

***Landscape Management and  
Configuration:  
Implications for Ecosystem and  
Community Resilience in the  
Face of Climate Change***

Pete Cutter  
WWF Greater Mekong Programme

# Contents

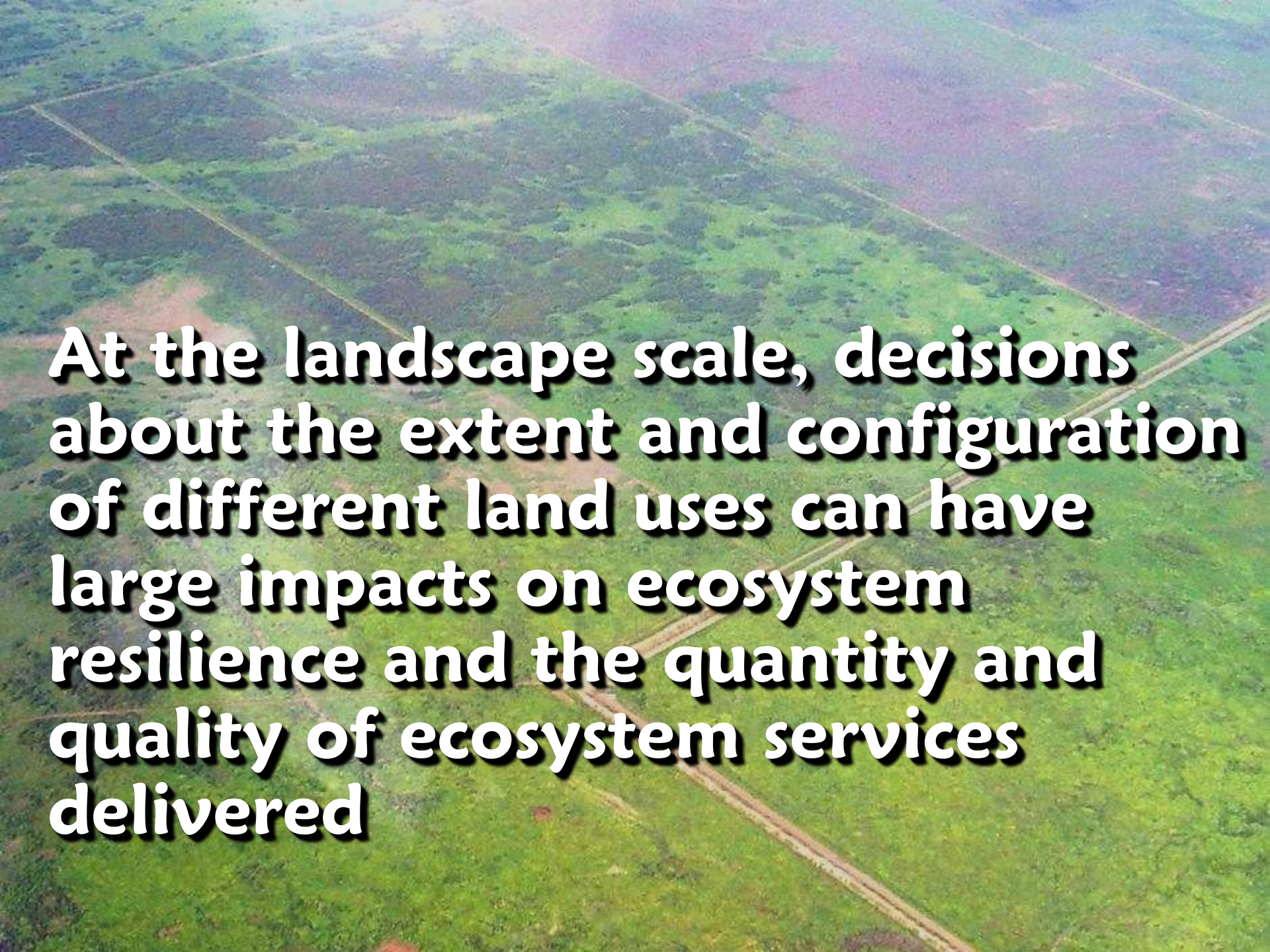
- Landscape ecology: Implications for landscape level planning and management
- Climate change: an added dimension
- Interactive activity:  
*Identifying priorities for Maintaining Ecosystem and Community Resilience in Focal Conservation Landscapes*

An aerial photograph of a river delta system. The image shows a complex network of brown, winding water channels that branch out across a vast, green landscape. The vegetation appears dense and healthy, with varying shades of green. The overall scene is a natural, undisturbed ecosystem. The text is overlaid on the upper left portion of the image.

***Land use and management decisions have implications for conservation, production, and the level of resilience of ecosystems and communities***

**At the patch scale, management practices can have significant implications for soil conservation, biodiversity protection, water quality, etc.**



An aerial photograph of a landscape featuring a grid of agricultural fields. The fields are primarily green, with some patches of purple or dark green, possibly indicating different crops or soil types. The text is overlaid on the lower-left portion of the image.

**At the landscape scale, decisions about the extent and configuration of different land uses can have large impacts on ecosystem resilience and the quantity and quality of ecosystem services delivered**

# A Road Map to Landscape Ecology

## Principles

Four categories:

1. landscapes and regions;
2. patches and corridors;
3. mosaics;
4. applications

*Forman, R. T. T., and S. K. Collinge. 1996. The “spatial solution” to conserving biodiversity in landscapes and regions. Pages 537-568 in R. M. DeGraaf, and R. I. Miller, editors. Conservation of Faunal Diversity in Forested Landscapes. Chapman and Hall, London.*

# Elements of Landscape Ecology

- 1) landscape and region,
- 2) patch-corridor matrix,
- 3) large natural-vegetation patches,
- 4) patch shape,
- 5) interactions among ecosystems,
- 6) metapopulation dynamics,
- 7) landscape resistance,
- 8) grain size,
- 9) landscape change,
- 10) mosaic sequence,
- 11) aggregate-with-outliers and
- 12) indispensable patterns

*Forman, R. T. T., and S. K. Collinge. 1996. The "spatial solution" to conserving biodiversity in landscapes and regions. Pages 537-568 in R. M. DeGraaf, and R. I. Miller, editors. Conservation of Faunal Diversity in Forested Landscapes. Chapman and Hall, London.*

# Stokstad, E. 2005. *ECOLOGY: Taking the Pulse of Earth's Life-Support Systems. Science 308:41-43.*

## Ecology

### *The Millennium Ecosystem Assessment*

## Taking the Pulse of Earth's Life-Support Systems

A massive effort to document the state of ecosystems—and their ability to provide food, comfort, and other services—lays out some grand challenges, but no easy answers

The plan was nothing if not ambitious: assess the state of ecosystems across the entire planet, from peat bogs to coral reefs. Rather than solely chart pristine habitats and count species, as many surveys have done, the \$20 million Millennium Ecosystem Assessment (MA) put people and their needs front and center. At its core was the question: How well can ecosystems continue to provide the so-called services that people depend on but so often take for granted? These include not just the food and timber already traded on international markets but also assets that are harder to measure in dollar values, such as flood protection and resistance

ecosystem services poses huge problems; it really pushes the envelope," says an apparently indefatigable Reid.

There's broad agreement that the envelope has been filled with a valuable status report, the first overview of which was released this week. "It is a magnificent achievement," comments Stuart Pimm, an ecologist at Duke University in Durham, North Carolina, who

### **Widespread degradation**

The MA's first report,\* a summary of the major technical reports to follow, identifies three main problems with how humans are managing ecosystems. Topping the list is widespread abuse and overexploitation of resources. Although some ecosystems have yielded more and more goods—principally fish, livestock, and crops—their integrity, and the productivity of many more, has been compromised. Of the 24 kinds of services described by the MA, 60% are being degraded, the report found. "We're undermining our ecological capital all around the

### **Ecosystem Services**

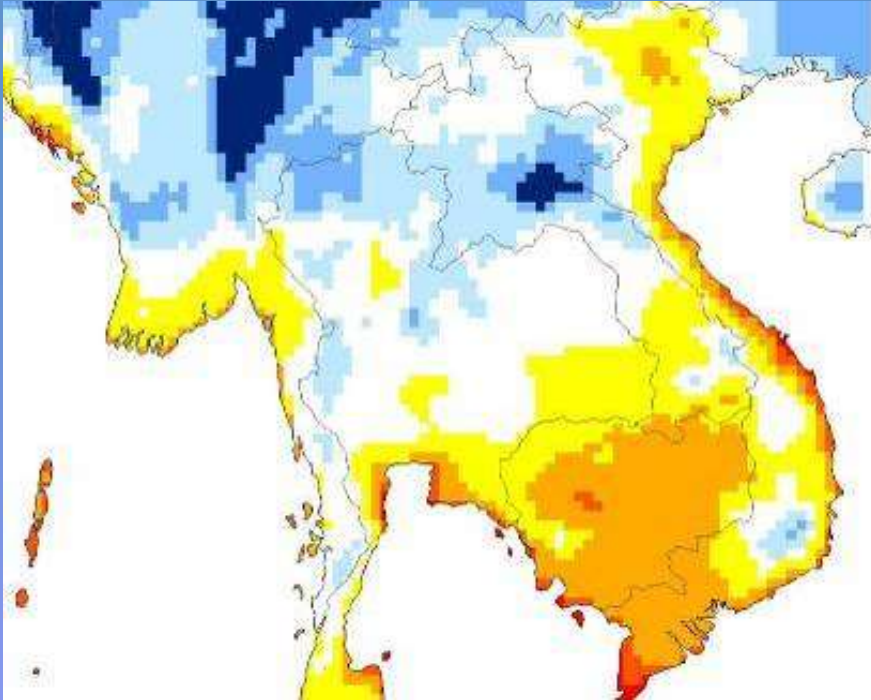
**Provisioning**, including food, water, fuel, and fiber.

**Regulating**, such as the prevention of soil erosion and flooding.

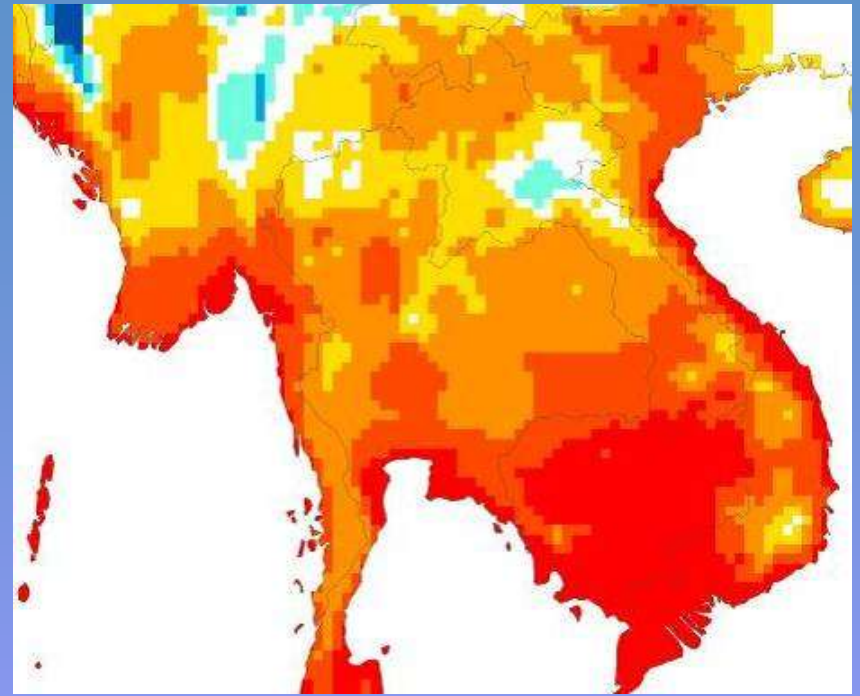
**Cultural**, including recreation, spiritual values, and a "sense of place."

**Basic support**, including soil formation, nutrient cycling, and oxygen from photosynthesis.

1980s



2090s



*Mean Daily Minimum Temperatures (°C)*

The expected patterns and impacts of climate change are forcing planners and managers to add yet another dimension to the land use puzzle

# A Response

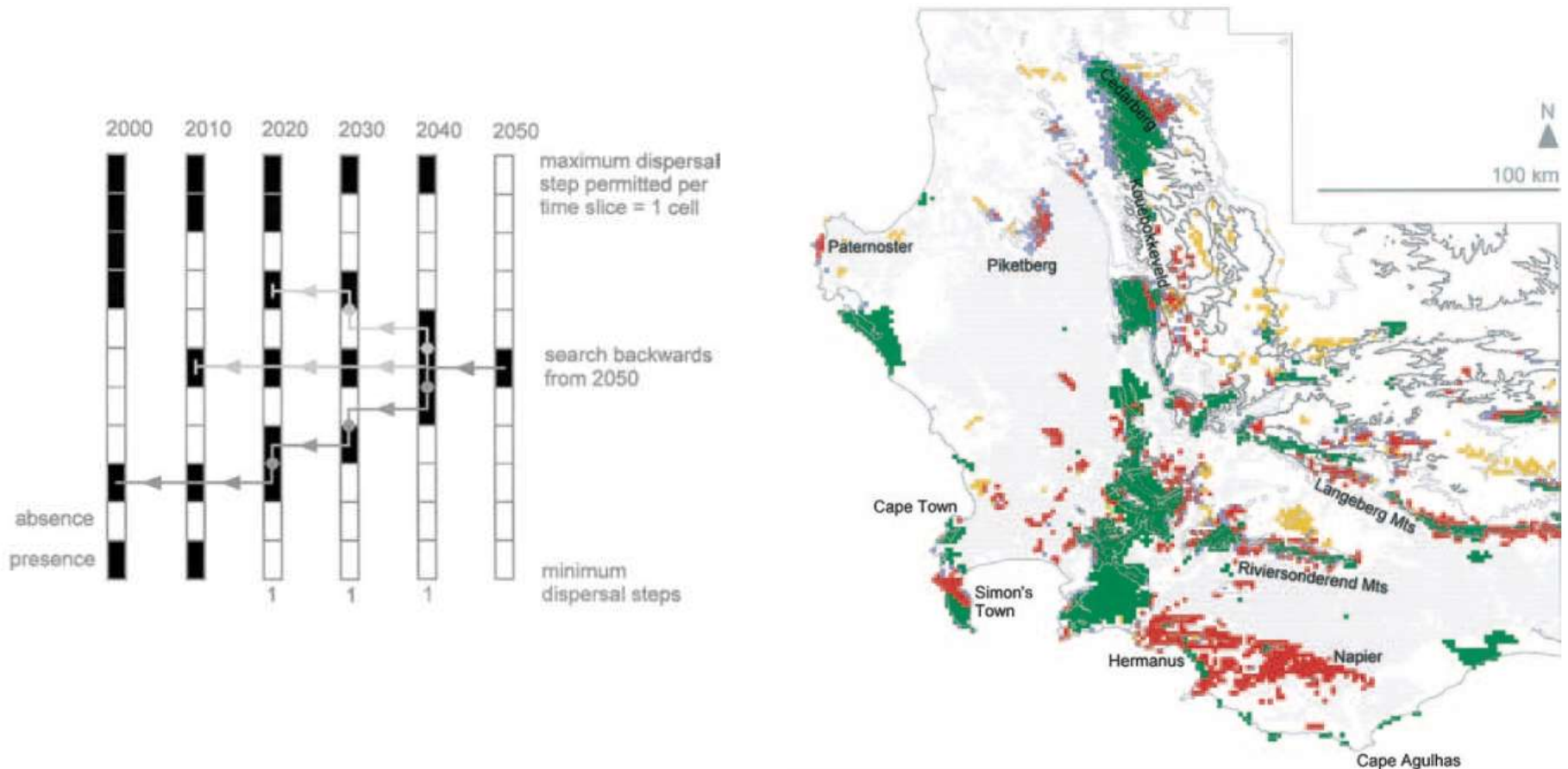
- ***Exploring possible future scenarios*** through analysis and planning
- ***Identifying complementarity, synergies, and incompatibilities*** in achieving ecosystem and community resilience
- ***Working Together*** to understand the opportunities and challenges in achieving both ecosystem and community resilience in the face of climate change
- ***Applying*** conservation, restoration, and other management interventions at strategic sites throughout landscapes

# Planning for Climate Change: Identifying Minimum-Dispersal Corridors for the Cape Proteaceae

Conservation Biology

Volume 19, No. 4, August 2005

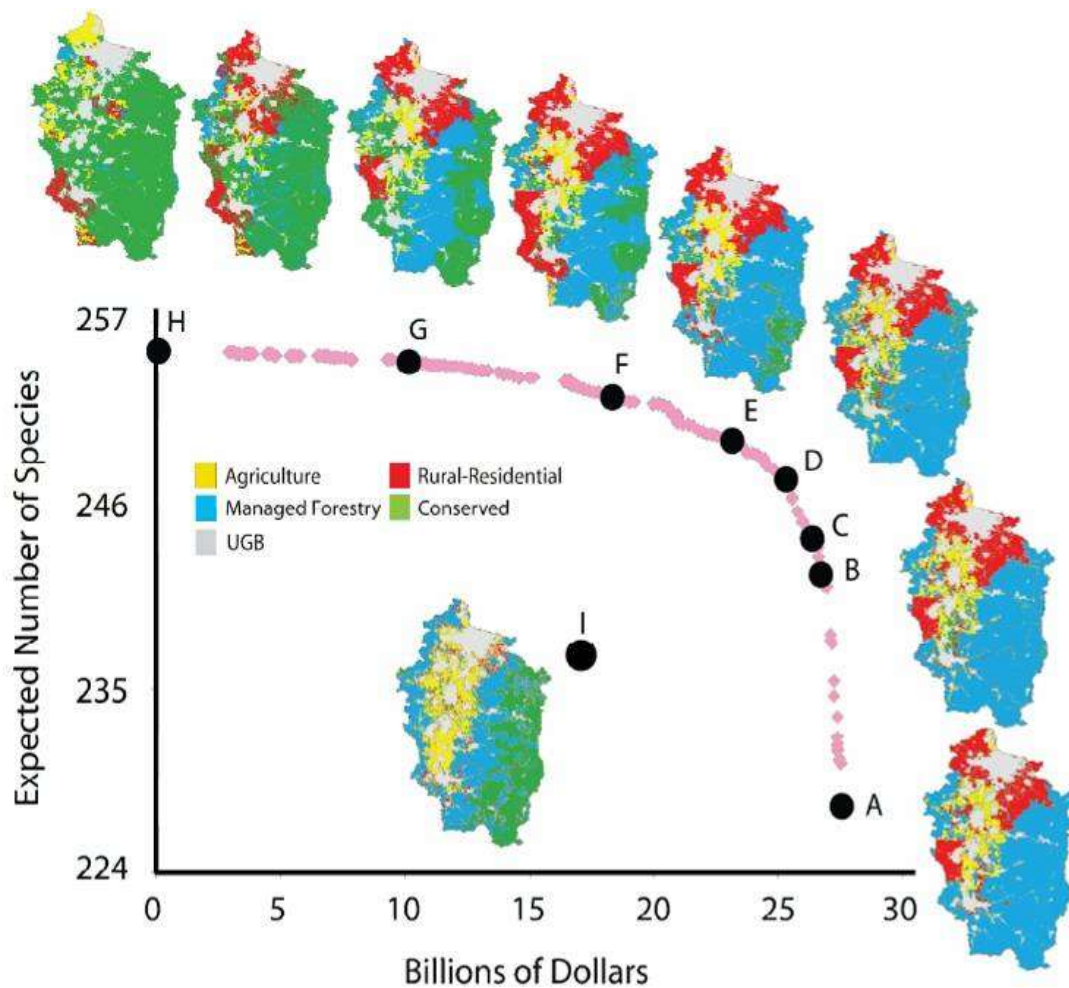
PAUL WILLIAMS,\*§§ LEE HANNAH,† SANDY ANDELMAN,‡ GUY MIDGLEY,§ MIGUEL ARAÚJO,\*††† GREG HUGHES,§ LISA MANNE,†† ENRIQUE MARTINEZ-MEYER,‡‡ AND RICHARD PEARSON††



## Where to put things? Spatial land management to sustain biodiversity and economic returns

Stephen Polasky<sup>a,b,\*</sup>, Erik Nelson<sup>m</sup>, Jeff Camm<sup>c</sup>, Blair Csuti<sup>d</sup>, Paul Fackler<sup>e</sup>, Eric Lonsdorff<sup>f</sup>, Claire Montgomery<sup>g</sup>, Denis White<sup>h</sup>, Jeff Arthur<sup>i</sup>, Brian Garber-Yonts<sup>j</sup>, Robert Haight<sup>k</sup>, Jimmy Kagan<sup>l</sup>, Anthony Starfield<sup>b</sup>, Claudine Tobalske<sup>l</sup>

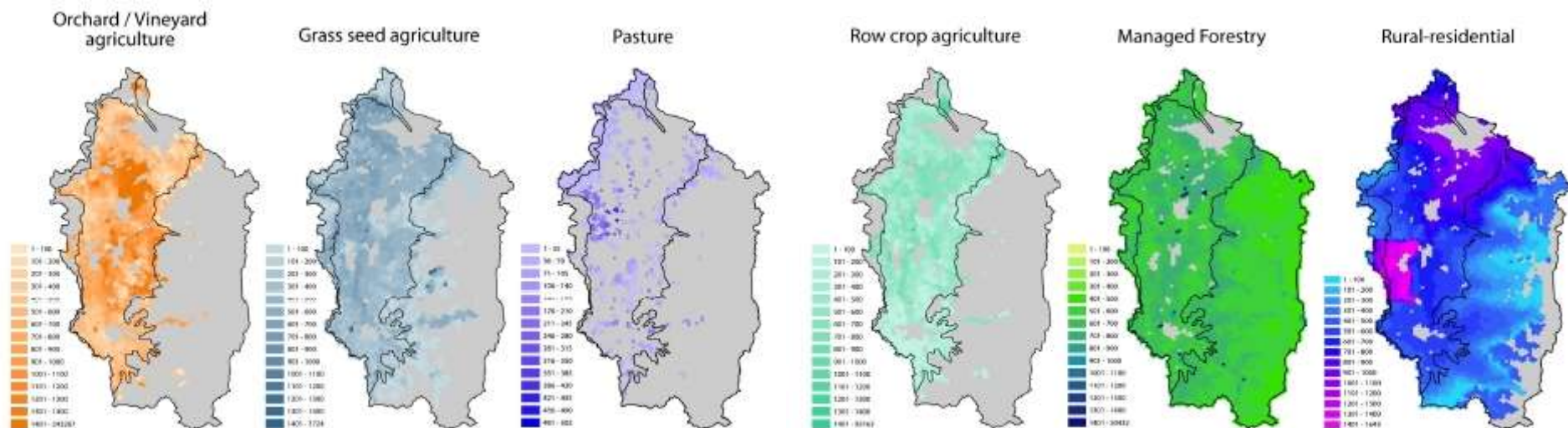
- ❖ Spatially explicit landscape-level model for analyzing the biological and economic consequences of alternative land-use patterns.
- ❖ **biological model** incorporates habitat preferences, area requirements and dispersal ability between habitat patches for terrestrial vertebrate species to predict the likely number of species that will be sustained on the landscape.
- ❖ **economic model** incorporates site characteristics and location to predict economic returns for a variety of potential land uses.
- ❖ **Objective:** find efficient land-use patterns that maximize biodiversity conservation objectives for given levels of economic returns, and vice versa.



## Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales

Erik Nelson, Guillermo Mendoza, James Regetz, Stephen Polasky, Heather Tallis, D Richard Cameron, Kai MA Chan, Gretchen C Daily, Joshua Goldstein, Peter Kareiva, Eric Lonsdorf, Robin Naidoo, Taylor H Ricketts, and M Rebecca Shaw

- ❖ *Used InVEST to predict changes in ecosystem services, biodiversity conservation, and commodity production levels*
- ❖ *found that scenarios receiving high scores for a variety of ecosystem services also had high scores for biodiversity, suggesting there is little tradeoff between biodiversity conservation and ecosystem services.*
- ❖ *Scenarios involving more development had higher commodity production values, but lower levels of biodiversity conservation and ecosystem services.*
- ❖ *However, including payments for carbon sequestration alleviates this tradeoff.*
- ❖ *Quantifying ecosystem services in a spatially explicit manner, and analyzing tradeoffs between them, can make management decisions more effective, efficient, and defensible.*



# Here today, gone tomorrow? Targeting conservation investment in the face of climate change

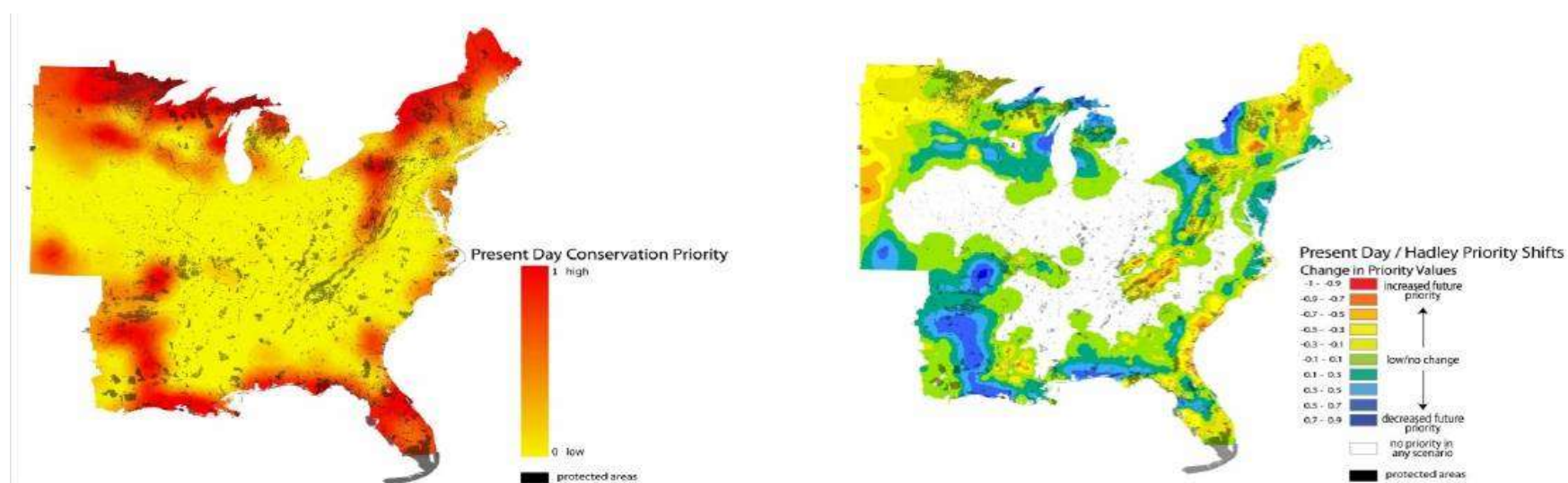
Leif Thomas Olson<sup>1</sup> and Kathryn Freemark Lindsay<sup>2</sup>

<sup>1</sup>Geomatics and Landscape Ecology Research Laboratory at Carleton University, Ottawa, Canada. Carleton K1S 5B6

<sup>2</sup>Canadian Wildlife Service of Environment Canada, Gatineau, Quebec, Canada. EC K1A 0H3.

Accepted 24 December, 2008

To optimize the use of scarce resources, it is imperative to target conservation investment wisely. We discuss the impact assessment of potential climate-driven shifts in species distributions on the future conservation utility of a present-day reserve design. We provide examples using breeding bird survey data for 150 species in the eastern USA, and two predicted future species distributions models. Using present-day distributions, this study systematically selects sets of units meeting a range of conservation targets; 10 to 100 occurrences of each species in the reserve network. Units provide coverage to 68 – 79% of bird species in the two future scenarios. Underrepresented species fall into two principal groups. those associated with northern tree species (*Balsam fir* *Abies balsamea* or *Paper birch* *Betula*





# Climate change-integrated conservation strategies

L. HANNAH,\* G. F. MIDGLEY\*† and D. MILLAR\*†

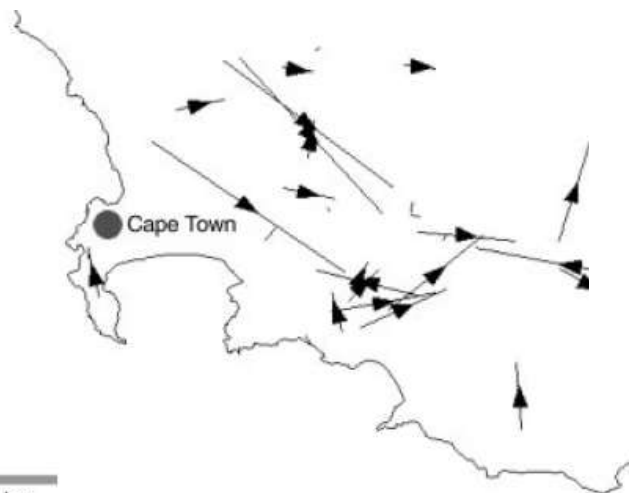
\*Center for Applied Biodiversity Science, Conservation International, 1919 M Street, Washington, DC 20036, U.S.A., and †Climate Change Research Group, Ecology and Conservation, National Botanical Institute, P/Bag X7, Claremont 7735, Cape Town, South Africa

## ABSTRACT

**Aim** Conservation strategies currently include little consideration of climate change. Insights about the biotic impacts of climate change from biogeography and palaeoecology, therefore, have the potential to provide significant improvements in the effectiveness of conservation planning. We suggest a collaboration involving biogeography, ecology and applied conservation. The resulting Climate Change-integrated Conservation Strategies (CCS) apply available tools to respond to the conservation challenges posed by climate change.

systems within the planning region are based on modelling results. Management of the matrix between protected areas provides continuity for processes and species range shifts outside of parks. Regional coordination of park and off-park efforts allows harmonization of conservation goals across provincial and national boundaries. Finally, implementation of these CCS elements in the most biodiverse regions of the world will require technical and financial transfer of resources on a global scale.

**Main conclusions** Collaboration across disciplines is neces-



**Fig. 3** Movement tracks of species of the genus *Serruria* (Proteaceae) in the Cape Floristic Province. Using the modelling techniques described in Midgley *et al.* (2002), centroids of present and future (2050) distribution for each species were connected to produce movement vectors. This technique helps in the visualization of range shifts in multiple species as landscape linkages are designed.



# A Simplified Landscape Geographic Logic

## 3 distinctive landscape zones

- *Protected Areas and Sensitive Ecological Sites*
- *Corridors*
- *Remaining matrix*

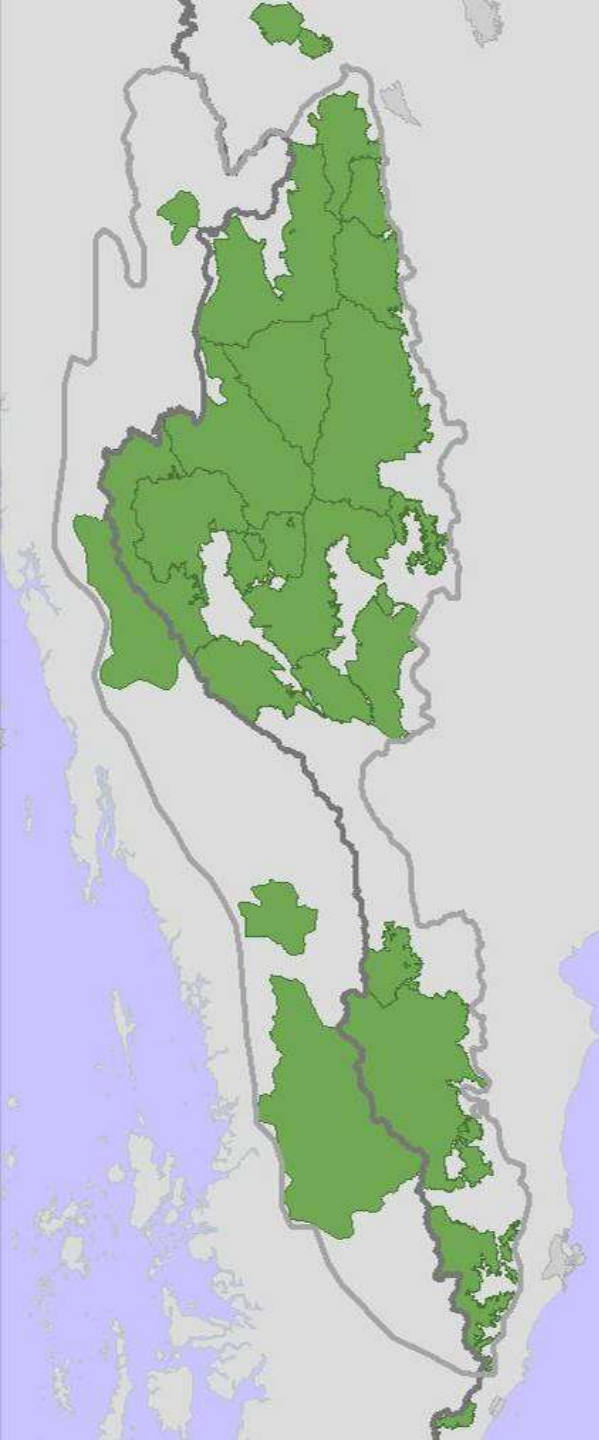
# *Protected Areas and Sensitive Ecological Sites*

## Role in landscape ecological integrity & climate change resilience:

- “anchors” of natural habitat and biological diversity
- Maintain representativeness of rare communities and organisms
- Managed for long-term viability of representative habitats and species
- “nodes” of ecological connectivity

## Potential Activities:

- Active habitat management & restoration (e.g. management of invasives, fire, etc.; managing seed dispersal mechanisms)
- Enforcement, patrolling
- Enhancing governance systems (e.g. community co-management, other participatory governance mechanisms)
- Monitoring biodiversity targets



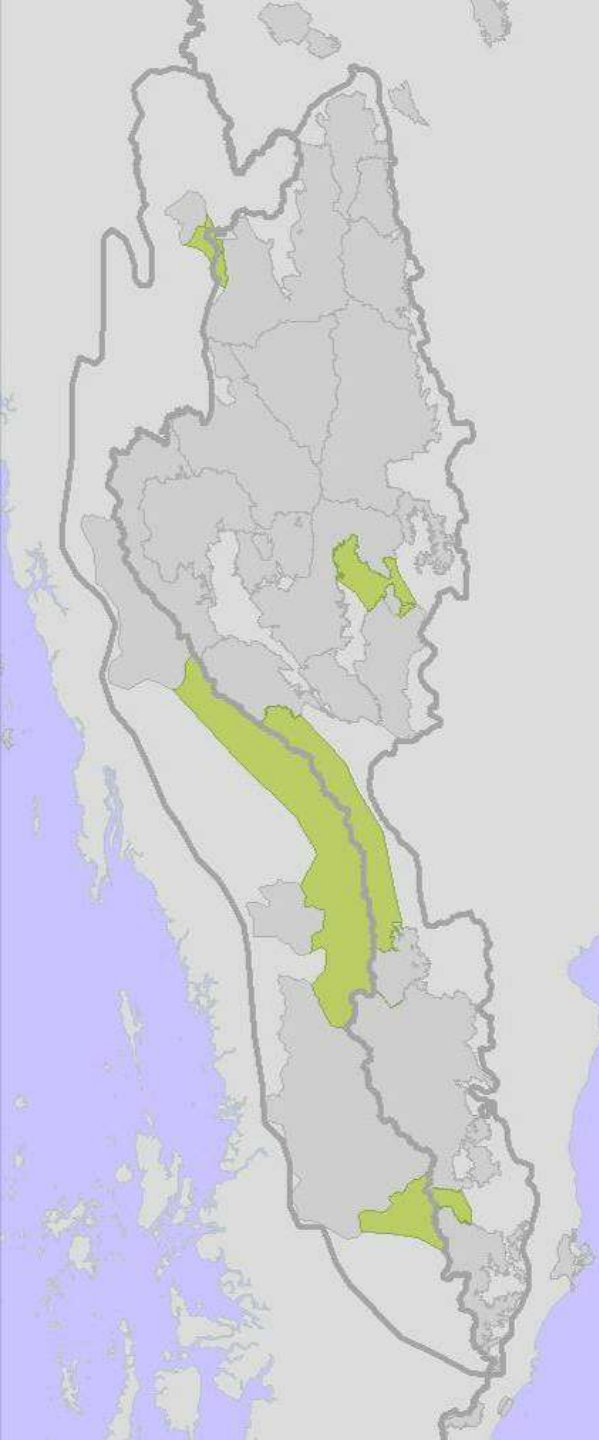
# *Corridors*

## Role in landscape ecological integrity & climate change resilience:

- Maintenance of ecological processes
- Facilitating normal migration, dispersal, and range shift of organisms
- Focal areas for multiple-use sustainable management

## Potential Activities:

- Sustainable forest production and harvest
- Active habitat management & restoration (e.g. management of invasives, fire, etc.; managing seed dispersal mechanisms)
- Application of best practices for sustainable management & market linkages
- Enhancing governance systems (e.g. community forestry, other participatory governance mechanisms)



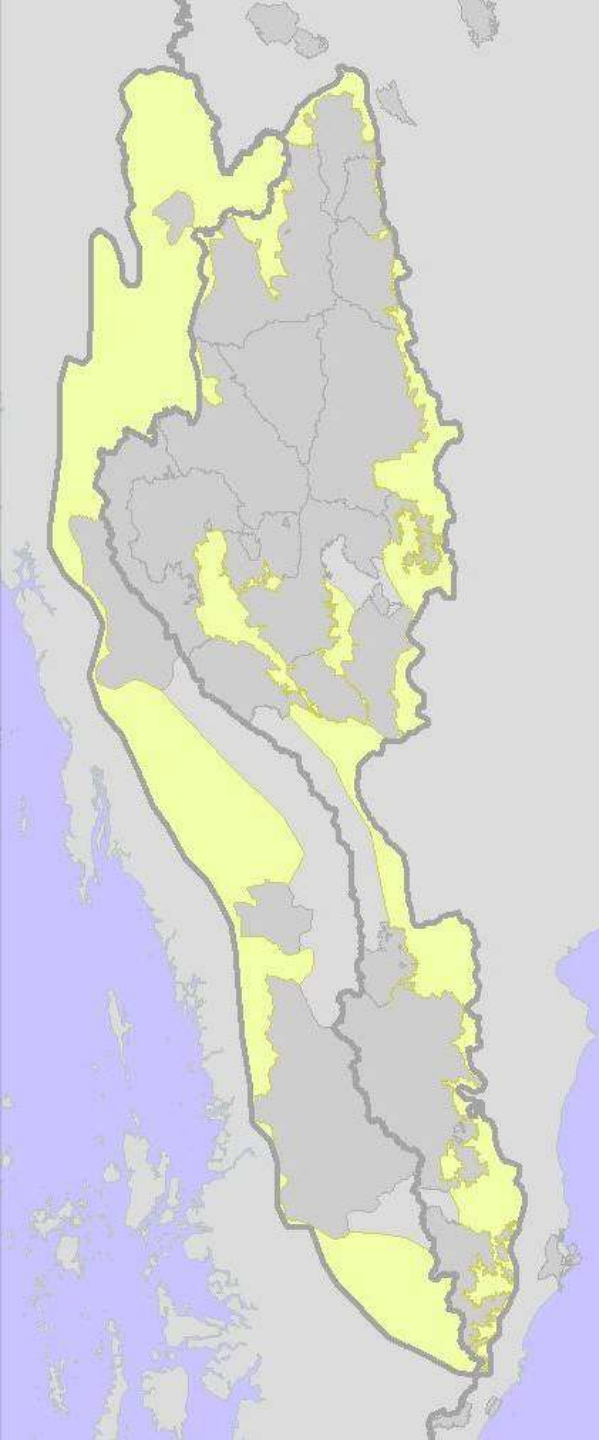
# *Remaining Matrix*

## Role in landscape ecological integrity & climate change resilience:

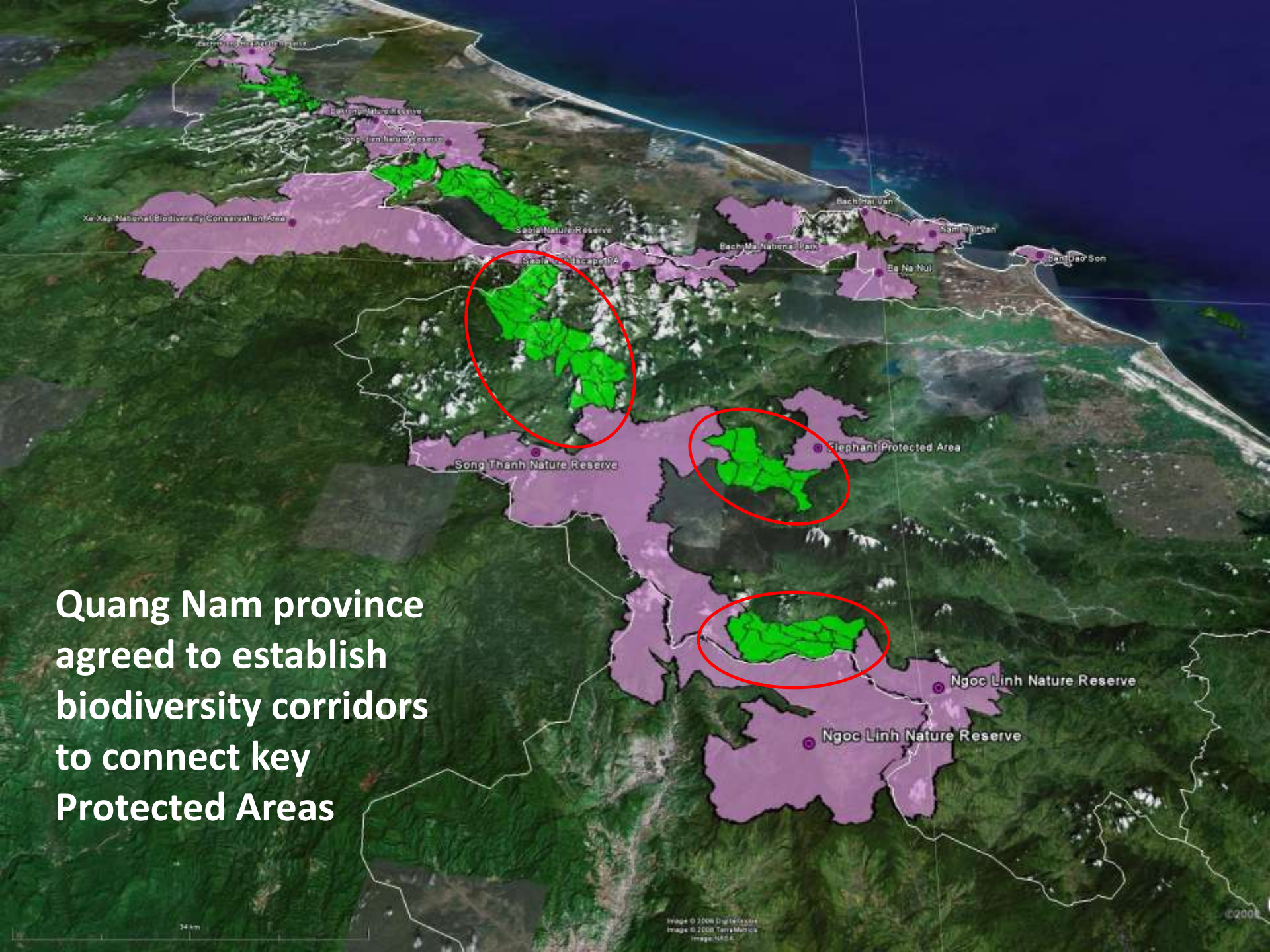
- Provision of goods and services for human communities
- Prevention of spread of disease and invasives (managing matrix pattern)

## Potential Activities:

- Land suitability analysis & planning
- Sustainable agriculture
- Rural landscape design, urban and suburban planning, etc.



**Quang Nam province  
agreed to establish  
biodiversity corridors  
to connect key  
Protected Areas**



*Interactive Activity:*

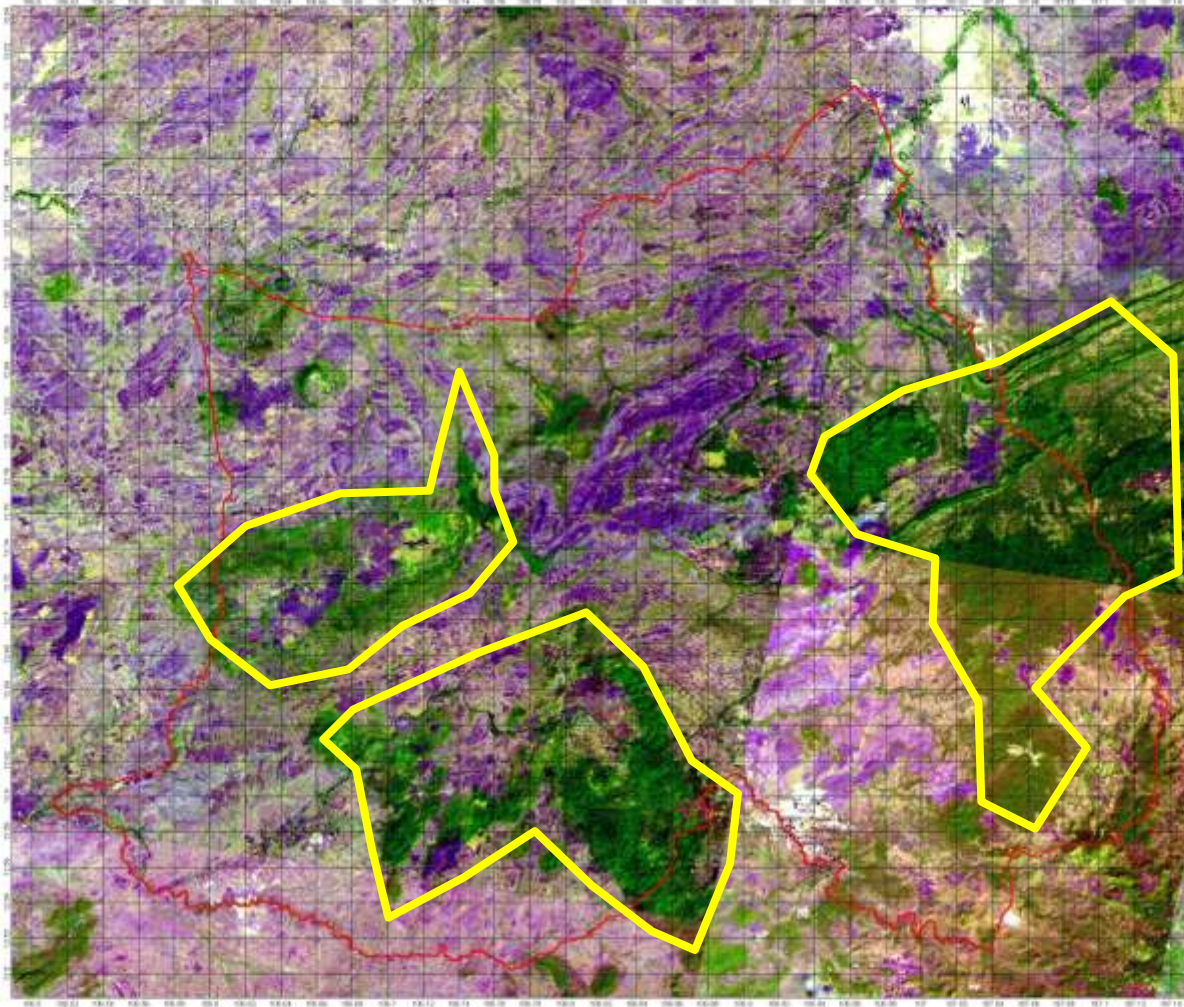
***Identifying Priorities for Maintaining  
Ecosystem and Community Resilience  
in Focal Conservation Landscapes***



# Objectives

- To identify conditions and/or areas where anticipated changes will have the greatest impact on the ability of ecosystems and communities to adapt to climate change.
- To identify situations and or areas where ecosystem-based adaptation needs/strategies are complementary with community-based adaptation needs/strategies and situations where these needs may be incompatible.

# ផែនទី ដែនជំរកសត្វព្រៃ ភ្នំព្រួច MAP OF PHNOM PRICH WILDLIFE SANCTUARY







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 ក្រសួងរាជធានីភ្នំព្រួច  
 ក្រសួងព្រៃឈើ និងសត្វព្រៃ  
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 ឆ្នាំ ២០០៧

**រូបសញ្ញា**  
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 ២ ផ្លូវជាតិលេខ១  
 ៣ ផ្លូវជាតិលេខ២  
 ៤ ផ្លូវជាតិលេខ៣  
 ៥ ផ្លូវជាតិលេខ៤  
 ៦ ផ្លូវជាតិលេខ៥  
 ៧ ផ្លូវជាតិលេខ៦  
 ៨ ផ្លូវជាតិលេខ៧  
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 ១១ ផ្លូវជាតិលេខ១០  
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 ១៣ ផ្លូវជាតិលេខ១២  
 ១៤ ផ្លូវជាតិលេខ១៣  
 ១៥ ផ្លូវជាតិលេខ១៤  
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 ២១ ផ្លូវជាតិលេខ២០

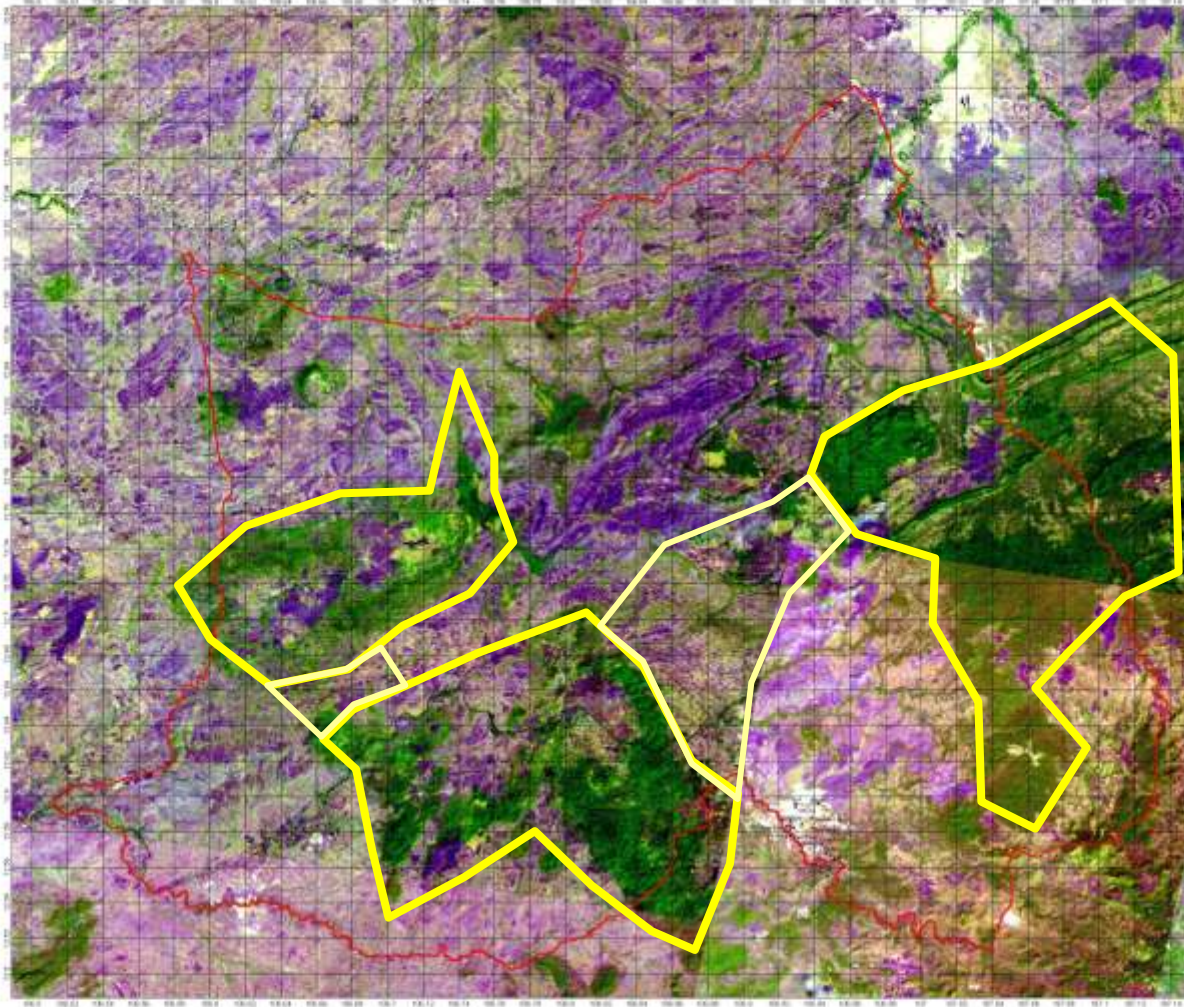
**LEGEND**  
 1 Wildlife Sanctuary  
 2 National Road 1  
 3 National Road 2  
 4 National Road 3  
 5 National Road 4  
 6 National Road 5  
 7 National Road 6  
 8 National Road 7  
 9 National Road 8  
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 20 National Road 19  
 21 National Road 20



# Step 1. Select one or two representative landscape-scale ecological patterns and map the areas where conservation is necessary to maintain the long-term viability of these patterns. (~45 Min)

Landscape	Example of Representative Landscape-scale Ecological Pattern	Mapping Guidelines	Key	
Terrestrial	Habitat necessary to maintain a viable banteng population	Map areas where stricter conservation measures are needed such as those representing "core habitat" or critical breeding areas Map other areas where habitat needs may be met through management other than strict conservation (e.g. corridors, dispersal areas, etc.)	 	= Areas in need of strict conservation measures =Other areas in need of conservation-oriented management
Freshwater	Flood zone of the Tonle Sap	Map areas where strict conservation is likely necessary for maintaining the integrity of flood zone (e.g. the rough extent of seasonal flooding) Map the stream network that delivers annual floods	 	= Areas in need of strict conservation measures to maintain freshwater ecological patterns and processes = Other areas where some level of conservation-oriented management is needed

# ផែនទី ដែនជំរកសត្វព្រៃ ភ្នំព្រួច MAP OF PHNOM PRICH WILDLIFE SANCTUARY

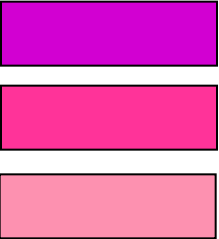


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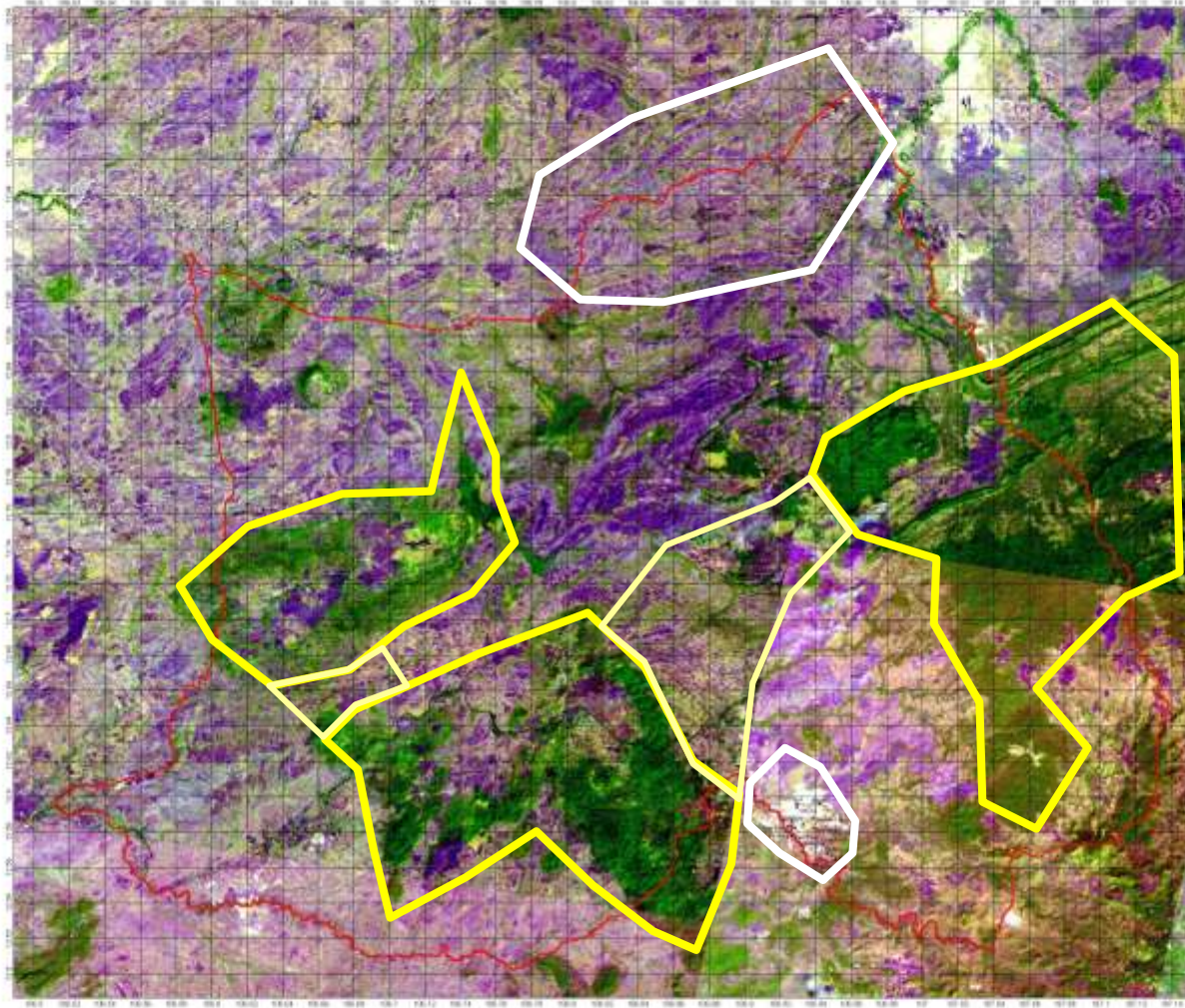
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# Step 2. Identify (and map if appropriate) conditions and/or areas likely to require interventions to maintain community resilience. (~45 min)

ID	Name of Area / Issue	Type of Area / Issue	Significance Score	Key for mapped items	
C1, C2, C3, etc.	Steep slopes of Tenasserim front range	Food security Disaster risk	1, 2, or 3		= Areas that must be managed to ensure food security =Areas that must be managed to reduce disaster risk =Other areas where management is needed to ensure community resilience

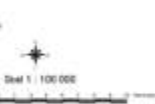
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 ភ្នំព្រួច ខេត្តកោះកុង  
 ២០១៧

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 ឆ្នាំ: ២០១៧

ស្ថាប័ន: វិទ្យាស្ថានស្រាវជ្រាវសត្វព្រៃ  
 រៀបចំដោយ: វិទ្យាស្ថានស្រាវជ្រាវសត្វព្រៃ  
 ឆ្នាំ: ២០១៧





Step 3. Identify (and map if appropriate) infrastructure projects, agricultural expansion, or other non-climate change impacts that are likely to significantly transform or fragment the landscape in the next 10 years. (~30 min)

ID	Name of Area / Issue	Type of Area / Issue	Significance Score	Key for mapped items	
A1, A2, A3, etc.	Highway 209	Road project Dam project Sea wall Etc.	1, 2, or 3		= Areas where major landscape change is anticipated





Step 4. Identify areas where management or policy to maintain community resilience are ***complementary*** to the conservation requirements identified in Step 1 and where they may be ***incompatible*** with the conservation requirements identified in Step 1. (~45 Min)

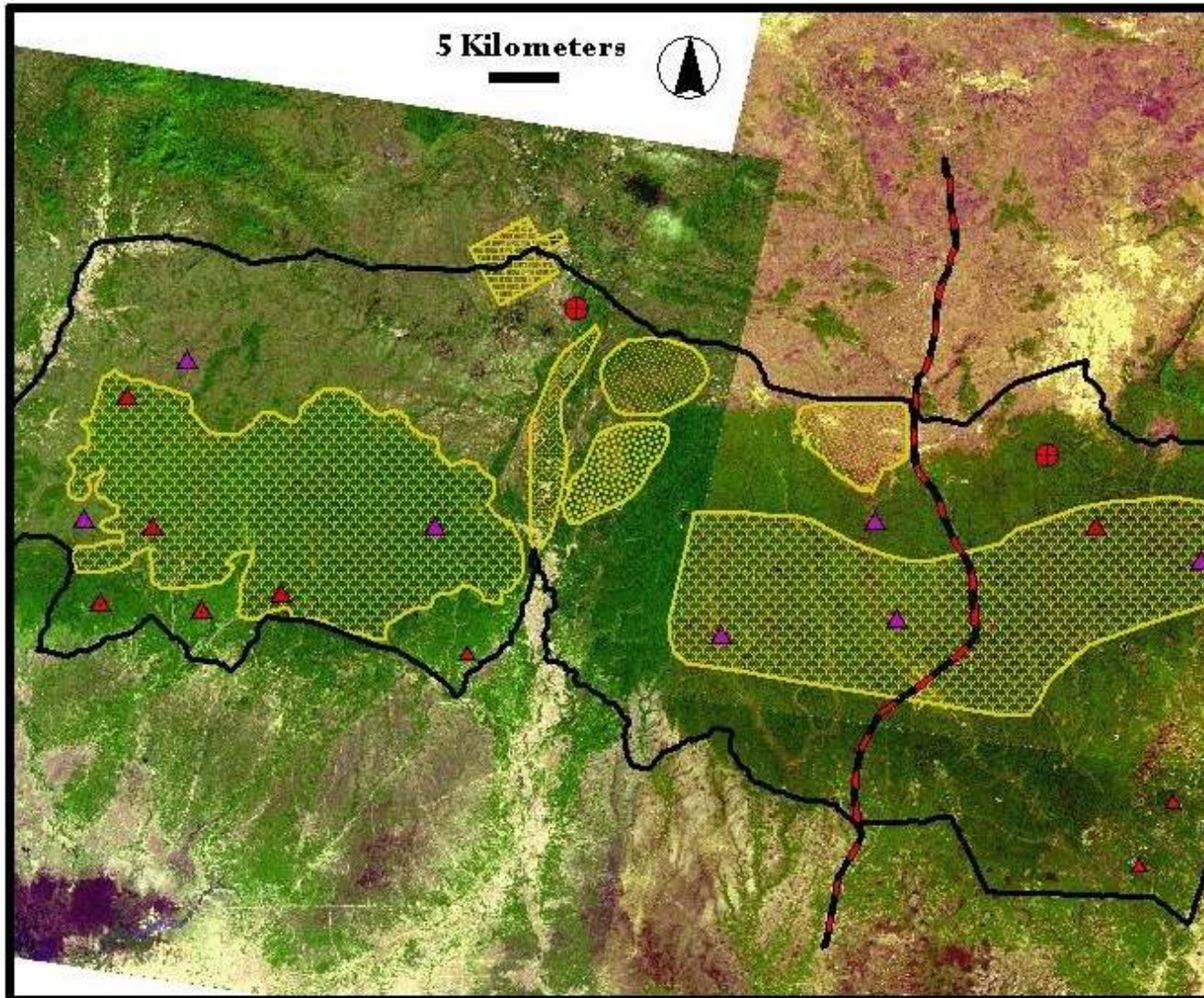
ID	Name of Area / Issue	Type of Area / Issue	Significance Score	Key for mapped items	
X1, X2, X3, etc.	East of Mae Wong NP	Reservoir in conflict with habitat needs Etc.	1, 2, or 3	 	= Areas of complementarity between ecosystem and community resilience needs = Areas of possible incompatibility between ecosystem and community resilience needs





23 10:48

# Map Outcomes



## Legend

### Protected Area Values

- Exemplary animal community
- Limited range animal
- Exemplary plant community
- Exemplary riparian area
- Architectural site

### Protected Area Threats

- Road Construction
- General poaching
- Clearcutting
- Selective logging
- Small-scale clearing
- Collection of non-timber forest products
- Protected Area Boundary

# Critical to Remember:

- Maps are not reality – they are models
- Inaccuracy is OK in this exercise – we're after the big picture
- Be creative – think about how best to synthesize the ideas of your group



***Thanks***