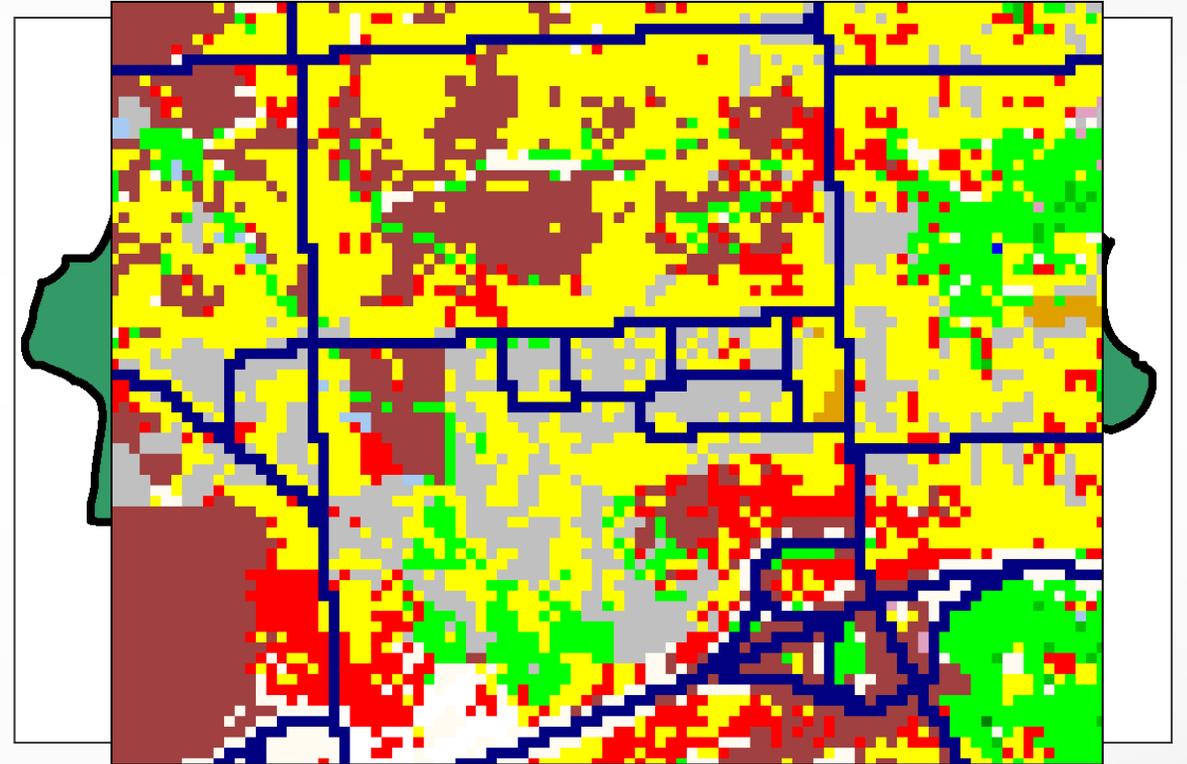
- Based on concept of Information Entropy
 - Higher as proportion becomes more ‘even’
 - All species are present in equal numbers
- S : The number of species.
 - Also called species ‘richness’
- p_i : The relative abundance of each species, calculated as the proportion of individuals of a given species (n_i) to the total number of individuals in the community (N)
- n_i : The number of individuals in species i
 - The abundance of species i
- N : The total number of all individuals
- One of many available indices: <http://onlinelibrary.wiley.com/doi/10.1002/ece3.1155/full>

$$H' = - \sum_{i=1}^S p_i \ln p_i$$



Habitat Fragmentation

- Look beyond aggregate view of habitat loss
- PATTERN of loss is also important
- Fragmentation: Break up of a continuous landscape containing large habitat patches into patches that are:
 - **Smaller**
 - **less-connected**
 - **more numerous**
- Can occur from construction of urban land uses, roads, rivers, trails, urban land uses (corridor barriers)



Habitat Fragmentation

- Fragmentation is recognized as a major threat to biodiversity
 - A primary cause of the extinction crisis
- Habitat broken into:
 - Core Habitat: interior forest, meadows, agricultural fields
 - Many species
 - Edge Habitat: Fence lines, riparian habitat (edge of fields)
 - Predator habitat
 - “Edge-adapted” species
- Fragmentation leads to patches with a **lower proportion of core** habitat
 - Core has more ‘surface area’
 - Measured as Core/Edge ratio



Effects of fragmentation

- Creates small patches of habitat
 - Only support small populations
 - Crowding can lead to population crashes
- Leads to population isolation
 - Inbreeding/ stops gene flow (small populations)
 - Gradual ‘extirpation’ / no re-colonization
 - Extirpation is localized extinction
- Threat to species survival
 - Reduction of habitat patch sizes to under minimum territory area needed
 - Reduced migration between fragments due to inhospitable crossing areas



Effects of fragmentation

- Arrival of unfavorable species
 - Colonization by new species (invasive) and by generalist predators (raccoons, foxes, coyotes, house cats, crows)
- Difficult to detect and quantify
 - Cannot measure as loss of habitat space (acres)
 - Must measure as effect of development pattern



Species response

- Not all animal or plant species will respond to fragmentation in the same way
 - **Species threatened:**
 - Species requiring large, continuous natural habitat areas
 - Large carnivores, bird species
 - Species with limited dispersal capacity
 - Species sensitive to edges and requiring pristine habitats.
 - **Species favored:**
 - ‘Generalist’ species – species that can live anywhere
 - Edge specialist – species adapted to edge habitats
- No universal model of fragmentation impact on species
 - Effects of given fragmentation patterns are highly dependant on the species of interest
 - Must be specific and include life history information



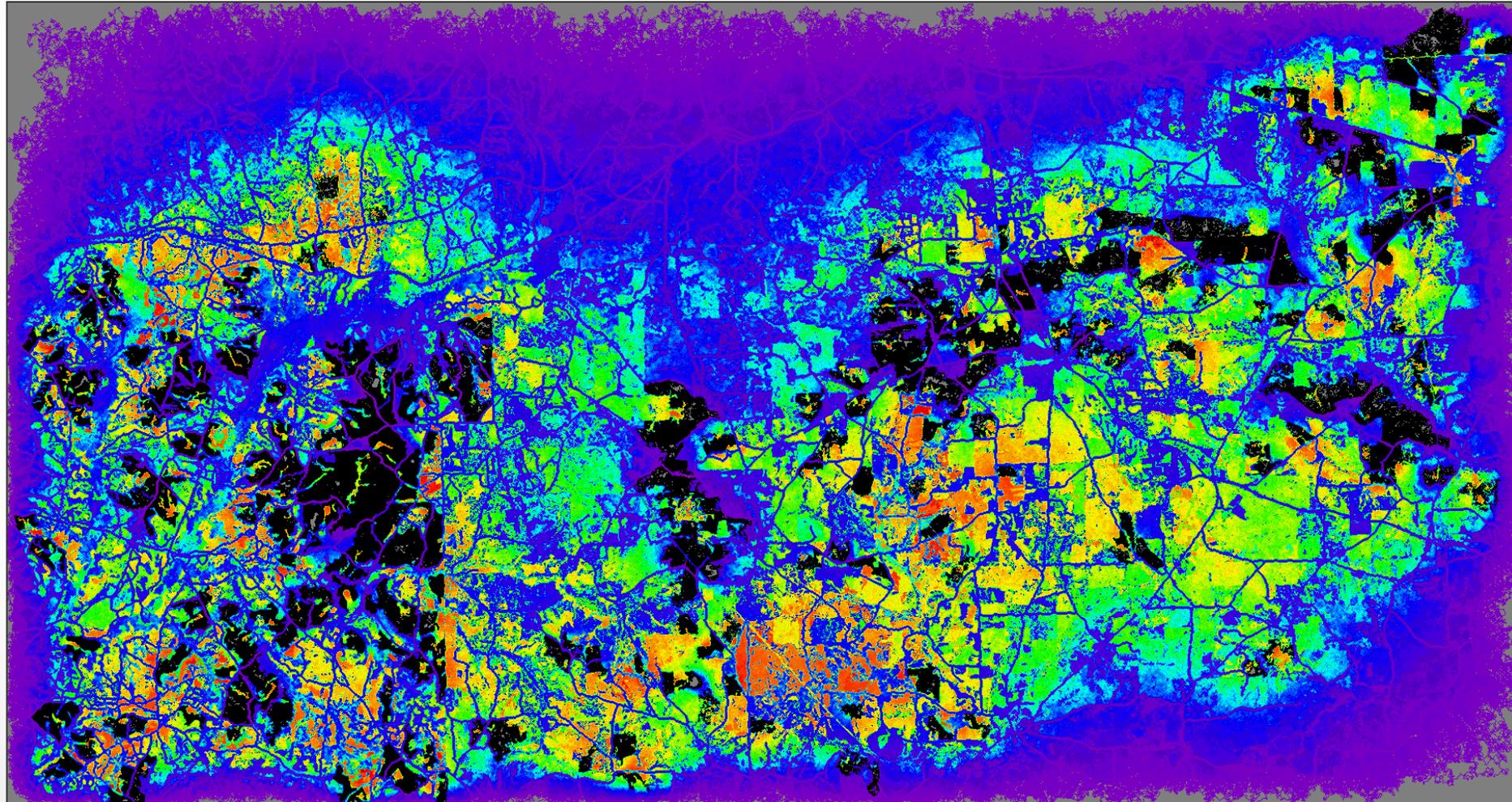
Methods of Assessment

- Maintaining ecological and open space databases
 - Poor data on subject
- Computer Modeling
 - FRAGSTATS
 - Software for assessing land use metrics
 - <http://www.umass.edu/landeco/research/fragstats/fragstats.html>
 - RAMAS
 - Spatially explicit modeling software
 - Uconn Landscape Fragmentation Tool
 - <http://clear.uconn.edu/tools/lft/lft2/index.htm>
 - Oak Ridge National Labs
 - Simulate species movement between habitat
 - Habitat patches as electrodes



Oak Ridge National Labs Corridor Tool

- Colors show relative use of corridors by Gopher Tortoises migrating between habitats (Georgia – Ft. Benning)
- Habitat: Black
- Likelihood of corridor use: High (red) -> low (purple)



Problems with models

- Integrate land use change/projections into the future?
 - No – very little focus on plans, development projections, or urban policy



U.S. Army “Species at Risk” (SAR) Program



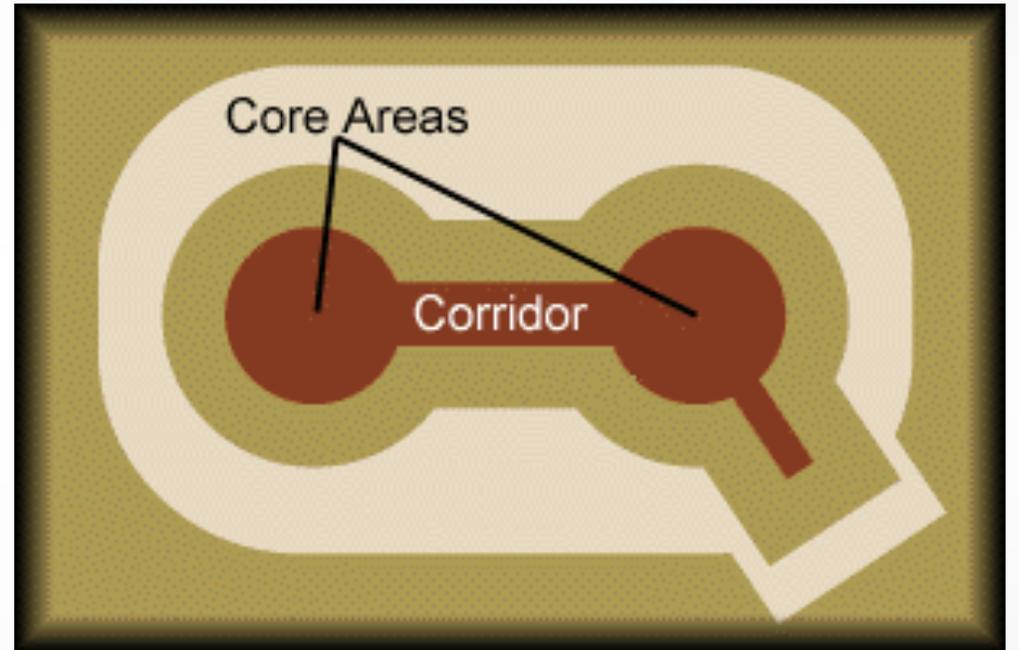
Any “species at risk” poses serious threat to maneuver training if it is listed threatened or endangered species

Army aims to intervene in habitat loss issues to prevent listing of species as endangered



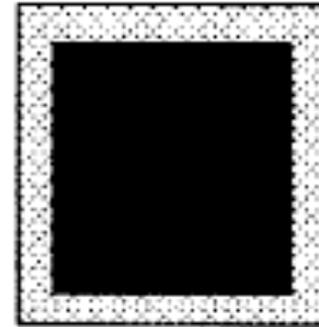
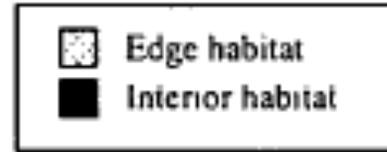
Mitigation Methods

- Early species assessments and inventories
- Green Infrastructure Concept
- Low Impact Development
 - Clustered development
- Greenway Construction
 - Link available open space
- Connect separated core habitats
 - E.g. Wildlife bridges/tunnels across highways
- Thinking about



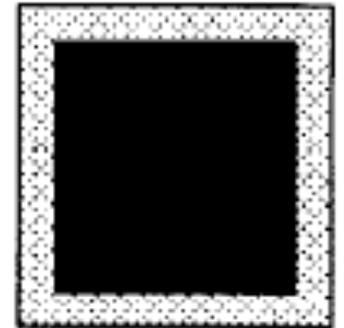
Reconnecting Isolated Habitat

Fragment connectivity

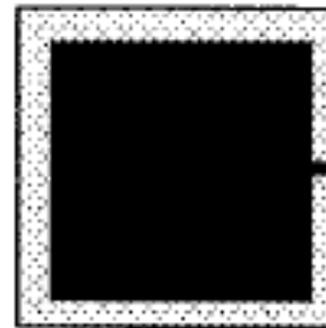


Habitat fragment

ISOLATED



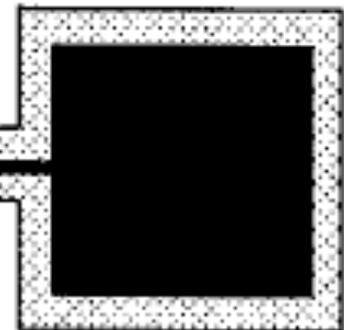
Habitat fragment



Habitat fragment

CONNECTED

Corridor

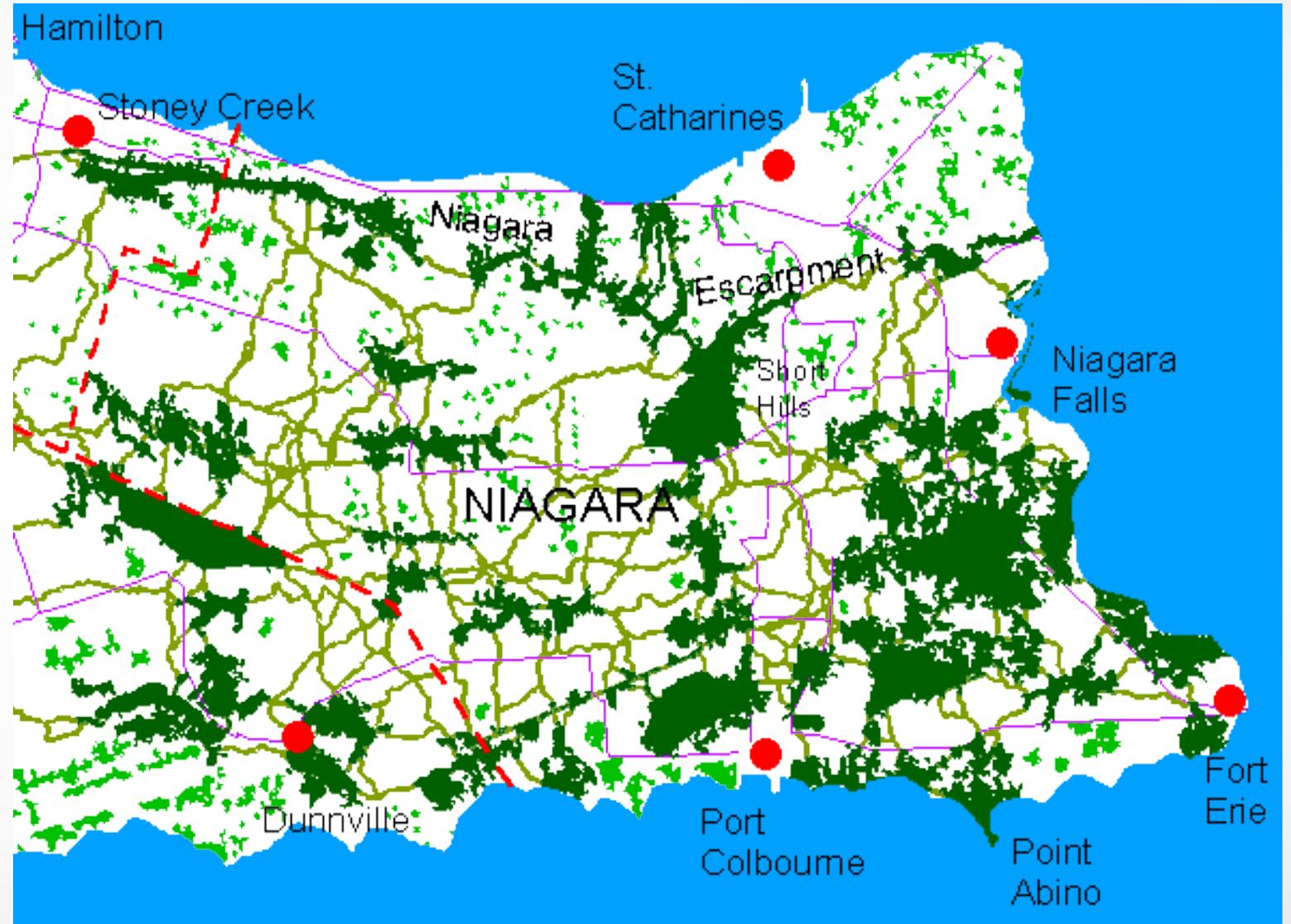


Habitat fragment



Connecting Together Core Habitat

Canadian Example: Niagara Area



Conservation Banking

- Based on wetland mitigation banking
- Offset habitat damage
- Lots of problems
 - Trust issues
 - Street level bureaucracy
 - Politics

