

Ecologia da Paisagem: conceitos e métodos de pesquisa (BIE 5770)

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Palestrantes e monitores:

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Data	Manhã	Tarde
21/11/2012	(1) O que é Ecologia de Paisagens	(2) Bases de sensoriamento remoto + Fragstats
2/11/2012	(3) Fragmentação e limiaries	(2) Métricas da paisagem
23/11/2012	(1) Fragmentação: a dimensão temporal	(2) Métricas da paisagem
24/11/2012 – sábado	(1) Conectividade estrutural e funcional	(2) Delineamento e discussão de projetos
26/11/2012	(3) Conectividade: importância da matriz	(2) IBM + EP em ação + Projeto
27/11/2012	(3) Genética da paisagem	(2) Projeto
28/11/2012	(1) Conservação e indicadores de paisagem	(2) Projeto
29/11/2012	(3) EP e restauração	(2) Projeto
30/11/2012	(1) EP, sustentabilidade e serviços ecossistêmicos	(1) Projeto + Apresentação
1/12/2012	(1) Apresentação de Projetos	(1) Apresentação de Projetos

Grupos para leitura e discussão de textos

Grupo	Alunos	Tema
1	Camila, Rogerio, Betania, Renan,	Limiares
2	Talita, Bruno, Juliana, Tatiana	Dimensão temporal
3	Cristiane, Marina, Lilian, Luciana	Conectividade funcional
4	Carolina., Rafael, Alexandrina, Leticia	Matriz
5	Isa, Andreia, Renato, Clecia	Genética
6	Maria, Luana, Carla, Rodolfo	Conservação e indicadores
7	Camila, Rossi, Taina, Daniel	Restauração
8	Rodrigo, Marion, Carolina, Mariana	Sustentabilidade e SE

Ecologia de Paisagens



1. O que é uma Paisagem?
2. A Ecologia de Paisagens trata de uma nova escala espacial de estudos ecológicos?
3. A Ecologia de Paisagens trata de um nível hierárquico acima de ecossistemas?

Origem da palavra “paisagem”

1. Região, espaço de terreno, terra agrária

HANS SACHS

HERAUSGEGEBEN

VON

ADELBERT VON KELLER.



ERSTER BAND.

FÜR DEN LITTERARISCHEN VEREIN IN STUTTGART
NACH BESCHLUSS DES AUSSCHUSSES VOM JULI 1867
GEDRUCKT VON H. LAUPP IN TÜBINGEN
1870.

*“Nachdem wir auf den thurn
Bayde gelassen wurn
Auff dem wir bayde sahen
Die **Landschaft** ferr und nahen”*

*Hans Sachs – Fábula Die
ehrentreich fraw Miltigkeit -
1537*

Origem da palavra “paisagem”

1. Região, espaço de terreno, terra agrária

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NACH BESCHLUSS DES AUSSCHUSSES VOM JULI 1867
GEDRUCKT VON H. LAUPP IN TÜBINGEN
1870.

*“Depois na torre
Nós dois vimos o por do sol □ Nós
dois vimos de lá □ A paisagem
distante e próxima”*

*Hans Sachs – Fábula Die
ehrentreich fraw Miltigkeit -
1537*



Aurélio - Dicionário da Língua Portuguesa:

“espaço de terreno que se abrange num lance de vista”

Noções originais/comuns :

- visual (algo que se “vê”)
- amplitude (vista, conjunto de elementos)
- áreas abertas



Marcos históricos

Origem da palavra “paisagem”

2. Representação artística de uma região

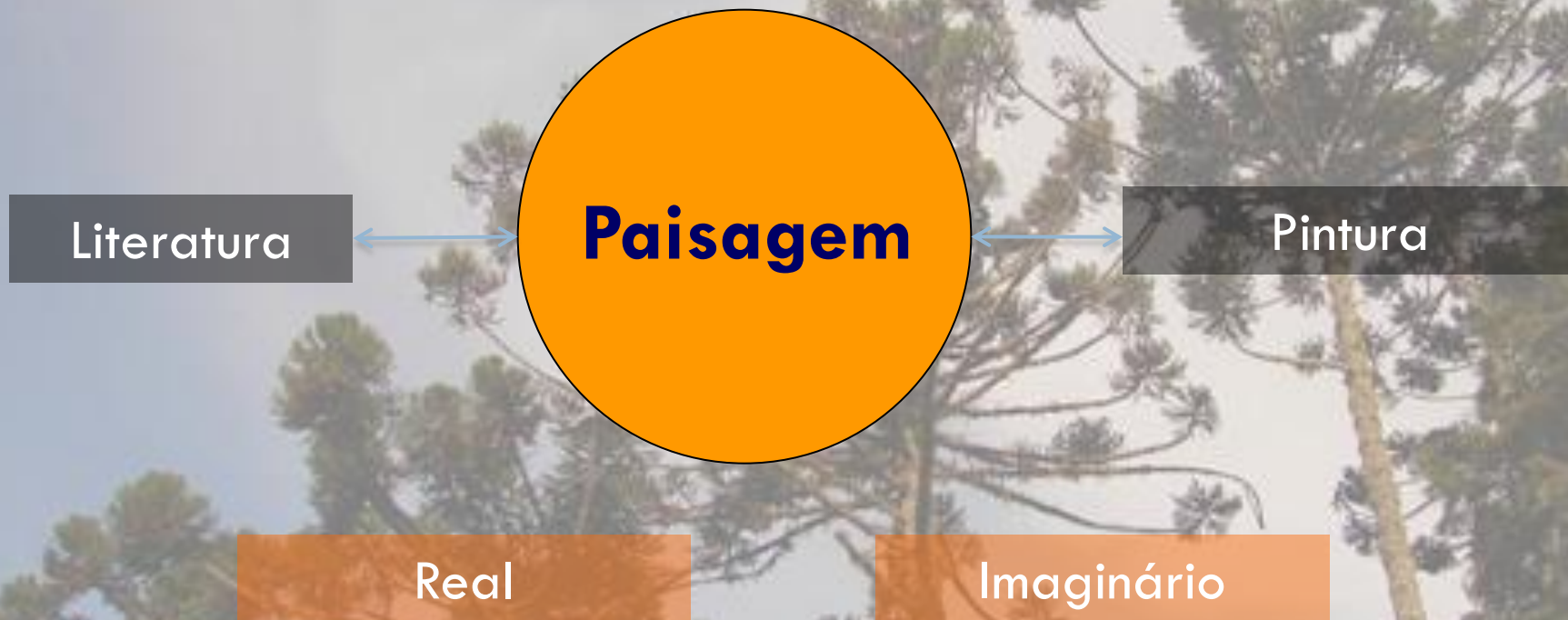


Pintores Chineses – Século XI



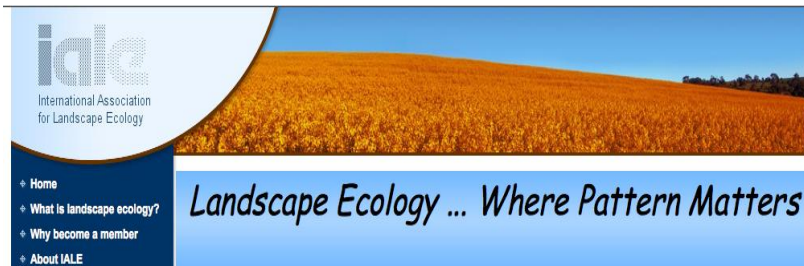
Renascença (pintores holandeses) – Século XVI
Impressionistas – Século XIX

É um termo agregador,
de uso universal



Paisagem como ciência ecológica

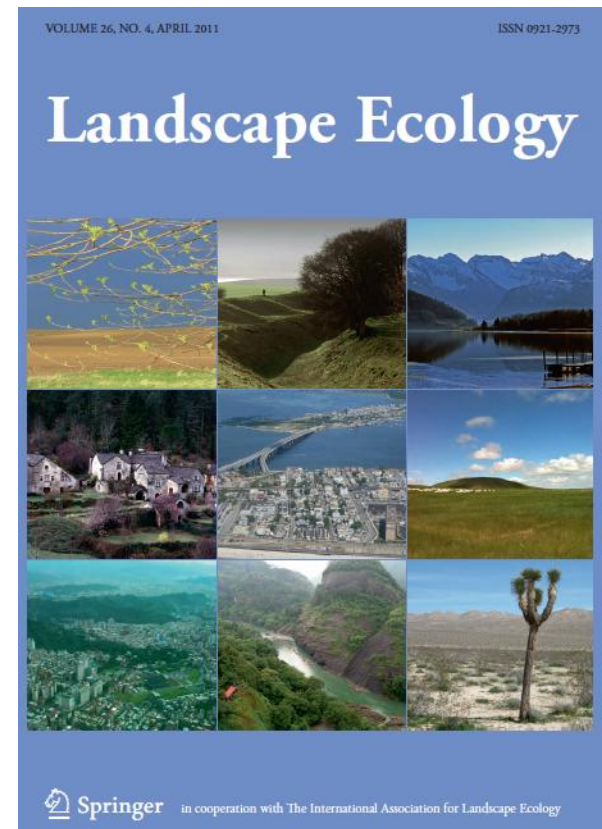
IALE - 1984



The 8th IALE World Congress

18 - 23 August, 2011, Beijing, China

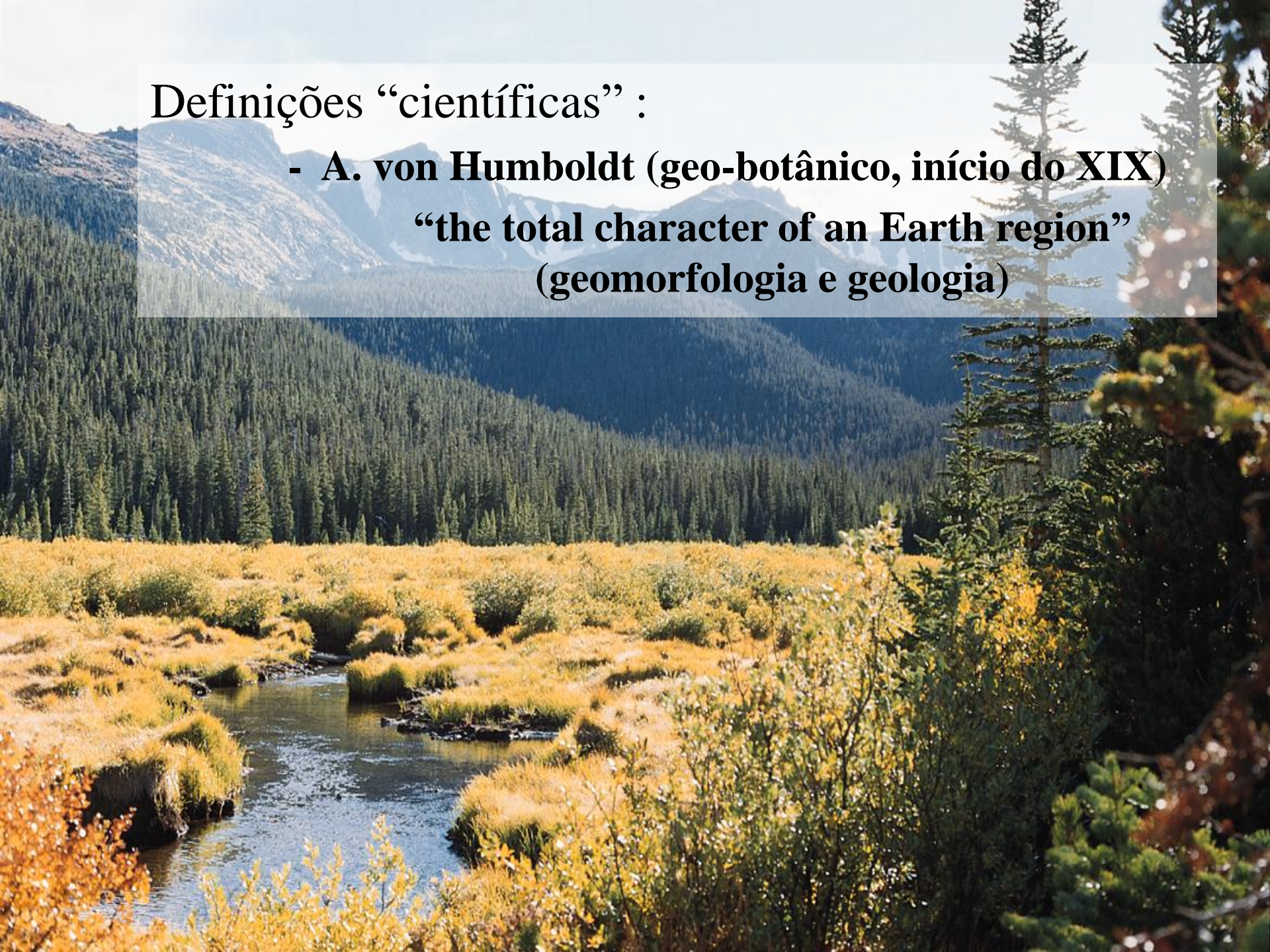
Landscape Ecology - 1987




(Impact Factor 2009: 3,3)

Definições “científicas” :

- **A. von Humboldt (geo-botânico, início do XIX)**
“the total character of an Earth region”
(geomorfologia e geologia)





Definições “científicas” :

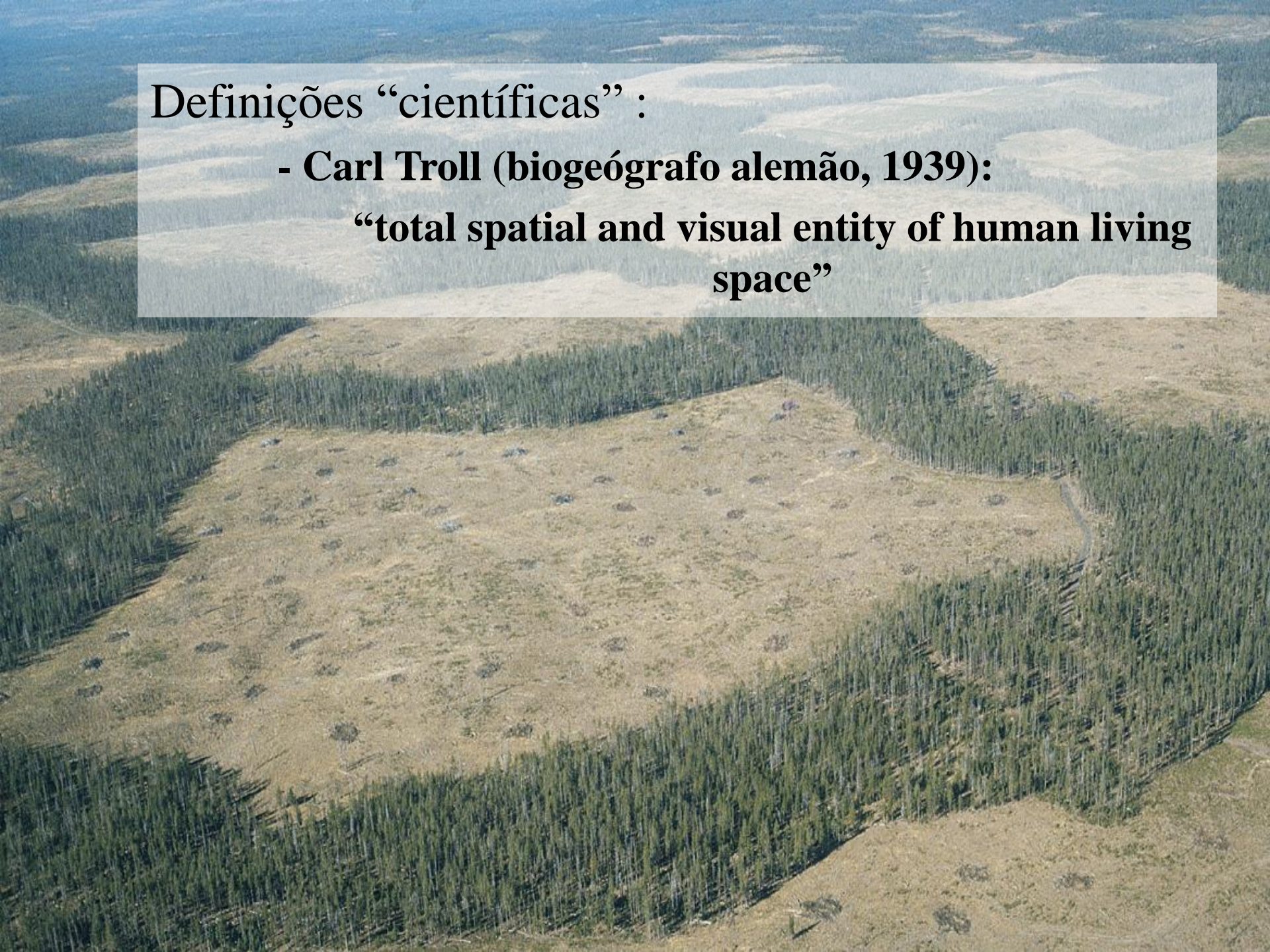
- **Geógrafos russos**

ampliaram o conceito de Humboldt para aspectos orgânicos (“landscape geography”)

Definições “científicas” :

- **Carl Troll (biogeógrafo alemão, 1939):**

“total spatial and visual entity of human living space”



Definições “científicas” recentes da “ecologia da paisagem”:

- a **heterogeneous** land of area composed of a cluster of interacting ecosystems (Forman and Godron 1986)
- a mosaic of **heterogeneous** land forms, vegetation types and land uses (Urban et al. 1987)
- a spatially **heterogeneous** area (Turner 1989)

❌ Propriedade básica : é uma *unidade heterogênea*

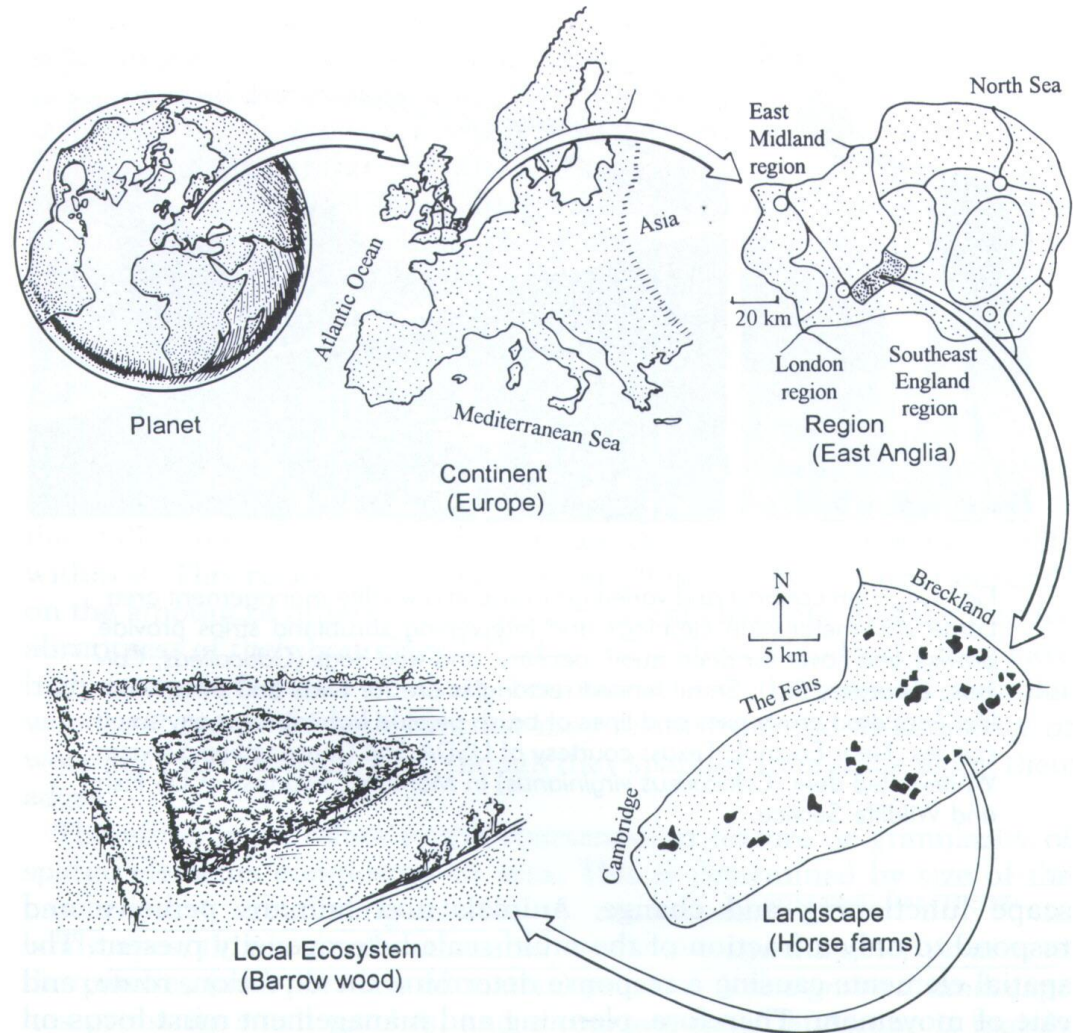
Paisagem

“ **a paisagem é um** mosaico heterogêneo formado por unidades interativas. Esta heterogeneidade existe para pelo menos um fator, segundo um observador e numa determinada escala”

- ▣ **Visão pelo olho do Homem**
- ▣ **Visão pelo “olho” de outras espécies**

Paisagem segundo a visão do Homem

- **Abrange amplas extensões espaciais (km²)**



Paisagem segundo a visão do Homem



- Fontes de heterogeneidade na paisagem :
 - **heterogeneidade do ambiente físico** (topografia, solos, umidade, dinâmica hidrogeomorfológica...);

Paisagem segundo a visão do Homem

- Fontes de heterogeneidade na paisagem :
 - **regime de perturbações naturais**
(fogo, tornado, pestes...);



Paisagem segundo a visão do Homem

□ Fontes de heterogeneidade na paisagem :

- **perturbações antrópicas** (desmatamento/fragmentação, criação de estradas, reservatórios...).



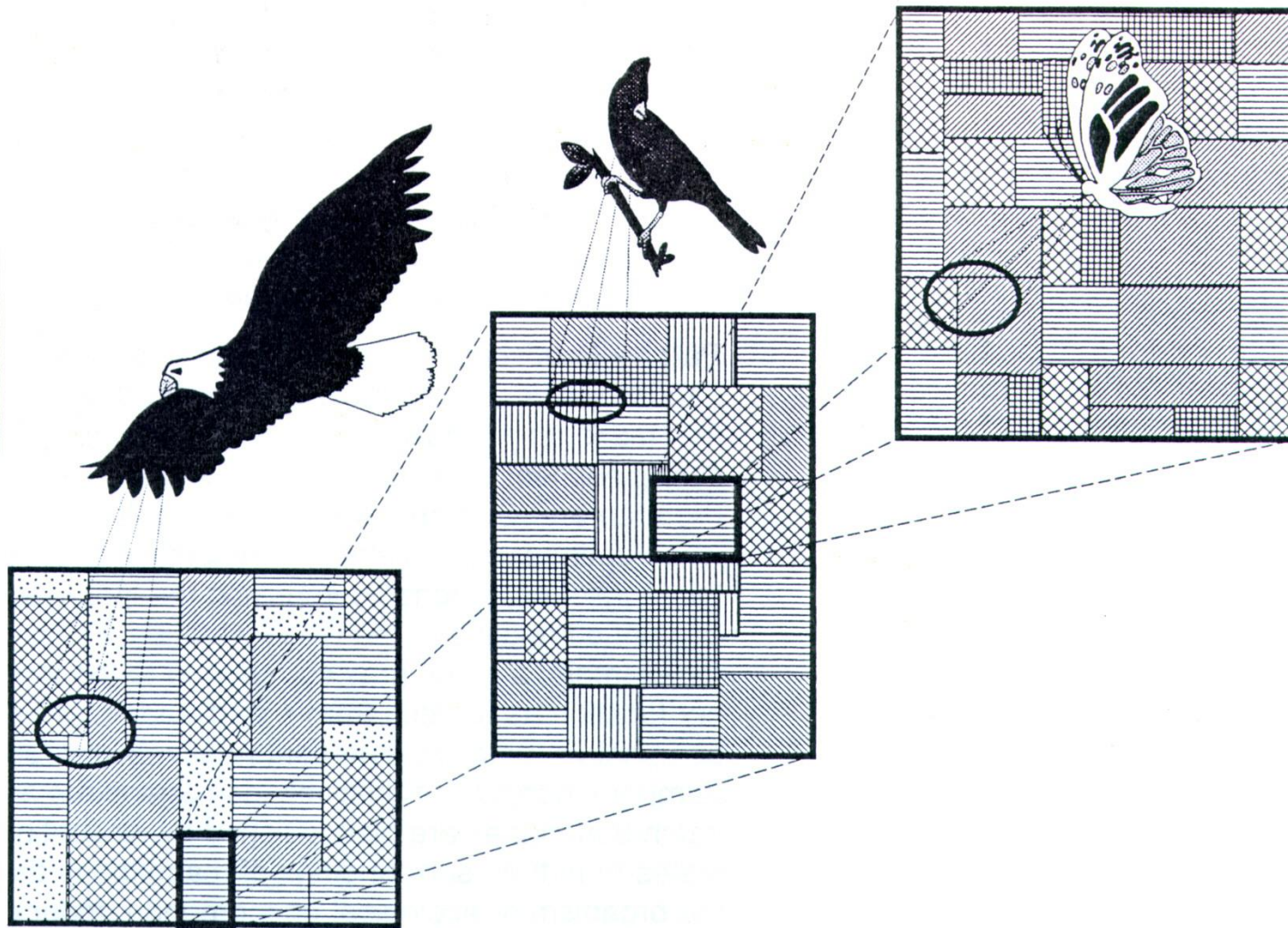
Paisagem

“ **a paisagem é um** mosaico heterogêneo, para pelo menos um fator e segundo um observador, formado por manchas interativas”

- ▣ **Visão pelo olho do Homem**

- ▣ **Visão pelo “olho” de outras espécies**

Paisagem segundo a visão das espécies



Paisagem segundo a visão das espécies

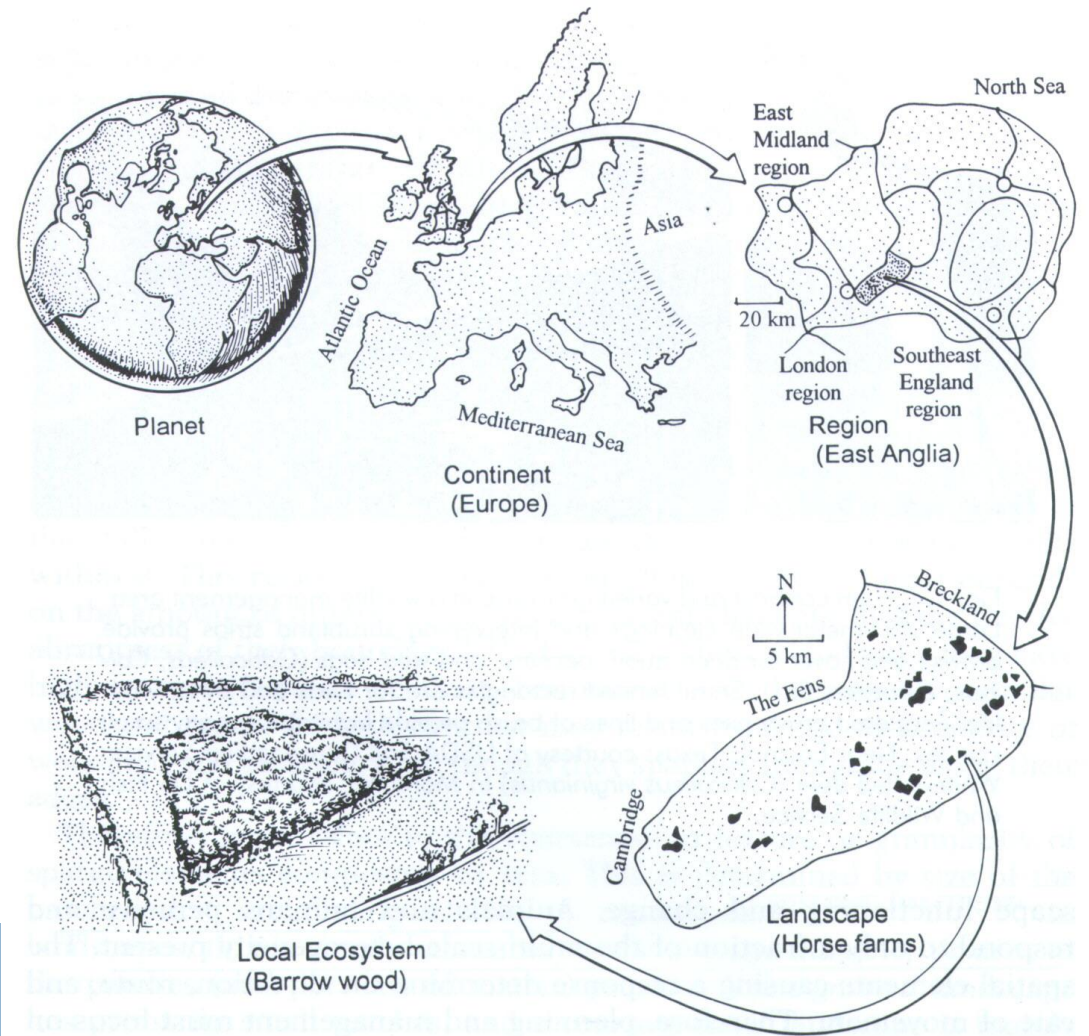




A paisagem de um gafanhoto (4 m²)

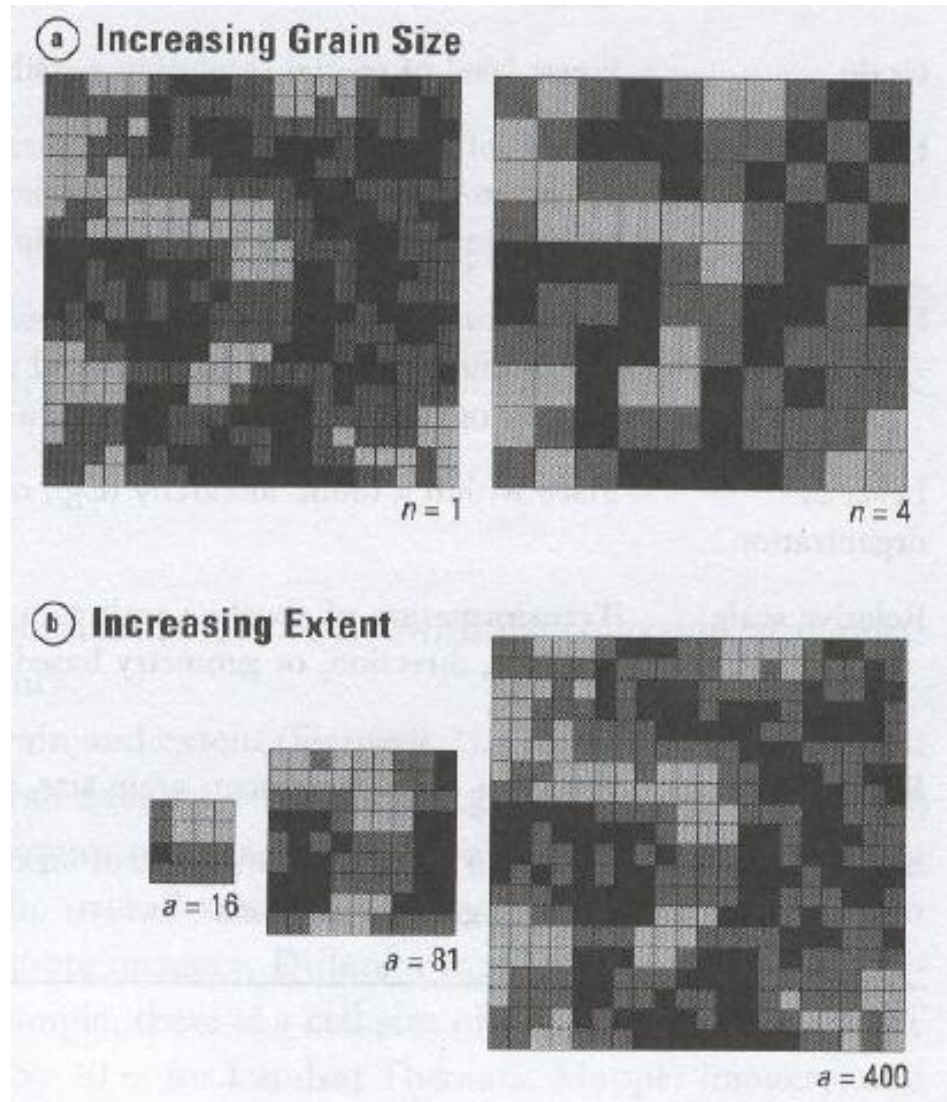
A “Ecologia de Paisagens” é....

... uma nova
escala espacial de
estudo ecológico?



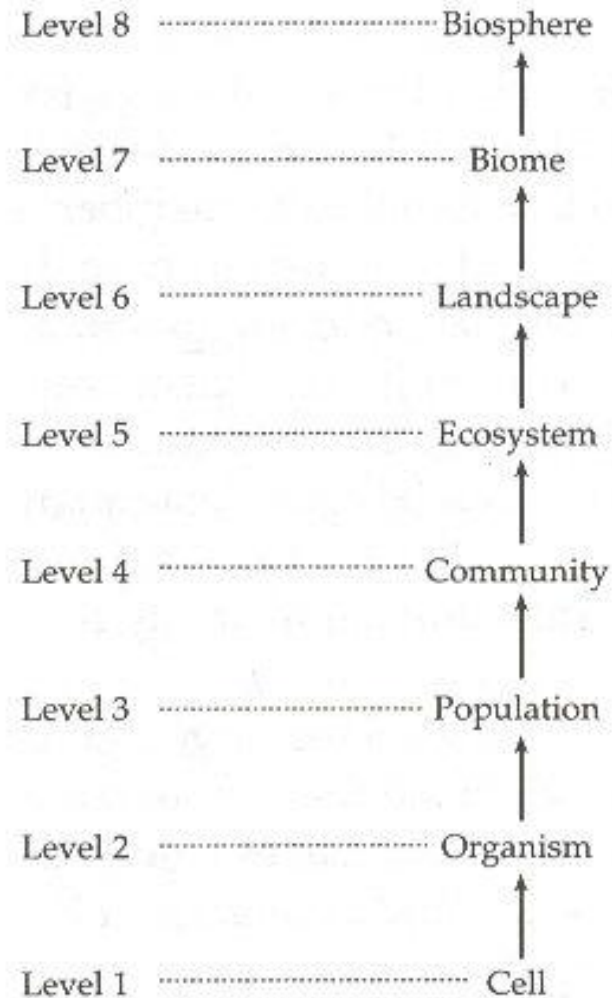
As escalas

escala espacial -
aspecto de extensão
e de resolução

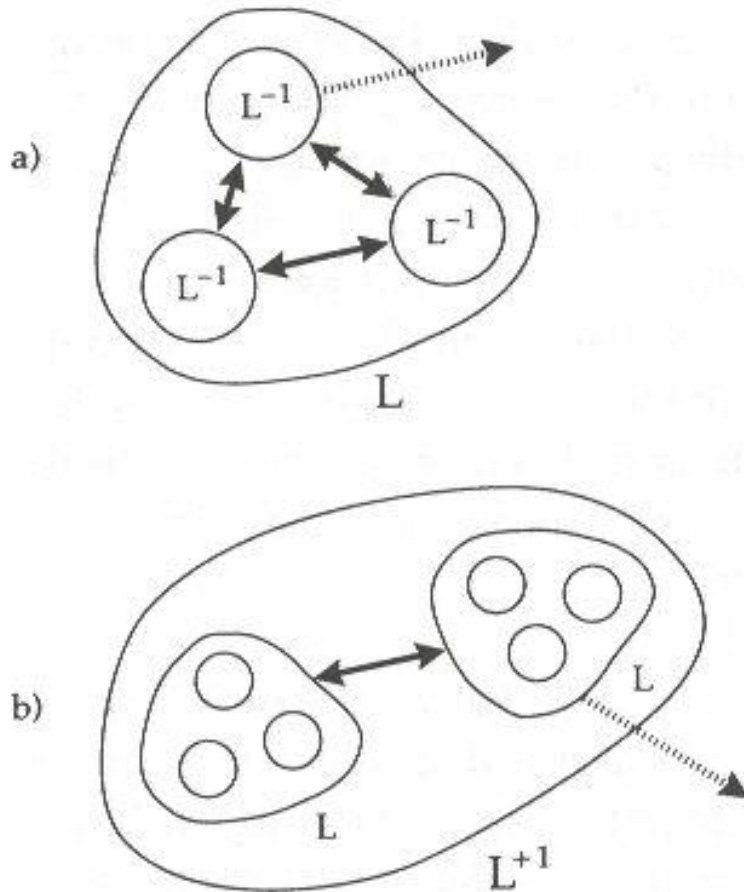


A “Ecologia de Paisagens” é....

... um novo nível
de organização
biológica ?



Níveis de organização hierárquica num sistema



- Propriedade fundamental de um sistema: as propriedades no nível L
 - dependem das interações/ associações em L-1
 - são condicionadas pelo nível L+1
- Células-tecidos-orgãos são níveis de organização.
- Populações-comunidades-ecossistemas-paisagens podem não ser.

Duplo nascimento da Ecologia de Paisagens

□ Escola Européia

- Origem em 1940
- Paisagens culturais
- Enfoque **geográfico**

- Voltada para planejamento espacial

□ Escola Norte-Americana

- Origem em 1980
- Paisagens naturais
- Enfoque **ecológico**
(padrões espaciais e processos ecológicos)
- Voltada para conservação



Carl Troll (biogeógrafo alemão, 1939):

Landscape: “total spatial and visual entity of human living space”

(1899– 1975)





Zev Naveh e Arthur Lieberman - 1994

"Interdisciplinary science dealing with the interrelation between **human society and its living space** (its open and buildt-up landscapes)"

Escola Norte-Americana



Fig. 1 Participants in the Allerton Park conference, 1983. From left to right: R.V. O'Neill, J.R. Karr, P.G. Risser, M. Wiley, S.A. Levin, W.G. Ruesink, M. Godron, H.H. Shugart, R.L. Rabb, F.B. Golley, R. Woodmansee, R. Costanza, J.A. Wiens, C. Steinitz, G.W. Barrett (back row), T. Hoekstra (middle

row), W.J. Parton (middle row), D.B. Botkin (front row), J.W. Thomas (back row), G. Merriam, D.M. Sharpe, L.R. Iverson, G.C. Sanderson, C. Becker, R.T.T. Forman. From Risser et al. (1984)

Allerton Park Workshop, April 1983

LANDSCAPE ECOLOGY

Directions and Approaches

Paul G. Risser
Illinois Natural History Survey

James R. Karr
University of Illinois

Richard T. T. Forman
Rutgers University

A workshop held at
Allerton Park
Piatt County, Illinois
April 1983

Illinois Natural History Survey Special Publication Number 2

Published March 1984 by the Illinois Natural History Survey
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607 East Peabody Drive
Champaign, Illinois 61820

A Division of the Illinois Department of Energy and Natural Resources

March 1984 RISSEK, KARR, AND FORMAN: LANDSCAPE ECOLOGY 7

INTRODUCTION

In recent years, several attempts have been made to define a field of science entitled "regional ecology" or "landscape ecology." These initiatives have originated from a number of scientific points of view (Watt 1947; Whittaker and Levin 1977), yet no clear set of general principles has emerged.

Current ideas about landscape ecology (e.g., Burgess and Sharpe 1981; Forman 1981; Forman and Godron 1981; Luder 1981; Minnich 1983; Naveh 1982; Romme and Knight 1982; Sharpe et al. 1981) are influenced by (a) a preoccupation with the extension of island biogeography theory to continental landscape patches, (b) the presumption that ecosystem-level characteristics are adequate to address landscape-level characteristics, (c) a recognition of the need to address landscape issues in land and resource management, (d) a belief that map-overlay methodology is sufficient to capture the essential attributes of multiunit landscapes, (e) the realization that human activities are an integral part of any meaningful concept of landscape ecology, and (f) the recognition that the inclusion of many appropriate scientific disciplines results in an exceedingly complex field. Collectively, these influences appear to have stalled the crystallization and communication of current understanding of "landscape ecology," especially as the concept might facilitate basic and applied research on natural resources.

A landscape perspective in ecology is not new (Neef 1967; Troll 1968); indeed, this is the perspective embodied in *A Sand County Almanac* (Leopold 1949) and in many early writings in ecology, natural history, and wildlife biology. Similarly, this landscape perspective is represented in related disciplines, such as landscape planning, economic geography, and cultural anthropology. However, these ideas have never been coalesced, organized, and confronted rigorously to produce a theoretically sound basis for understanding landscape-scale interactions. Further, the ecological base of this disciplinary integration is especially weak, and so developing definitive and ecologically based methods and models for managing natural resources is essential.

In spite of this conceptual bottleneck, ideas and concepts are developing (albeit slowly), research is being designed, and resource managers are grasping at even fragments of generalizations about the ecology of landscapes that can focus research efforts and guide resource management decisions (Forman 1979; Hansson 1977; Isard 1975; Klopatek et al. 1983; Naveh and Lieberman 1984; Samson and Knopf 1982). A mechanism for speeding the integration of a landscape ecology approach was to gather together experienced individuals with different viewpoints but with a strong desire to examine landscapes through the ideas of ecology and related disciplines. This report summarizes the deliberations of the 25 individuals (see List of Participants) who spent three days attempting to

outline the disciplinary area of landscape ecology, to evaluate the potential of such a discipline, and to describe its application to basic and applied natural-resource issues. Although the group represented diverse points of view, an ecological perspective prevailed. Ideas contained in this report represent the collective efforts of the group, and no attempt has been made to identify specific thoughts with any particular individual.

DEFINITION AND CONCEPT OF LANDSCAPE ECOLOGY

Ecology deals with the understanding of fundamental processes and consequences of management of spatially and temporally homogeneous and heterogeneous geomorphic and living systems.

Landscape ecology differs from subdisciplines of ecology, such as population, community, and ecosystem ecology, in matters of primary emphasis. Landscape ecology focuses explicitly upon spatial pattern. Specifically, *landscape ecology considers the development and dynamics of spatial heterogeneity, spatial and temporal interactions and exchanges across heterogeneous landscapes, influences of spatial heterogeneity on biotic and abiotic processes, and management of spatial heterogeneity*. Thus, the primary focus of landscape ecology is on (a) spatially heterogeneous geographic areas, e.g., pine barrens, regions of row crop agriculture, Mediterranean woodland landscapes, and areas of urban and suburban development; (b) fluxes or redistribution among landscape elements; and (c) human actions as responses to, and their reciprocal influences on, ecological processes. Principles of landscape ecology help to provide theoretical and empirical underpinnings for a variety of applied sciences, e.g., regional planning, landscape architecture, and natural-resource management.

The relationship between spatial pattern and ecological processes is not restricted to a particular scale. One's understanding of landscape ecology issues focused at one scale may profit from experiments and observations on the effects of pattern at both finer and broader spatial scales. In turn, results from landscape studies may find application in understanding the way organisms interact with patterned environments at other levels of scale (Wiens in press).

Ecological processes vary in their effects or importance at different scales. Thus, biogeographic processes may be relatively unimportant in determining local patterns but may have major effects upon regional patterns. Processes leading to population decline may produce extinction at a local scale, but may only appear as spatial redistributions or alterations in age structure at broader levels.

Different species and groups of organisms (e.g., plants, herbivores, predators, parasitoids) may operate at different spatial scales, and thus, investigations undertaken at a given scale may not treat such components with equivalent resolution. Operationally,

(Risser et al. 1984)

Escola Norte-Americana

- **Landscape** is a *spatially heterogeneous area*
(Turner 1989)
- **"Landscape ecology** considers
 - the development and dynamics of *spatial heterogeneity*,
 - spatial and temporal interactions and exchanges across *heterogeneous landscapes*,
 - influences of *spatial heterogeneity* on biotic and abiotic processes and
 - management of *spatial heterogeneity"*
(Risser et al. 1984)

Estrutura da
mosaicos
heterogêneos



Processos
Ecológicos

É uma ecologia espacialmente explícita

(Metzger 2001)

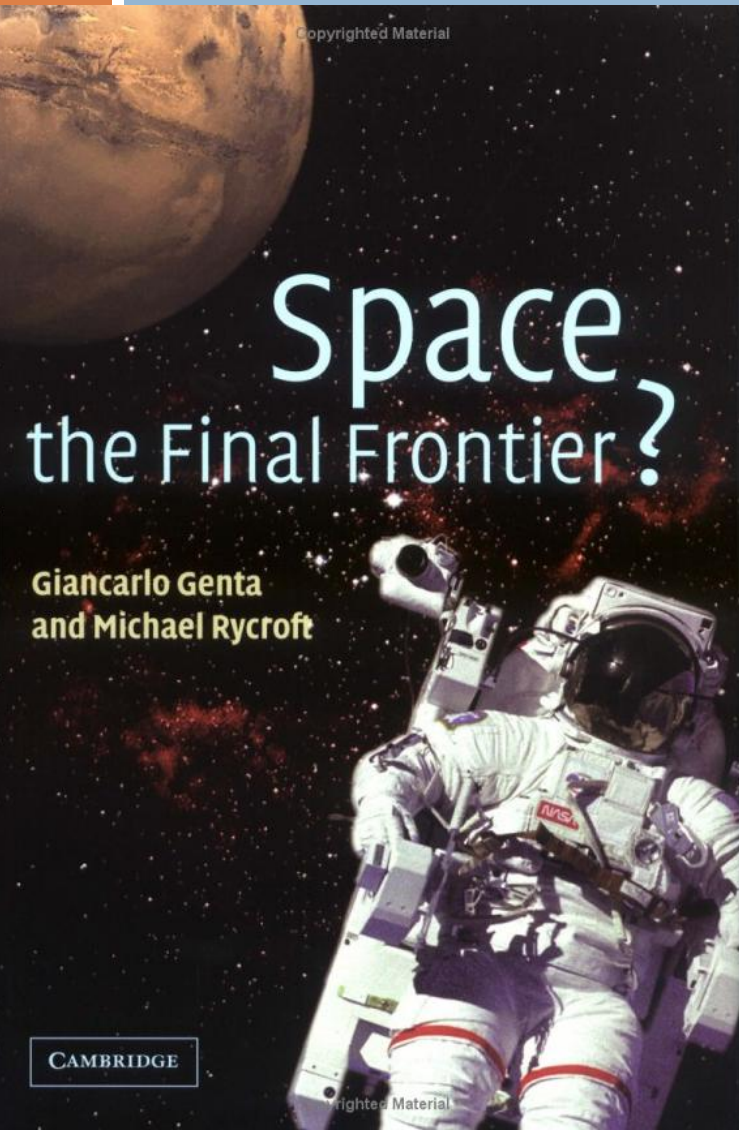
	<i>Geographical approach</i>	<i>Ecological approach</i>
Landscape definition	“a total human ecosystem” (Naveh and Lieberman 1994)	“a spatially heterogeneous area” (Turner 1989)
Man focus of landscape ecology	“society-centered holistic view that focuses on solution-driven research” (Wu 2006)	“bioecologically-centered spatial view that focuses on question-driven studies” (Wu 2006)
Disciplinary perspective	Trans or cross-disciplinary	Disciplinary
Application	Land use management and planning – focus on societal issues	Nature and ecosystem services conservation – focus on native species issues
Focal landscape type	Human-dominated or cultural landscapes	Native landscape or native patches in human-dominated landscapes
Approaches for data analyses	More qualitative	More quantitative
Emphasis in pattern-process relationships	Low	Strong

(Metzger, unpublished)

Características temáticas

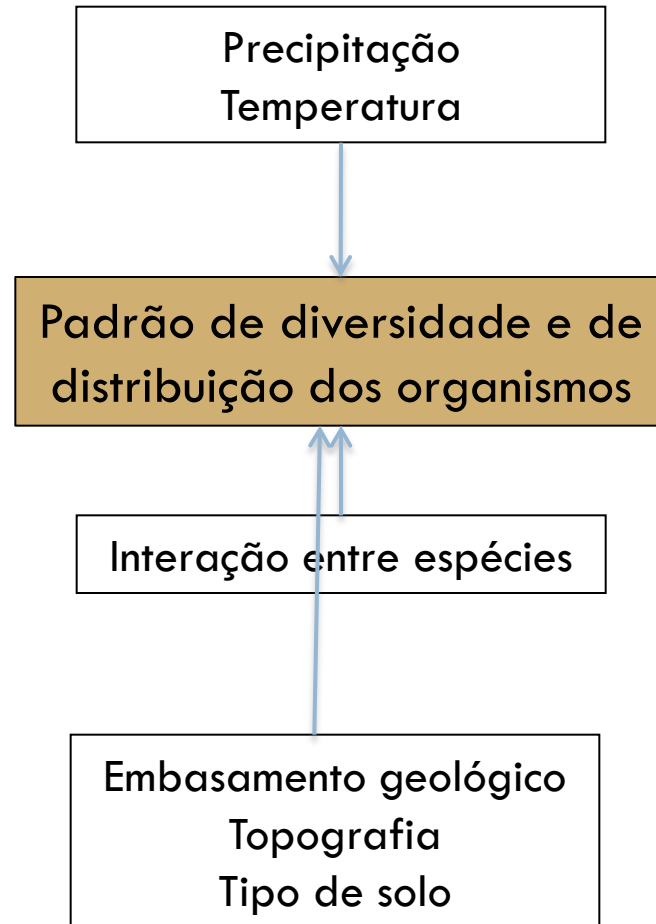
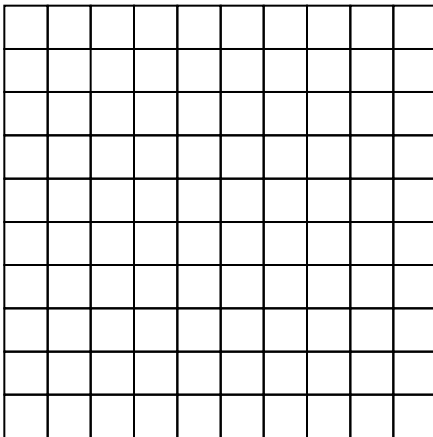
1. Inclui explicitamente o espaço
2. Base conceitual integradora e atraente
3. Trabalha com uma escala mais ampla
4. Considera múltiplas escalas
5. É beneficiado por avanços tecnológicos
6. É uma ecologia com alto potencial de aplicação

1. Inclui explicitamente o espaço



1. Inclui explicitamente o espaço

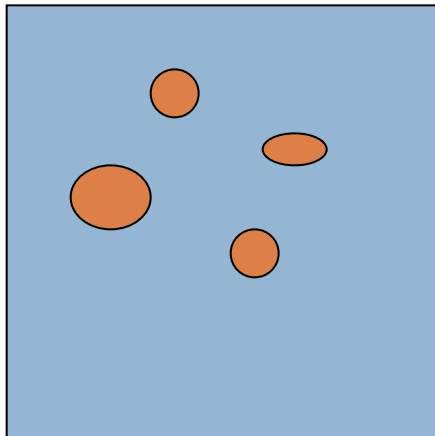
Ecologia
“tradicional”



1. Inclui explicitamente o espaço

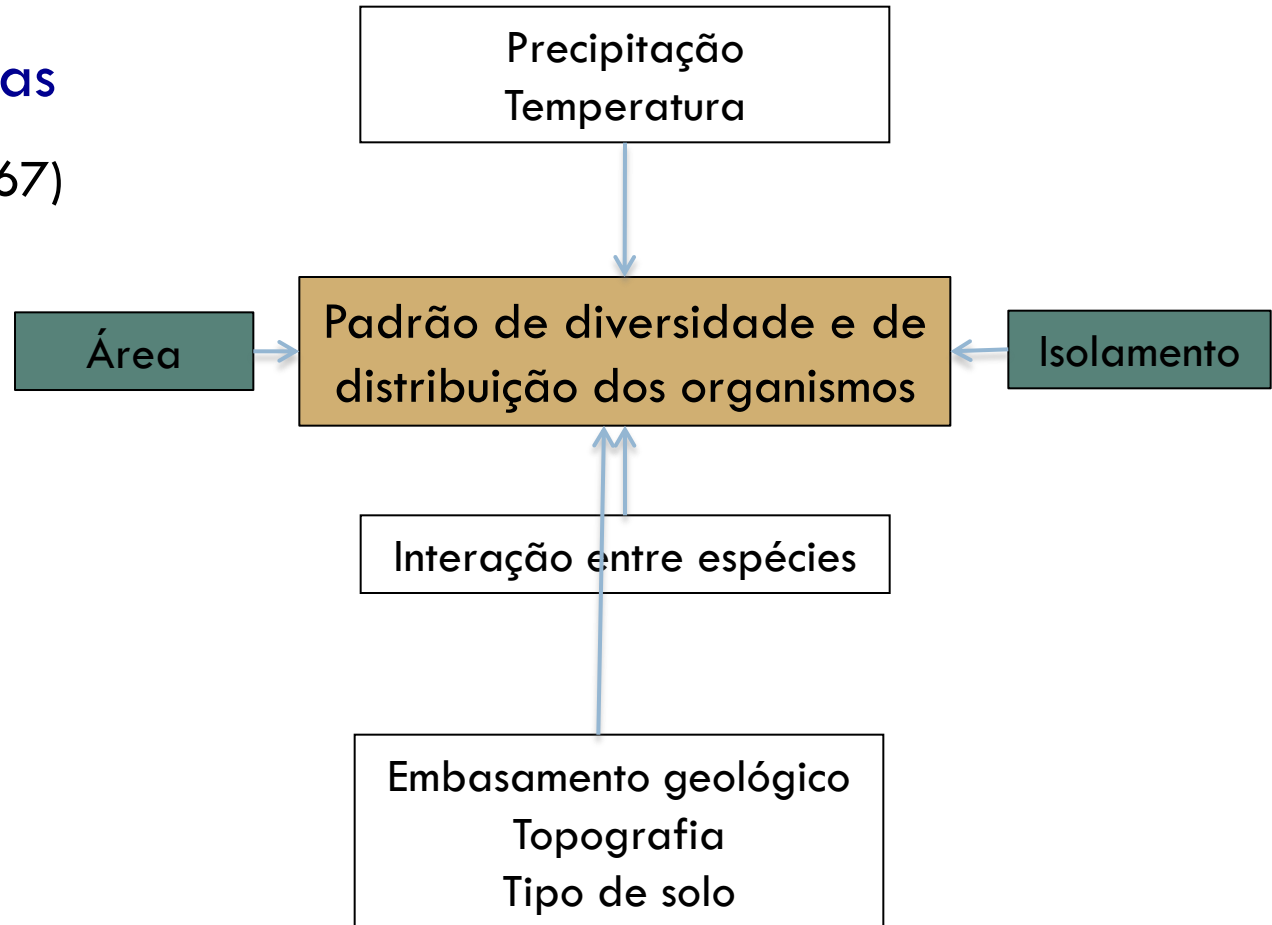
Biogeografia de ilhas

(MacArthur & Wilson 1967)



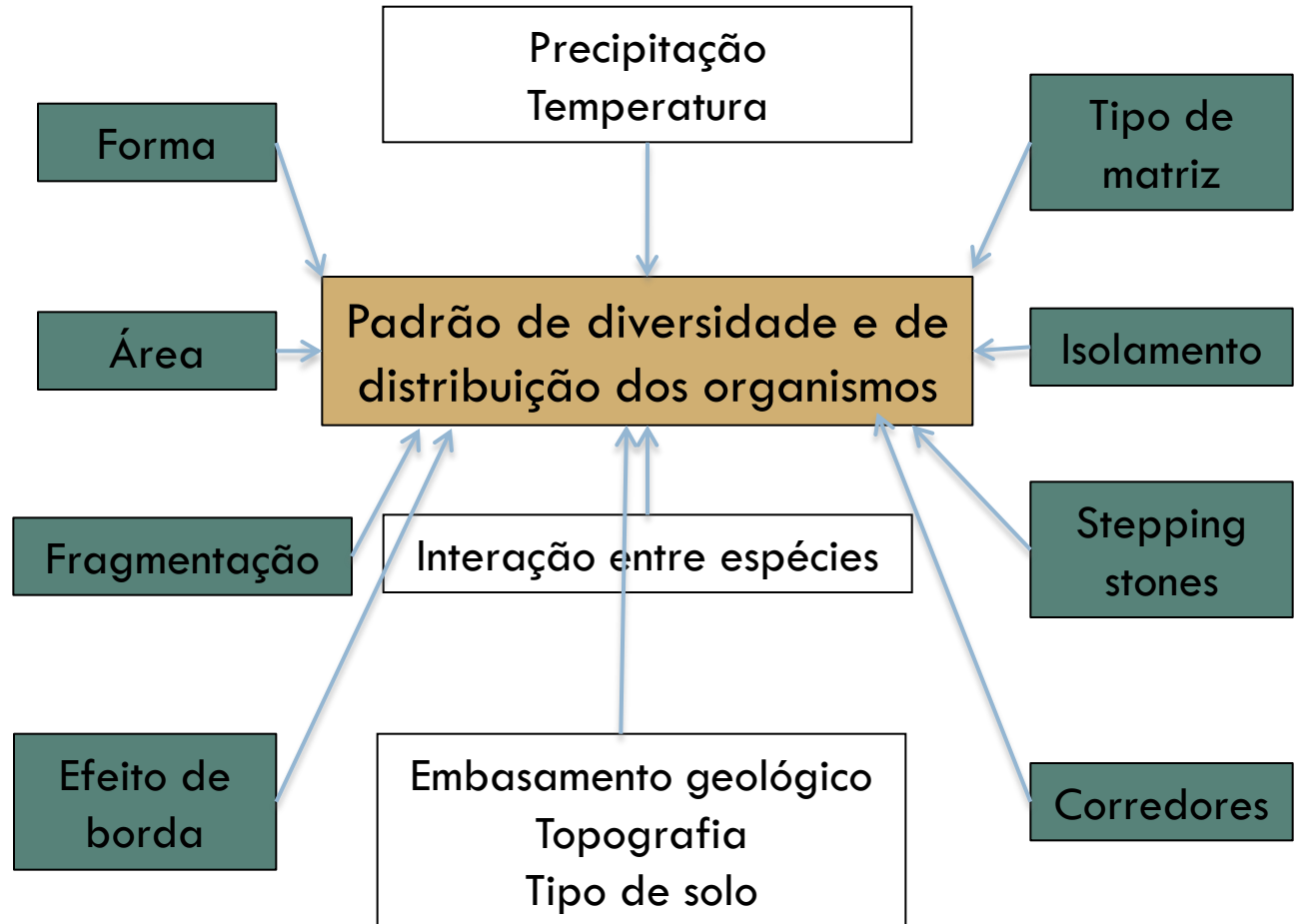
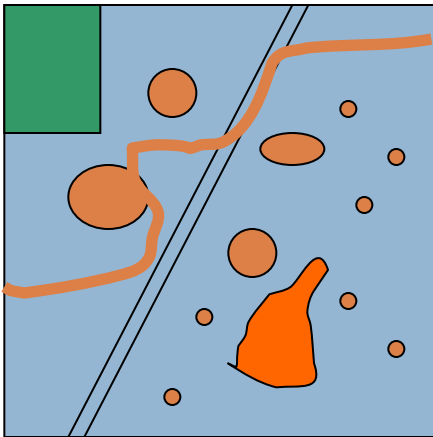
Ecologia de metapopulações

(Levins 1969)

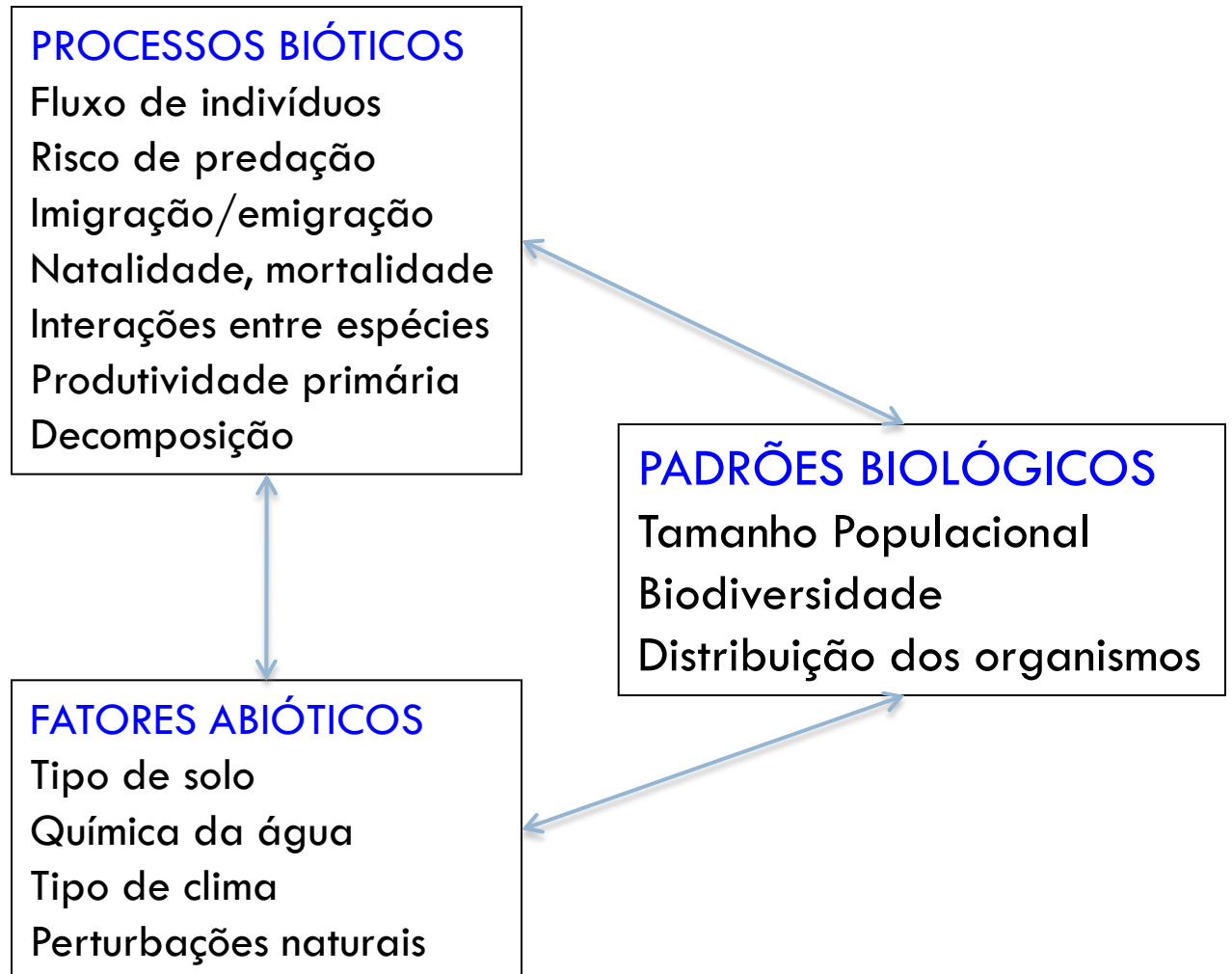


1. Inclui explicitamente o espaço

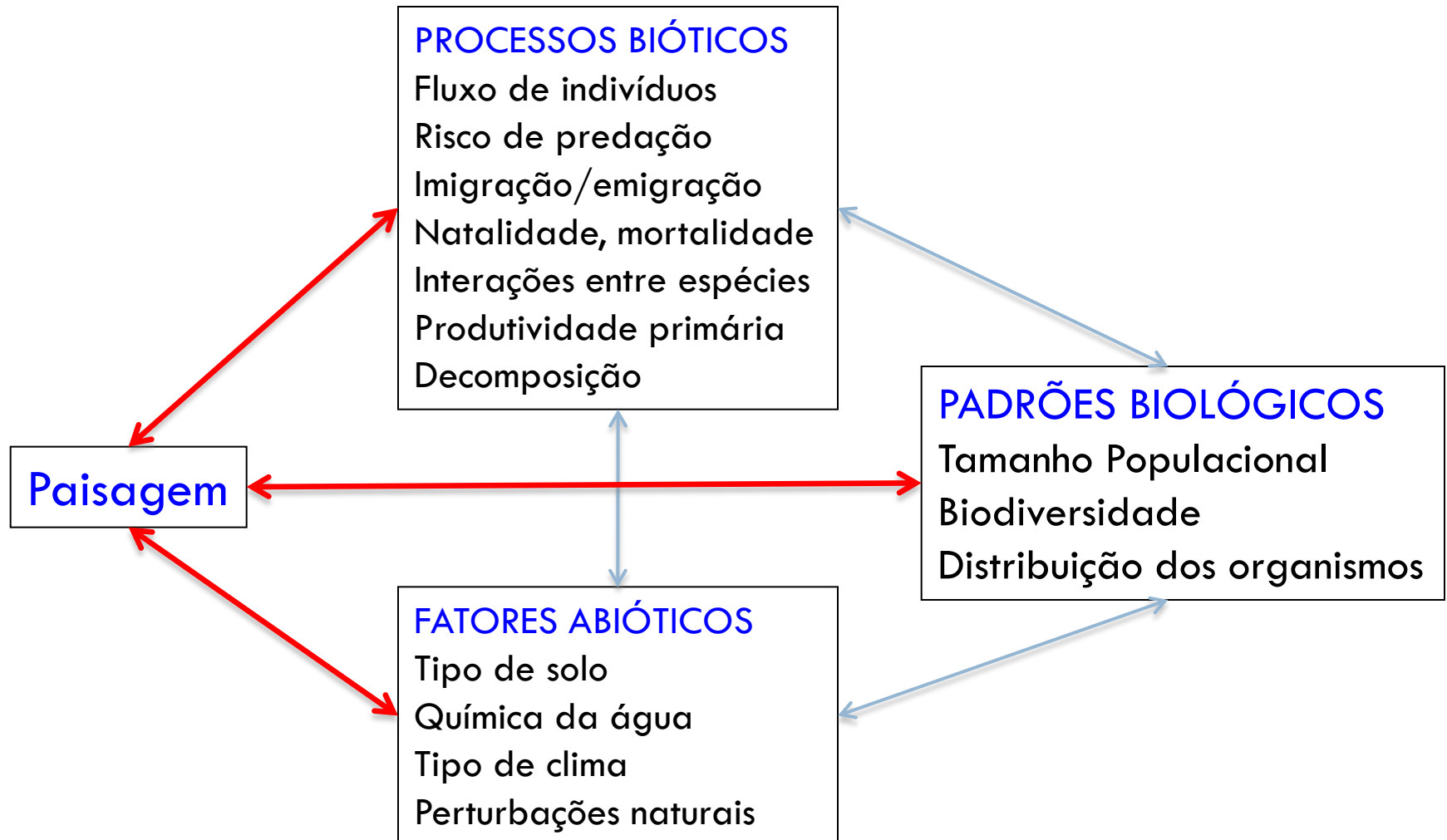
Ecologia de paisagens



2. Base conceitual integradora e atraente



2. Base conceitual integradora e atraente





Fluxo de indivíduos
Predação
Mortalidade

Populações
Biodiversidade

Perturbações



Fluxo de indivíduos
Predação
Mortalidade

Populações
Biodiversidade

Perturbações

2. Base conceitual integradora e atraente

Estrutura da
paisagem



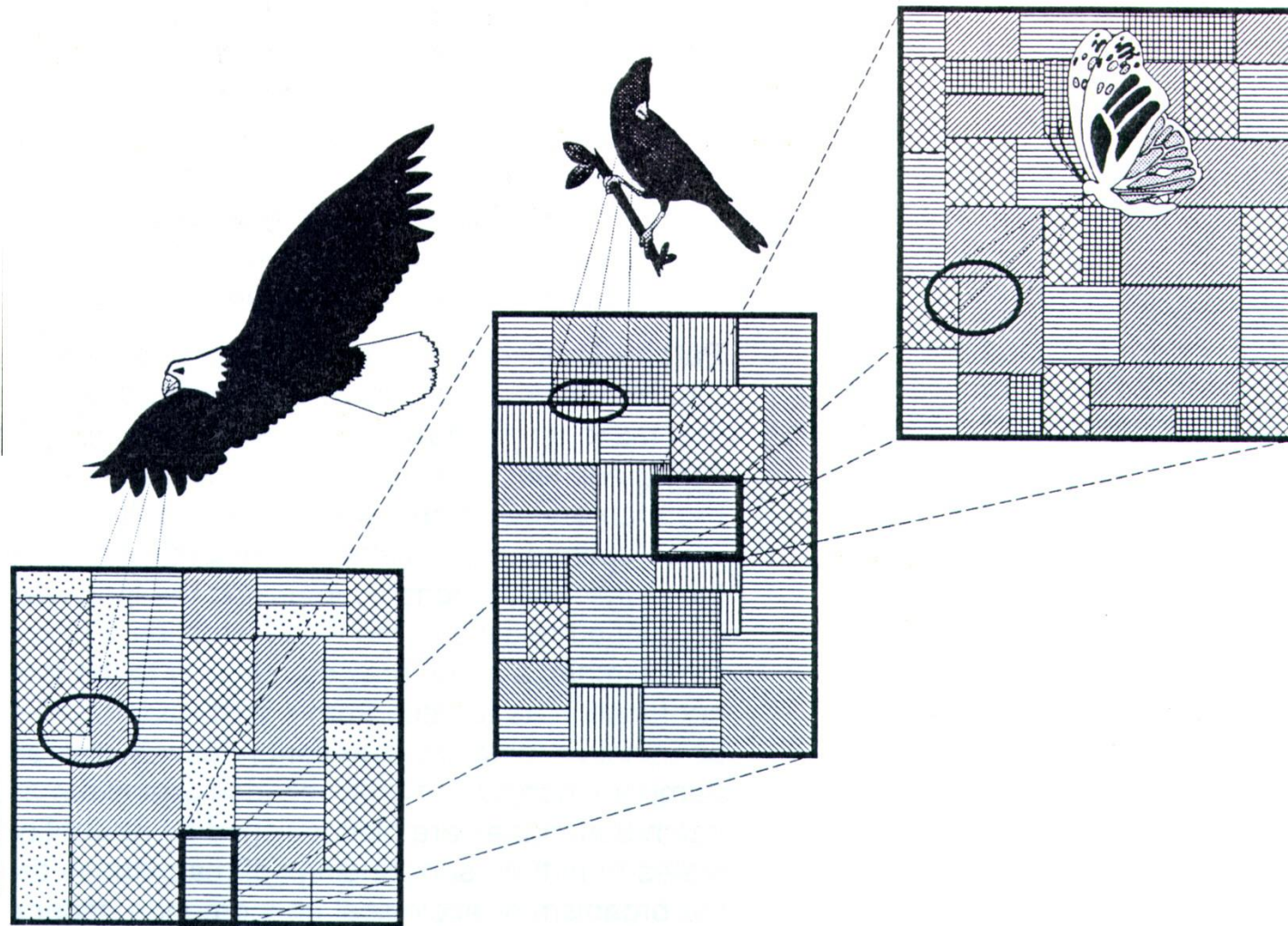
Processos

- Populacionais
- Interações entre spp
- Ecosistêmicos

3. Trabalha com uma escala mais ampla



3. Trabalha com uma escala mais ampla



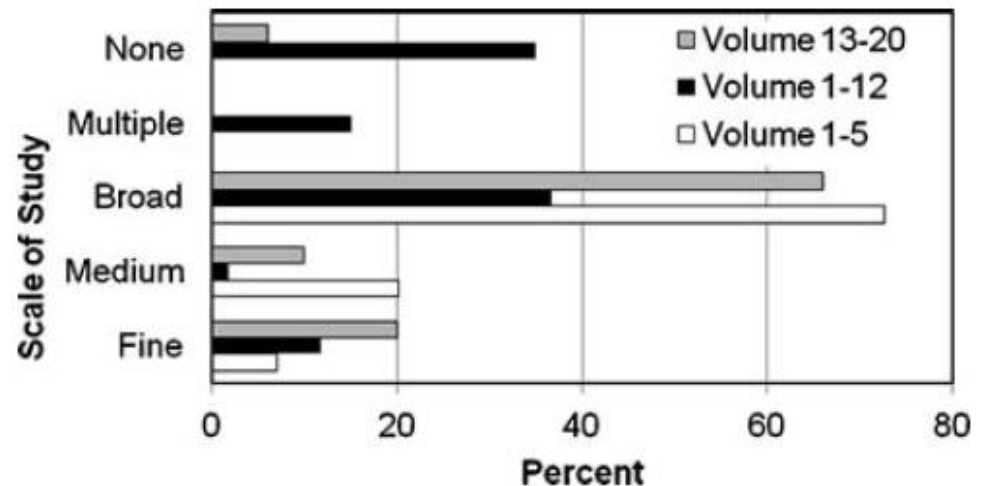
3. Trabalha com uma escala mais ampla

Research in the journal *Landscape Ecology*, 1987–2005

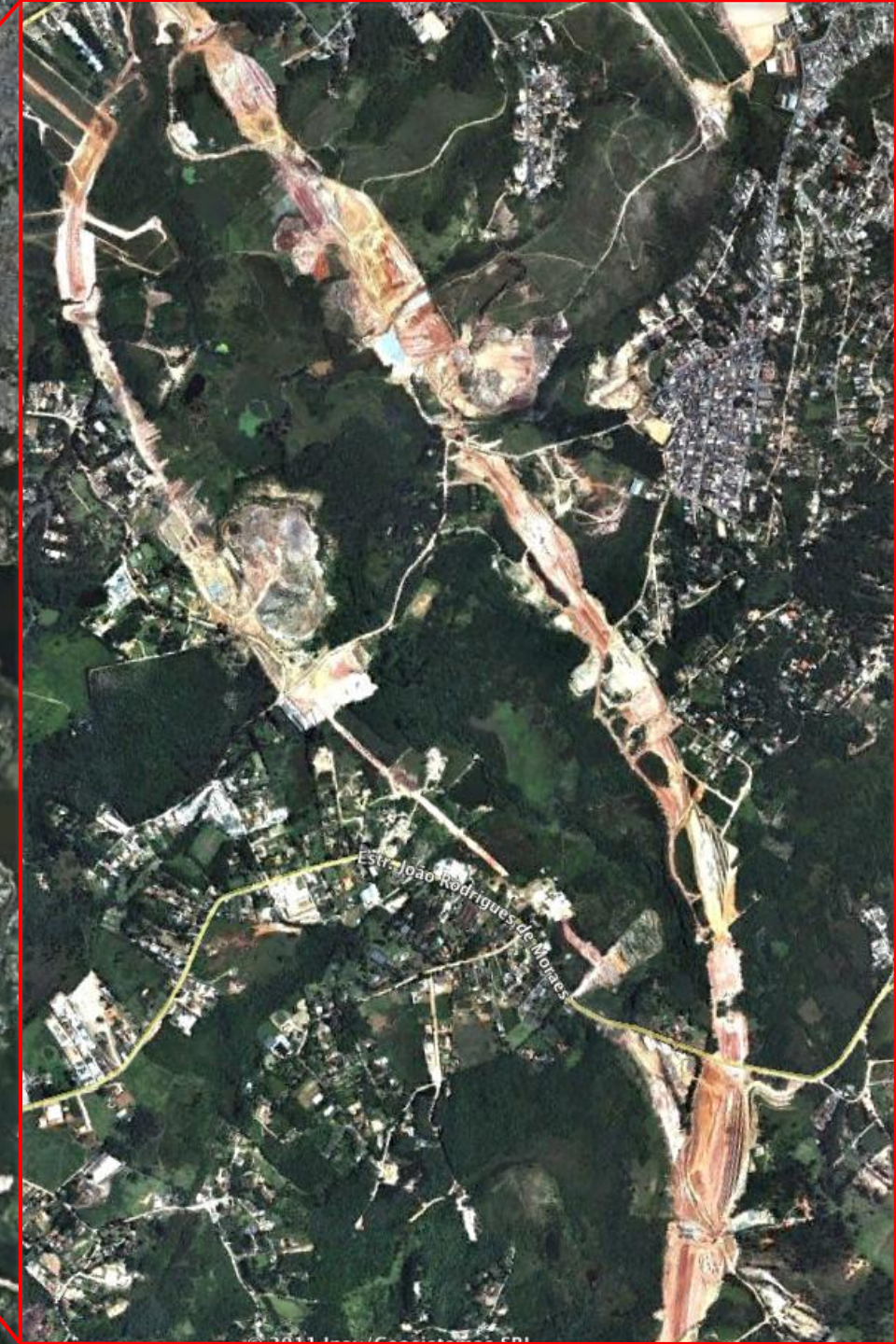
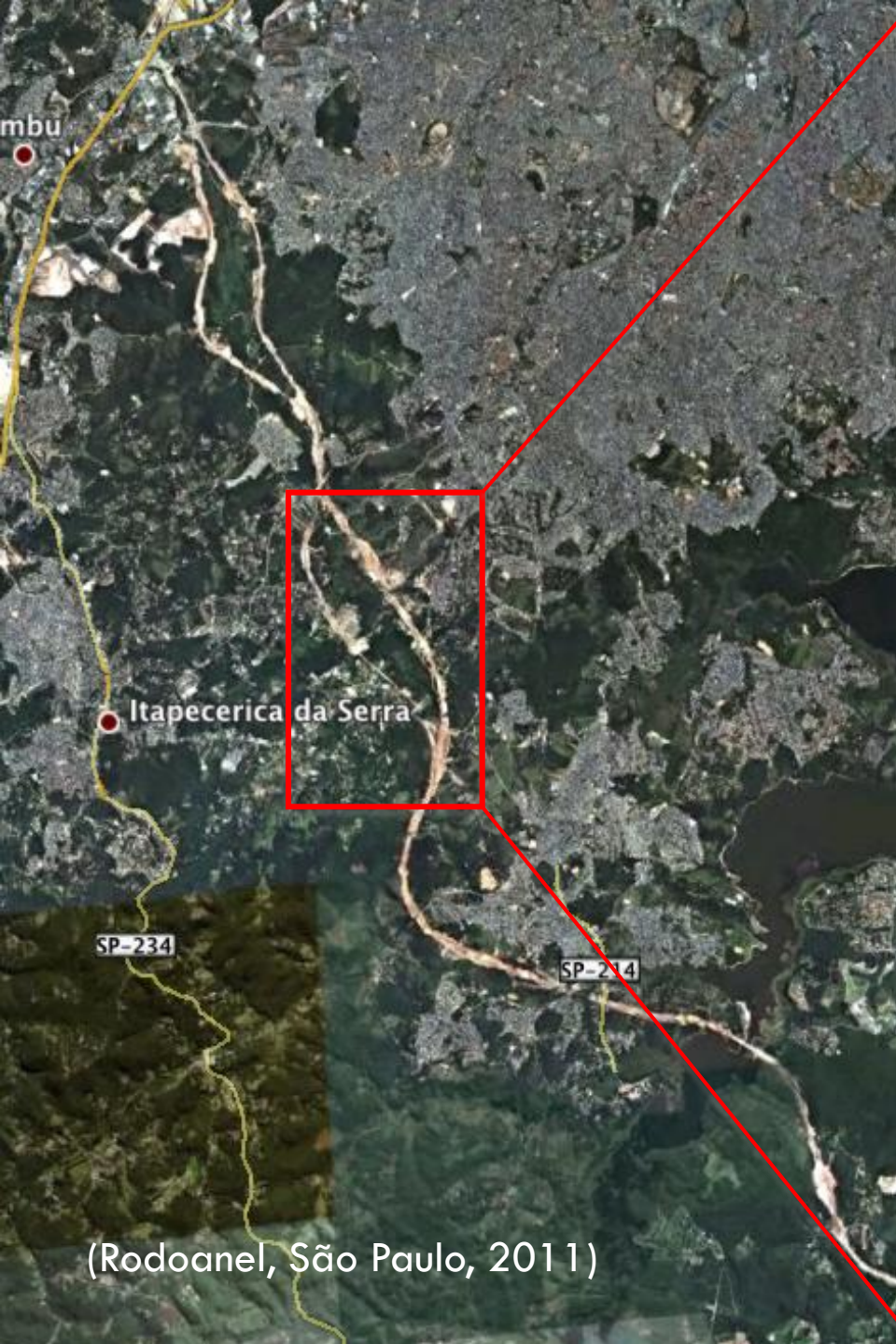
Barbara J. Andersen

Scale of study

- Fine (m^2) [i.e., <1 ha]
- Medium (ha) [1-100 ha]
- Broad ($ha\text{-}km^2$) [>100 ha]
- Multiple scales



(Andersen 2008)



(Rodoanel, São Paulo, 2011)

(Nova Friburgo, 2011)

ANTES



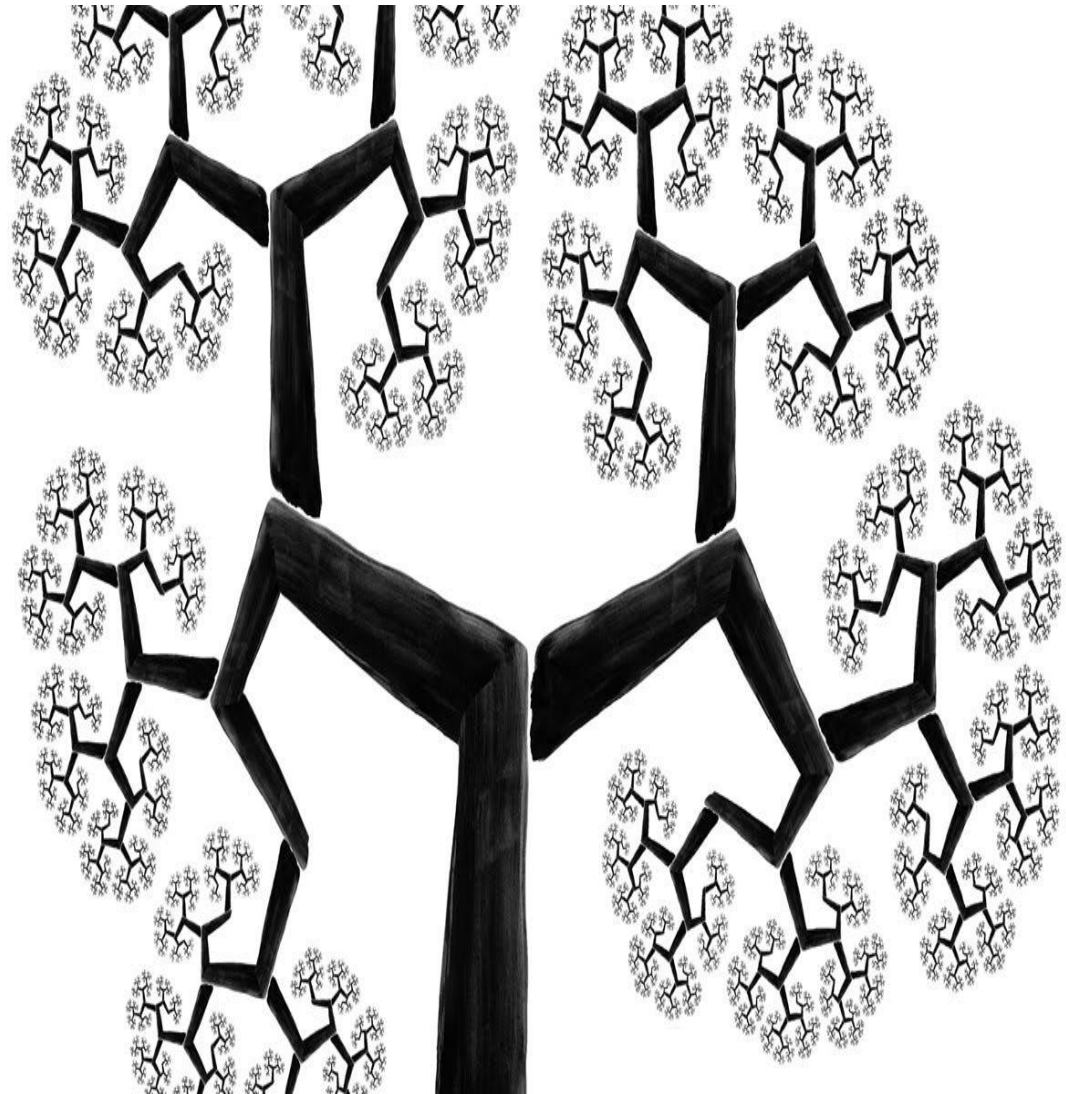
(Nova Friburgo, 2011)

DEPOIS



4. Considera múltiplas escalas

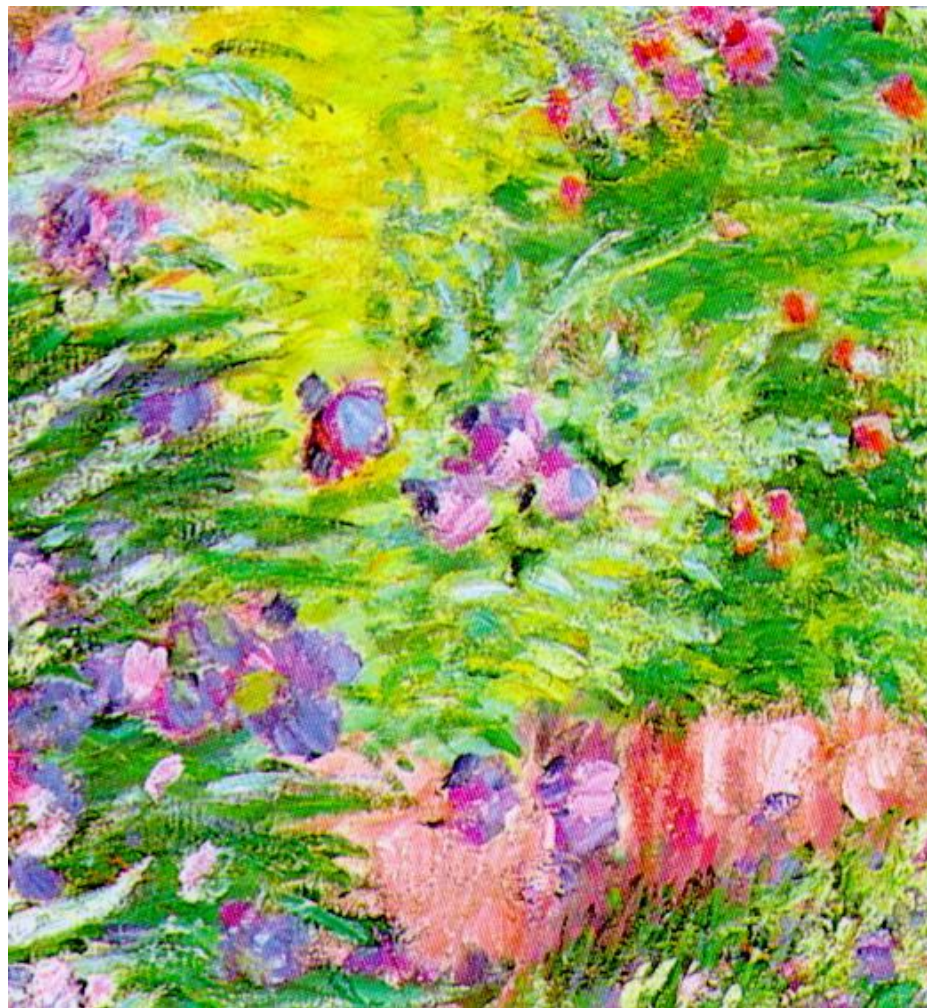
Qual é a escala adequada para analisar as relações entre padrões espaciais e processos ecológicos?



4. Considera múltiples escalas



4. Considera múltiples escalas



4. Considera múltiples escalas

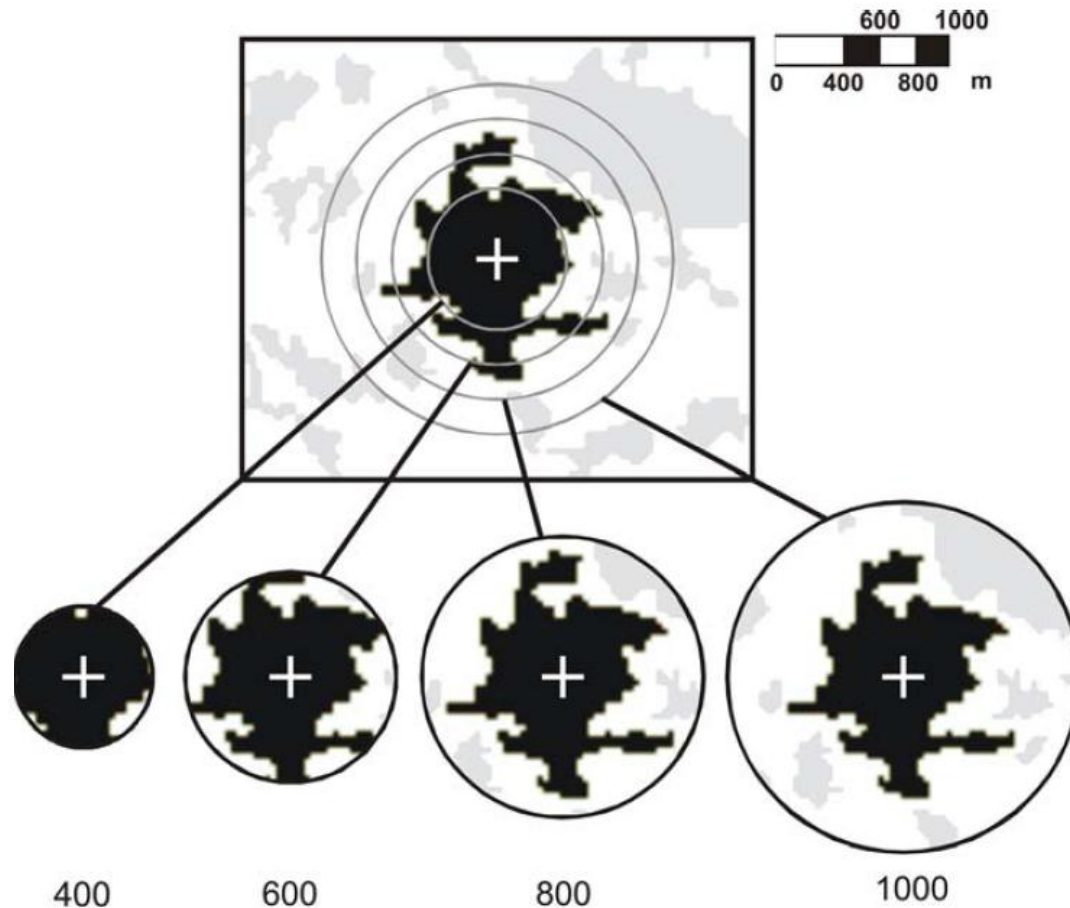


Que animal é esse?



Is bird incidence in Atlantic forest fragments influenced by landscape patterns at multiple scales?

Danilo Boscolo · Jean P. Metzger



Regressões logísticas

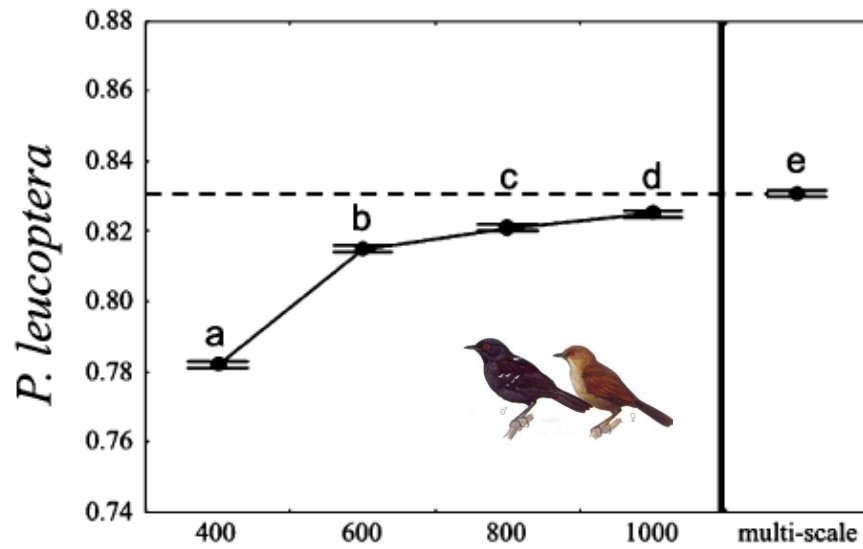
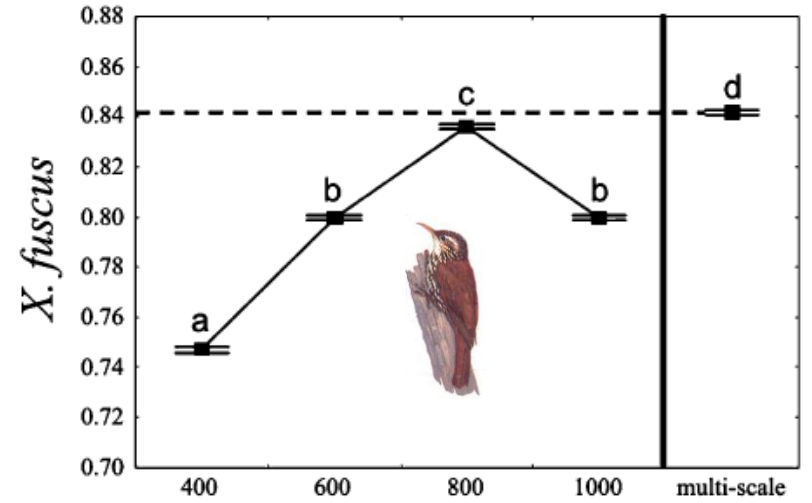
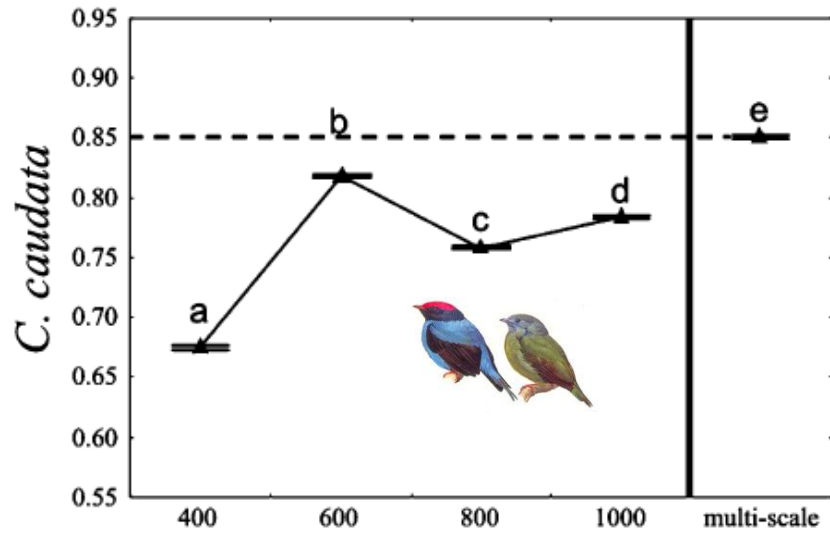
Sorteios com
reposição

60 pontos
X
1000 repetições

poder explanatório

R^2

poder explanatório (AUC)



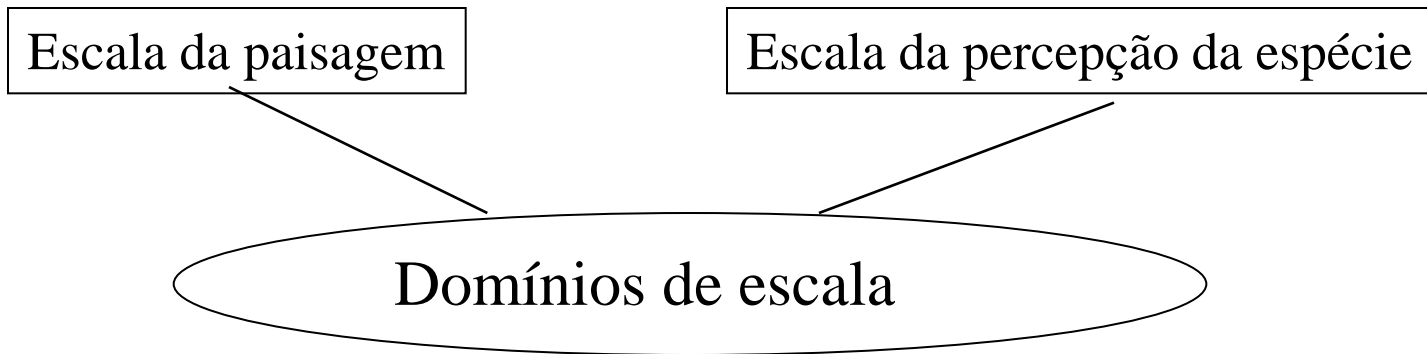
escala

(Boscolo & Metzger 2009)

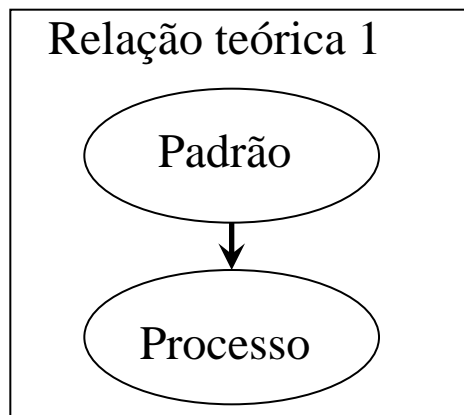
Duas questões básicas

- ✍ Existe uma escala espacial e temporal determinada para cada processo ecológico ou para cada espécie ?;
- ✍ É possível transpor resultados obtidos numa escala pontual para uma escala global ?

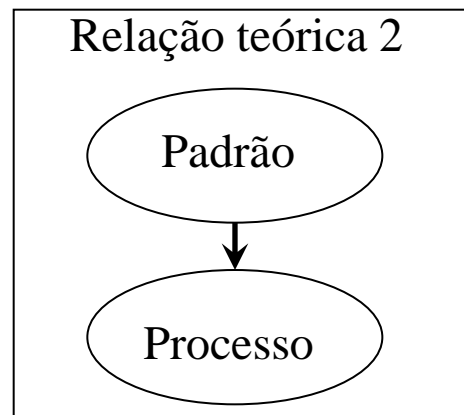
Domínios de escala e transmutação



Domínio de escala 1

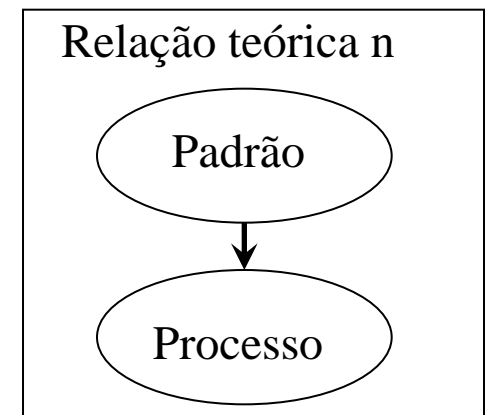


Domínio de escala 2



.....

Domínio de escala n



5. É beneficiado por avanços tecnológicos

□ Escola Européia



1958

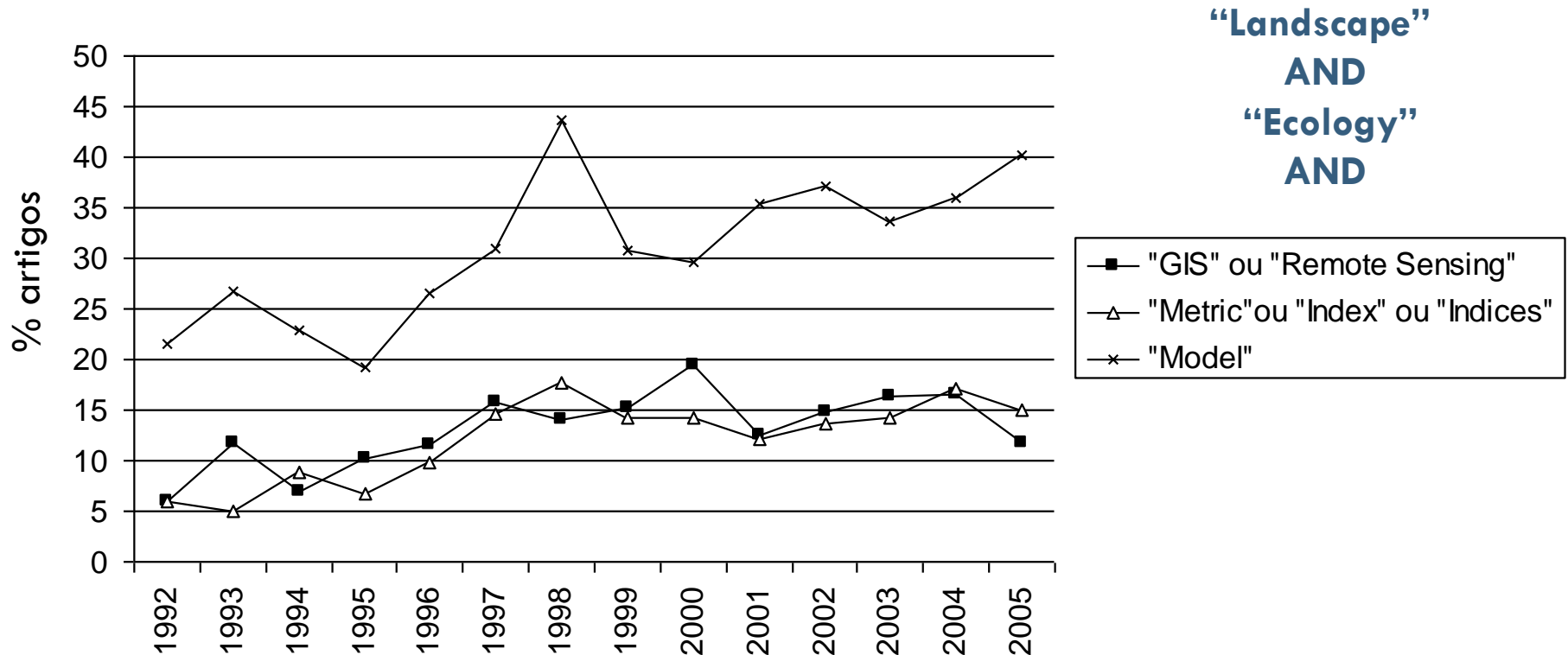
□ Escola Norte-



2008

Cidade Universitária

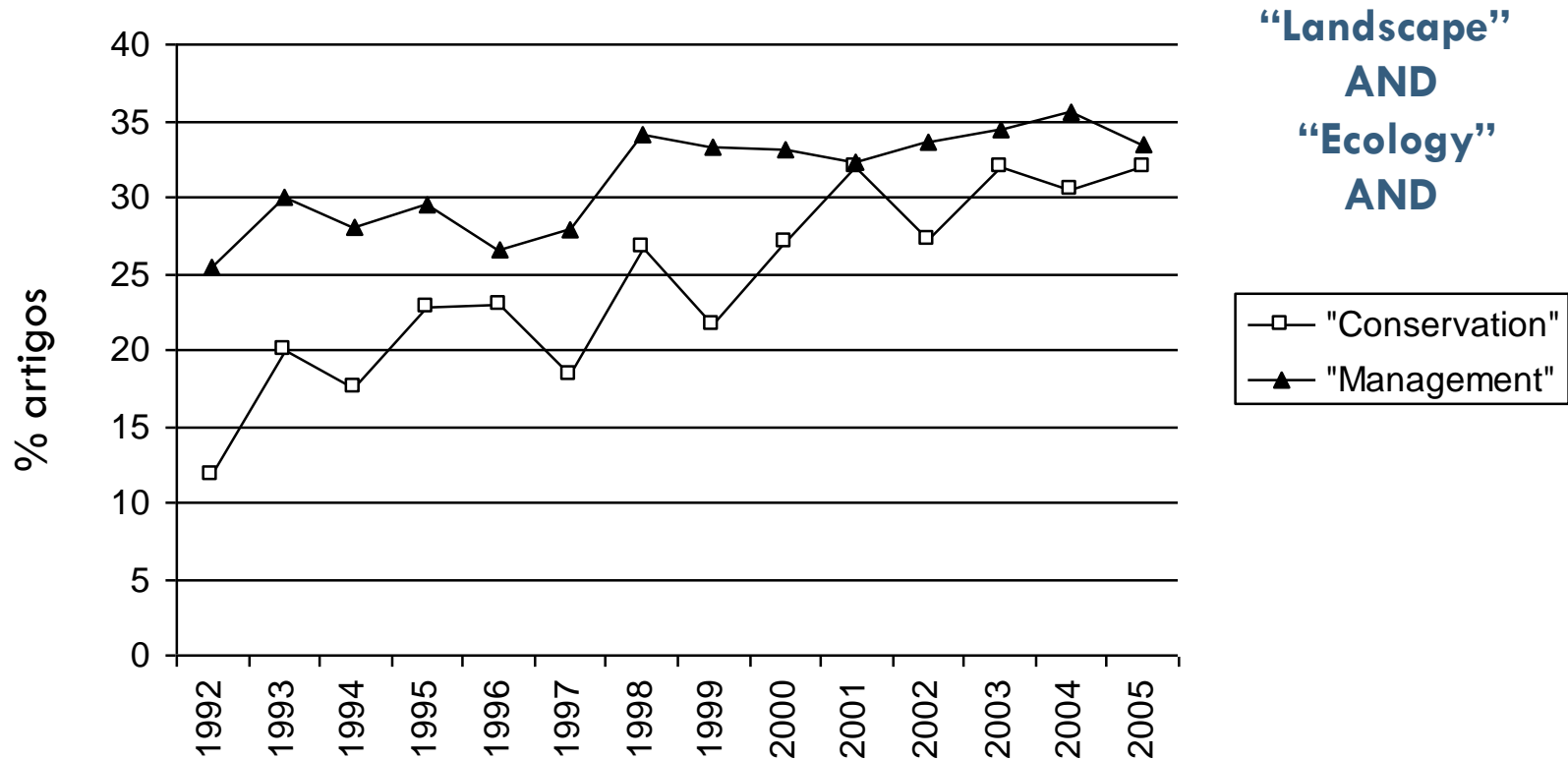
5. É beneficiado por avanços tecnológicos



% artigos em Ecologia de Paisagens na *Web of Science* (1992 – 2005)

(Metzger, 2006)

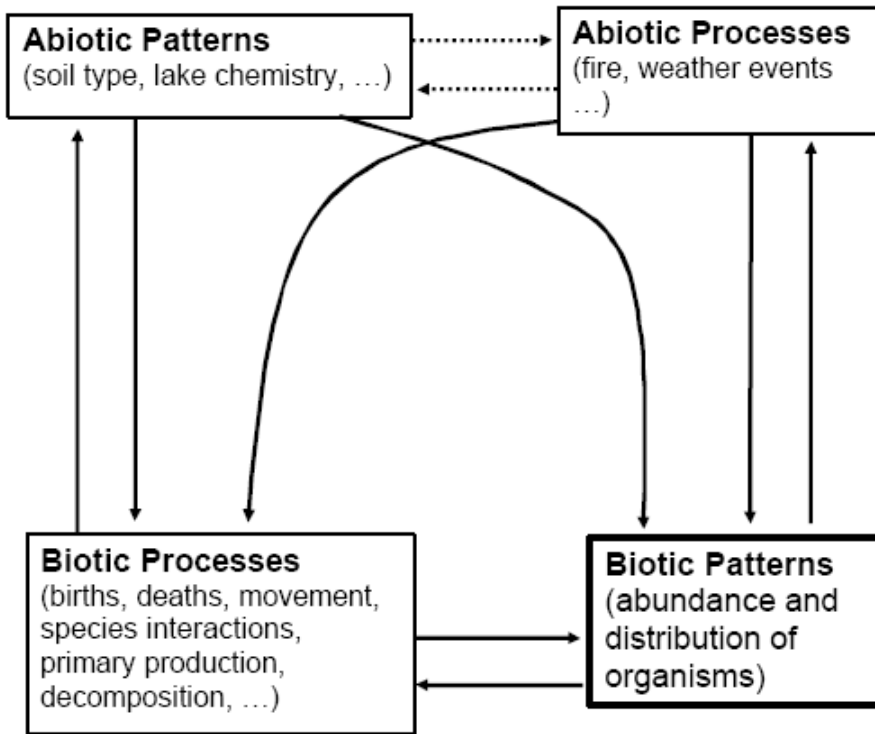
6. É uma ecologia com alto potencial de aplicação



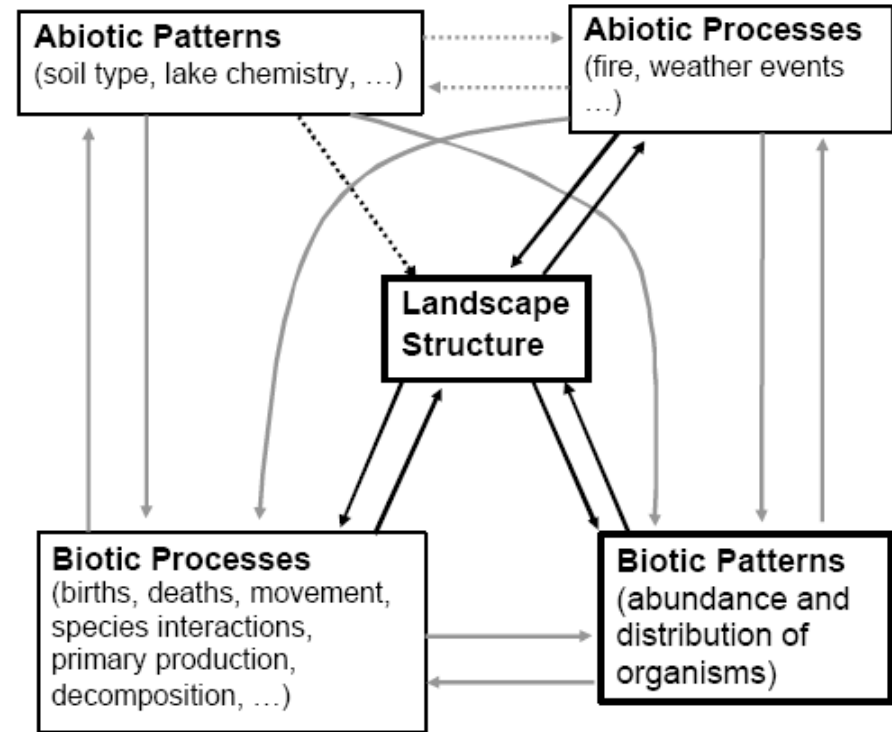
% artigos em Ecologia de Paisagens na *Web of Science* (1992 – 2005)

(Metzger, 2006)

Ecologia



Ecologia de Paisagens



(Fahrig 2005)

A Ecologia de Paisagens pode ser entendida como uma sub-disciplina da Ecologia

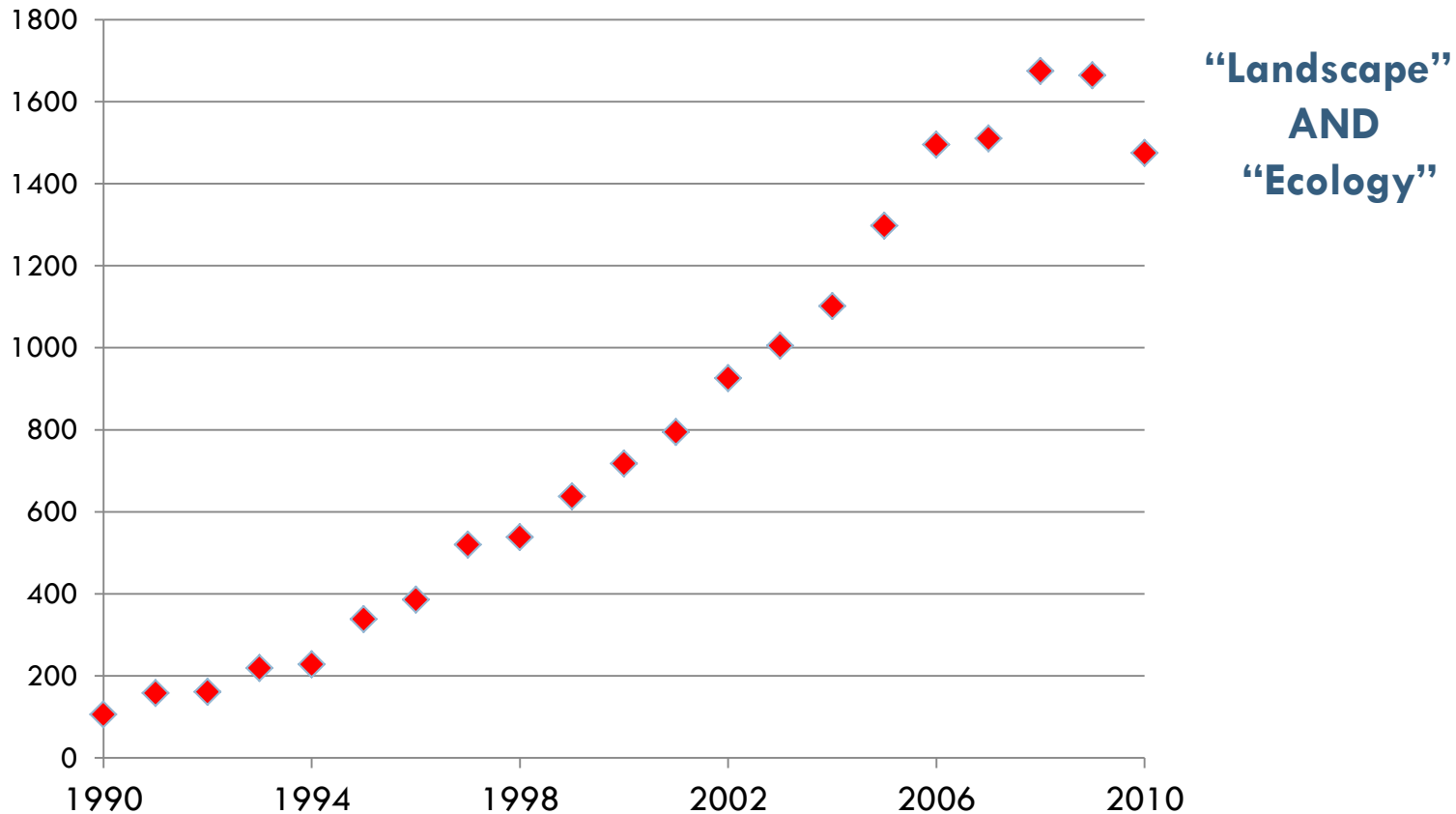
Perspectiva da Ecologia da Paisagem

- A ecologia da paisagem está promovendo uma **mudança de paradigma** na pesquisa em ecologia na medida que ela está deixando claro que o **padrão espacial** e a **escala** de análise importa e que as pesquisas não podem mais ignorar isso de agora em diante.



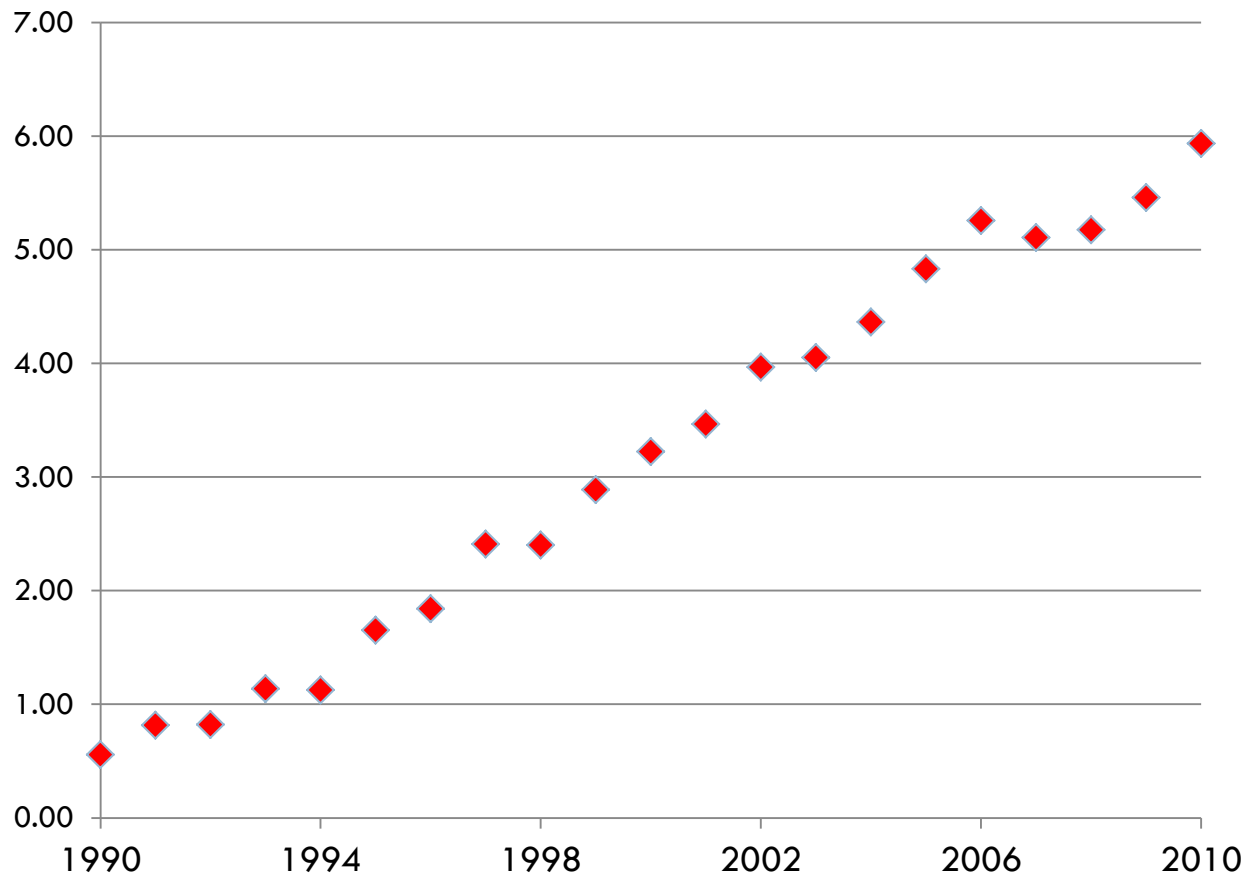
Crescimento da disciplina

□ Número de artigos *ISI Web of Science* (1990-2010)



Crescimento da disciplina

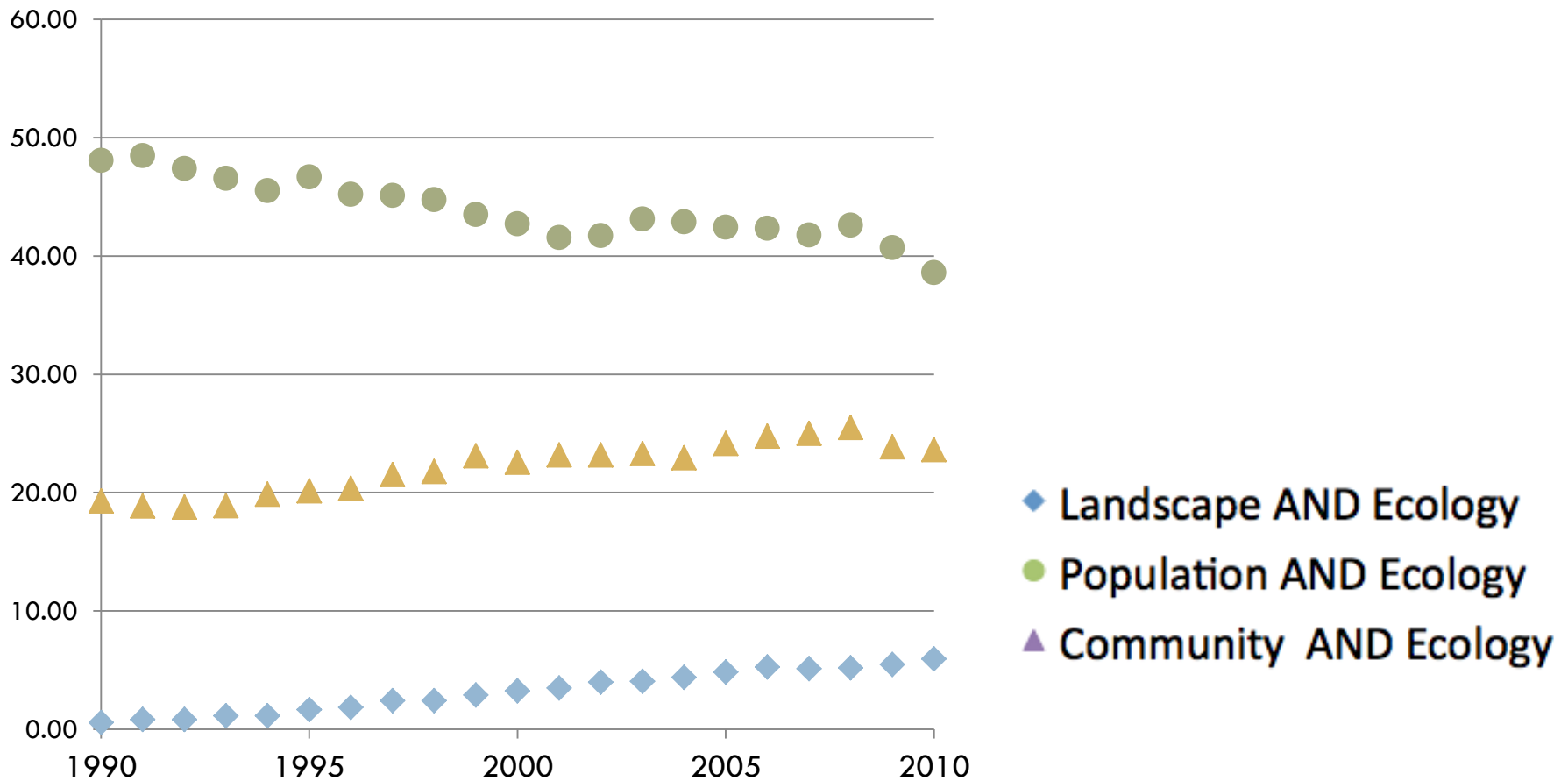
□ % de artigos de Ecologia *ISI Web of Science* (1990-2010)



**“Landscape”
AND
“Ecology”**

Crescimento da disciplina

□ % de artigos de Ecologia ISI Web of Science (1990-2010)



A expansão no Brasil



Helmut Troppmair
UNESP – Rio Claro

Universidade de Bohn
1969



Felisberto Cavaleiro
USP– FFLCH

Universidade de Hannover
1981



Maria Luiza Porto
UFRGS

Universidade de Ulm
1981

A expansão no Brasil

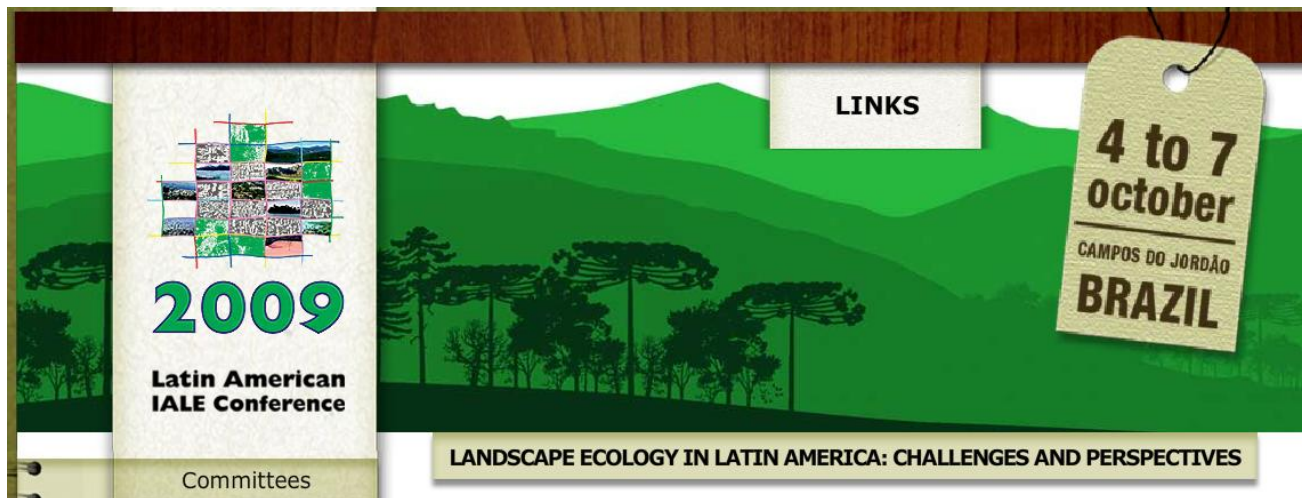


1995



1996

A expansão no Brasil



- IALE – LA 2009: > 300 participantes
- IALE-BR – 2012 : ~ 260 participantes
- IALE-BR: ca. 130 associados
- Novos concursos para professores: UFGRS, UFRN, UnB, UFMG, UNESP, UFSCAR, UFBA

➔ Grande potencial de expansão



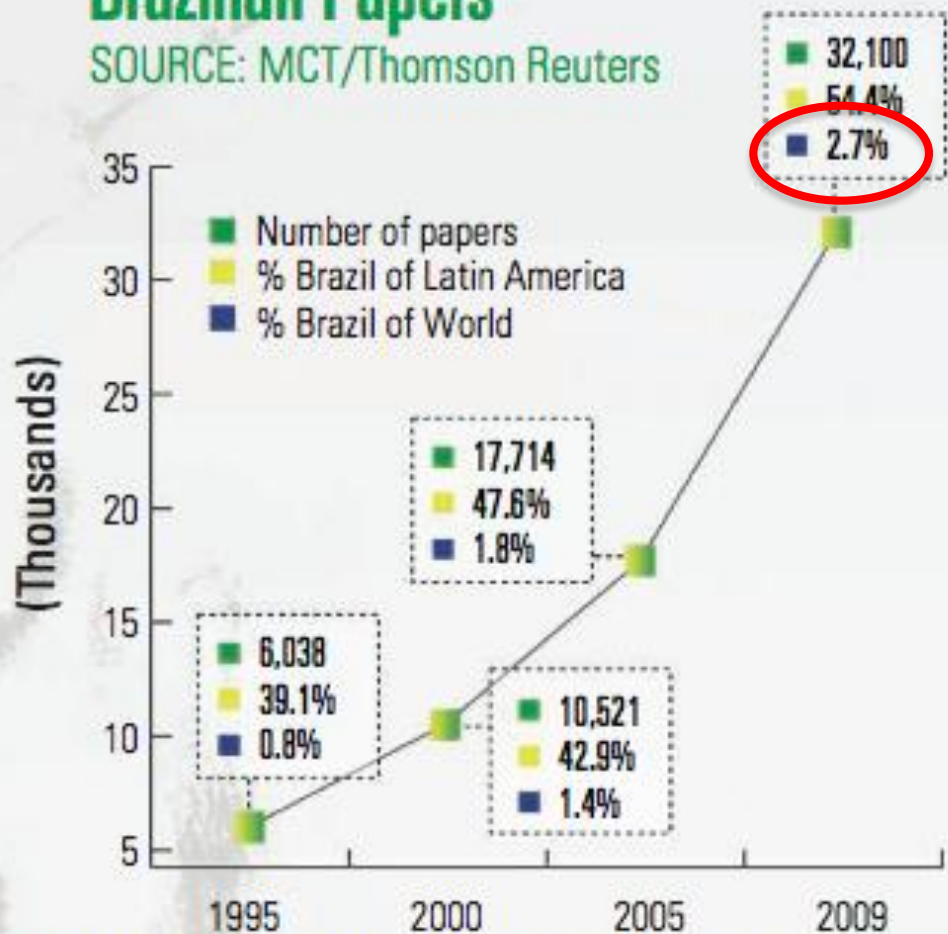
Brazilian Science: Riding a Gusher

A fast-growing economy and oil discoveries are propelling Brazil's research to new heights. But scientific leaders must overcome a weak education system and a low-impact track record

AP Photo/Mark 16/2011

Brazilian Papers

SOURCE: MCT/Thomson Reuters



2009 figure elevated due to increase in number of indexed journals

**Contribuição
para Ecologia
de Paisagens
(# de
documentos no
ISI Web of
Science
2001-2010)**

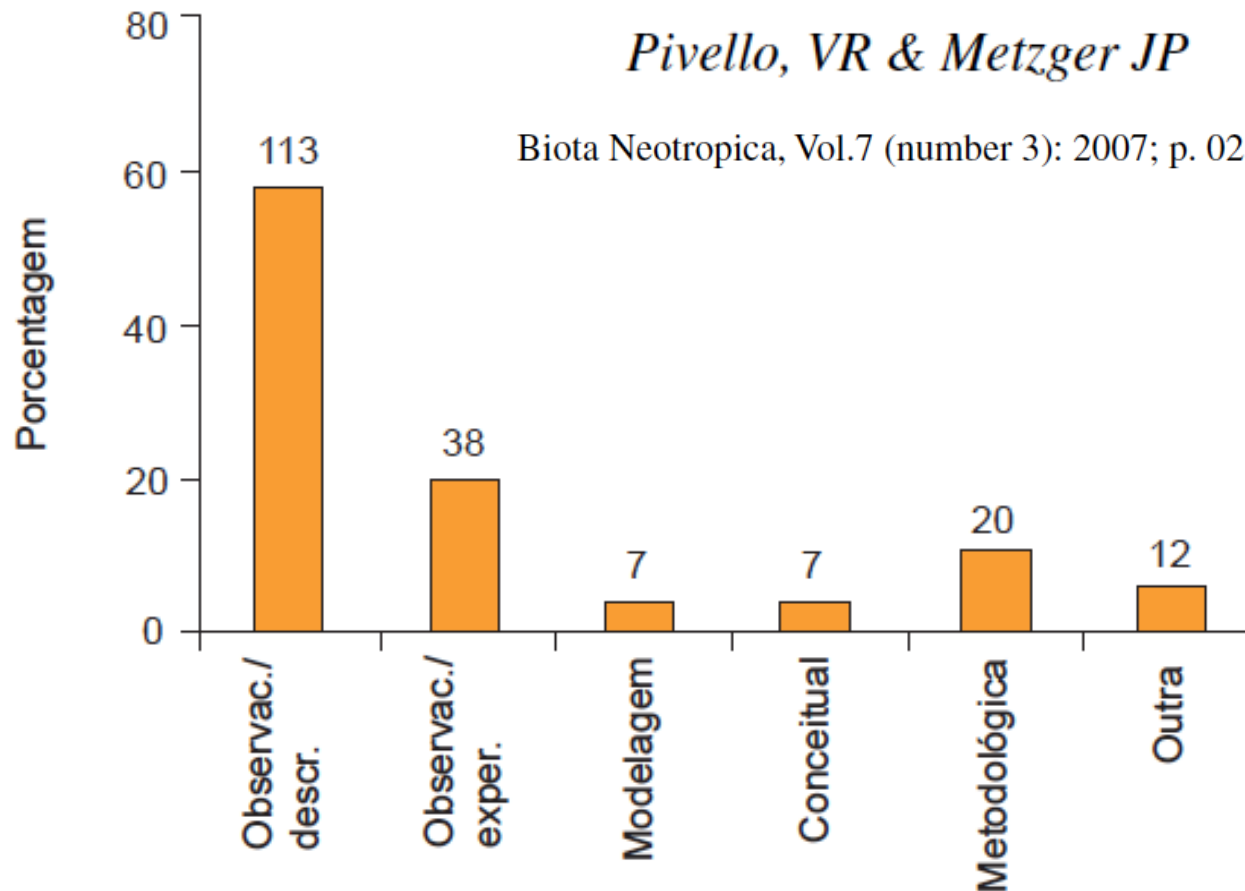
	PAÍS	2001-2010	CONTRIBUIÇÃO (%)
	TOTAL	12948	
1	USA	4785	36,96
2	Canada	1069	8,26
3	UK	1011	7,81
4	Australia	946	7,31
5	Germany	906	7,00
6	France	572	4,42
7	Spain	487	3,76
8	China	398	3,07
9	Poland	353	2,73
10	Sweden	352	2,72
11	Brazil	329	2,54
12	Netherlands	316	2,44
13	Finland	314	2,43
14	Switzerland	304	2,35
15	Italy	301	2,32

A expansão no Brasil

Diagnóstico da pesquisa em ecologia de paisagens no Brasil (2000-2005)

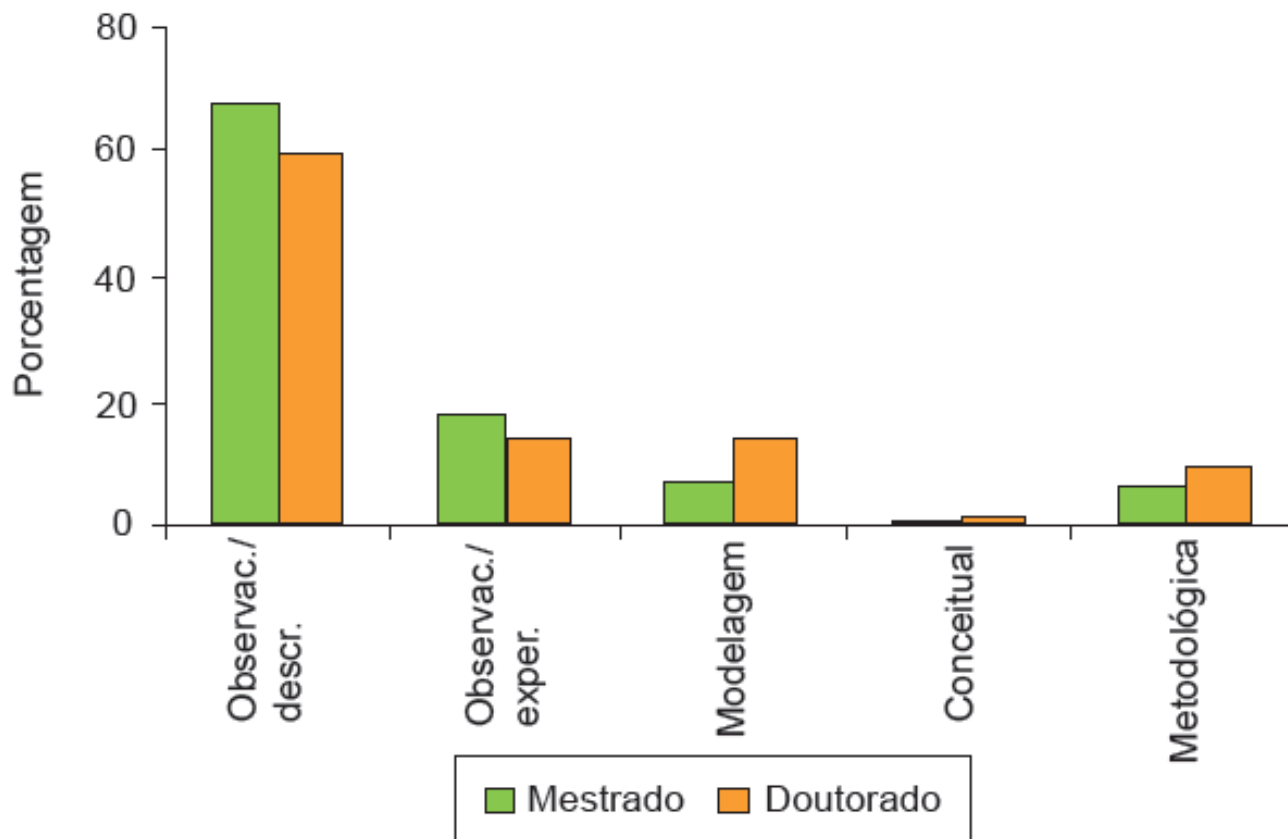
Pivello, VR & Metzger JP

Biota Neotropica, Vol.7 (number 3): 2007; p. 021-029.



Diagnóstico da pesquisa em ecologia de paisagens no Brasil (2000-2005)

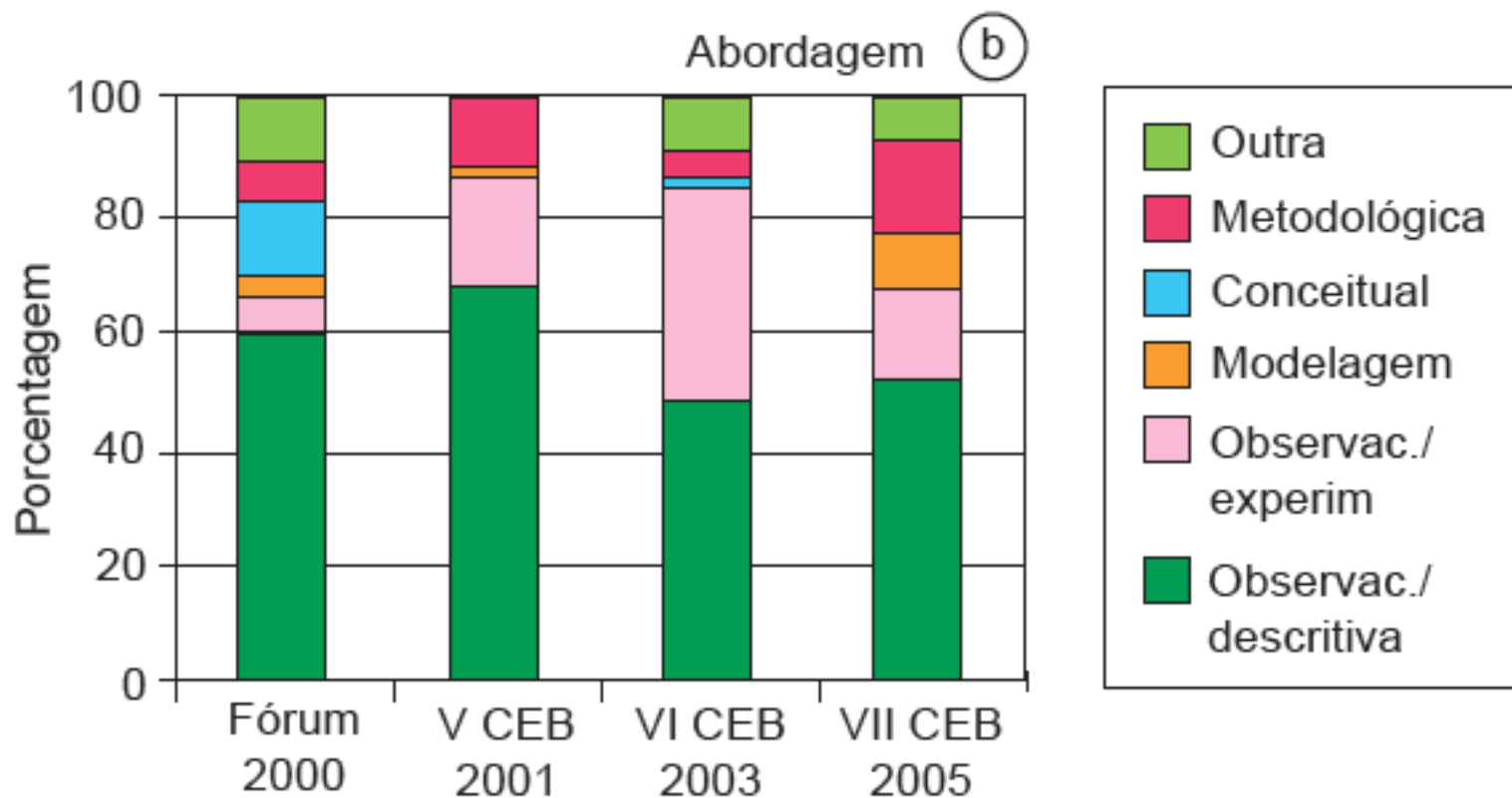
Pivello, VR & Metzger JP



Diagnóstico da pesquisa em ecologia de paisagens no Brasil (2000-2005)

Pivello, VR & Metzger JP

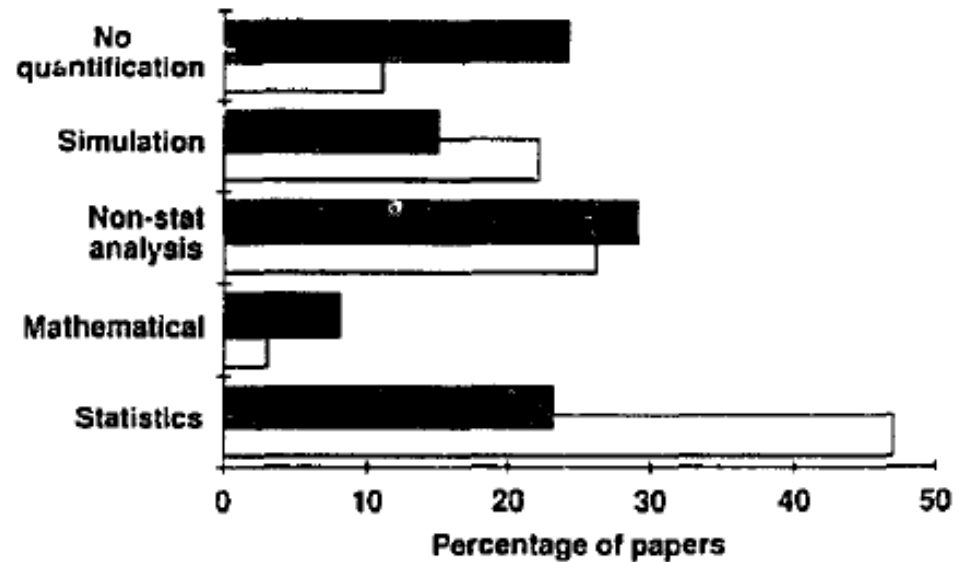
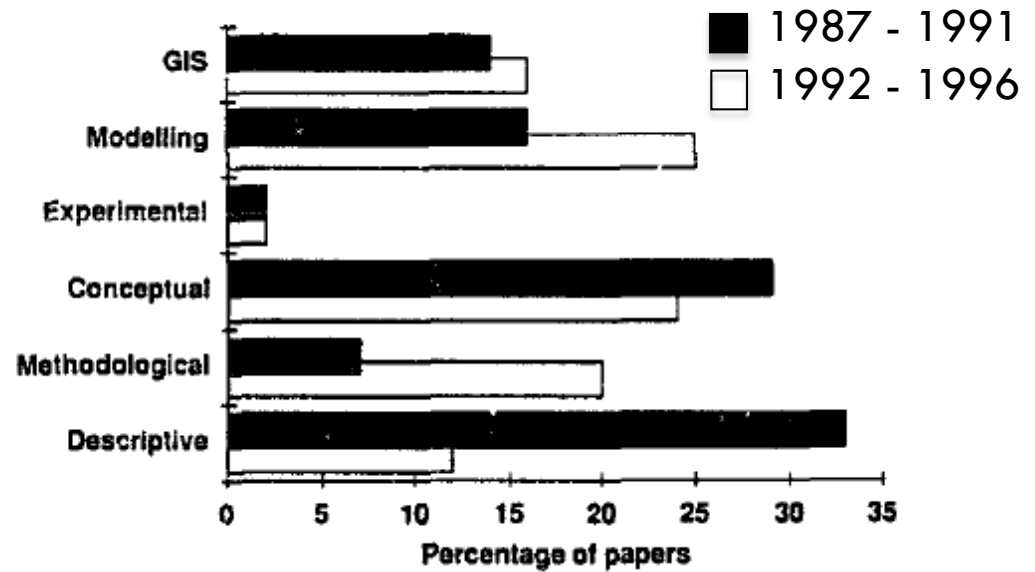
Resumos em reuniões científicas



Future landscapes and the future of landscape ecology

Richard Hobbs

Landscape and Urban Planning
1997



Observação 1

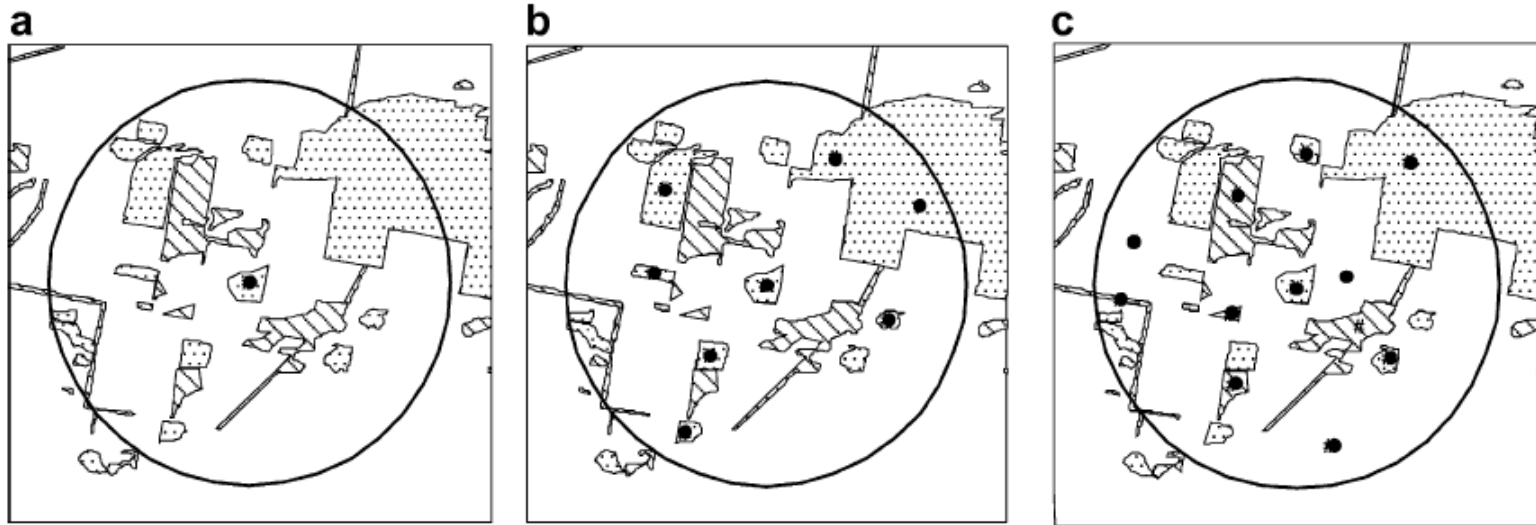
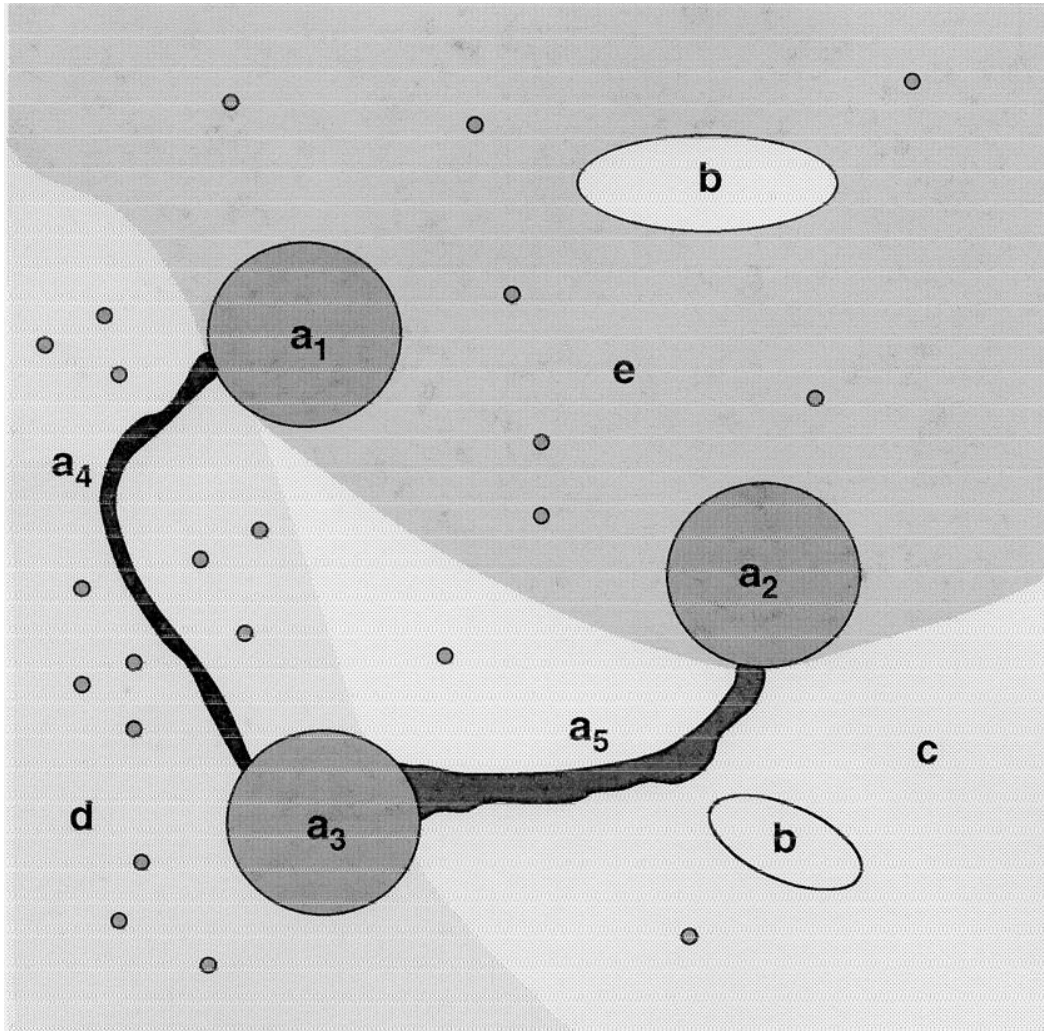


Fig. 1 – Comparison of sampling approaches to study the effects of mosaic properties on biota. (a) Patch-level sampling with the biota sampled in a single patch. The attributes of the surrounding mosaic may be measured as context for the patch. (b) Mosaic-level sampling with multiple sample points in a single type of patch. (c) Mosaic-level sampling with sample points in multiple types of patches.

(Bennett et al. 2006)

Conceito de patch-corridor-matriz



Numa determinada escala:

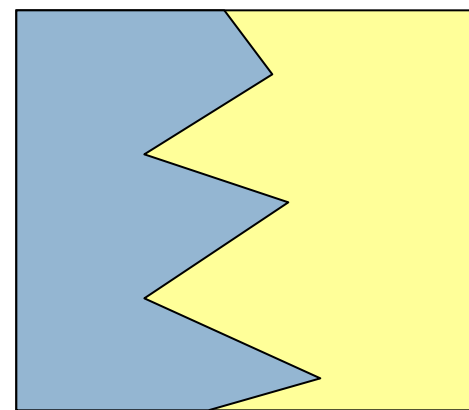
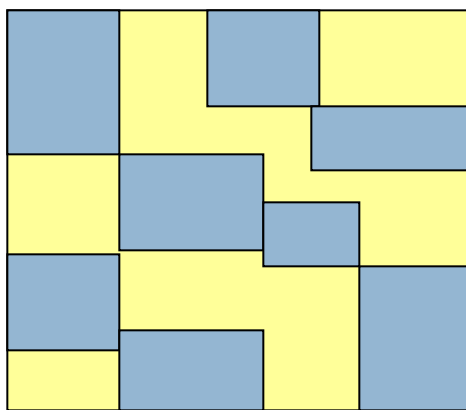
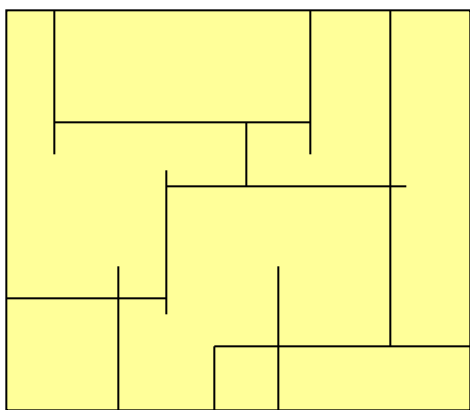
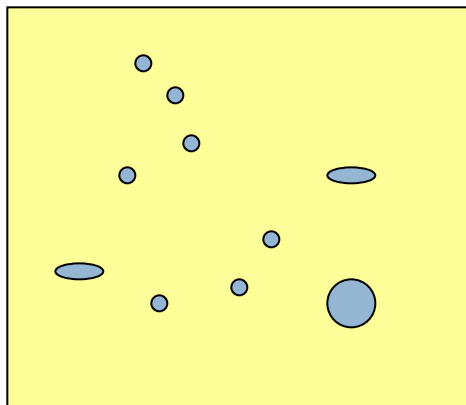
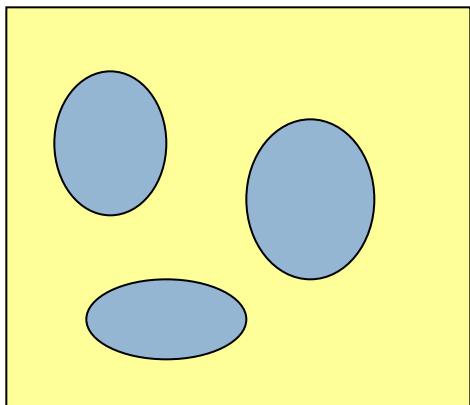
Mancha. Área homogênea, restrita e não-linear da paisagem que se distingue das unidades vizinhas.

Corredor. Área homogênea e linear da paisagem que se distingue das unidades vizinhas.

Matriz. Unidade dominante da paisagem (espacial e funcionalmente);
ou conjunto de unidades de não-habitat.

“Tipos” de paisagem

Modelo de mancha-corridor-matriz

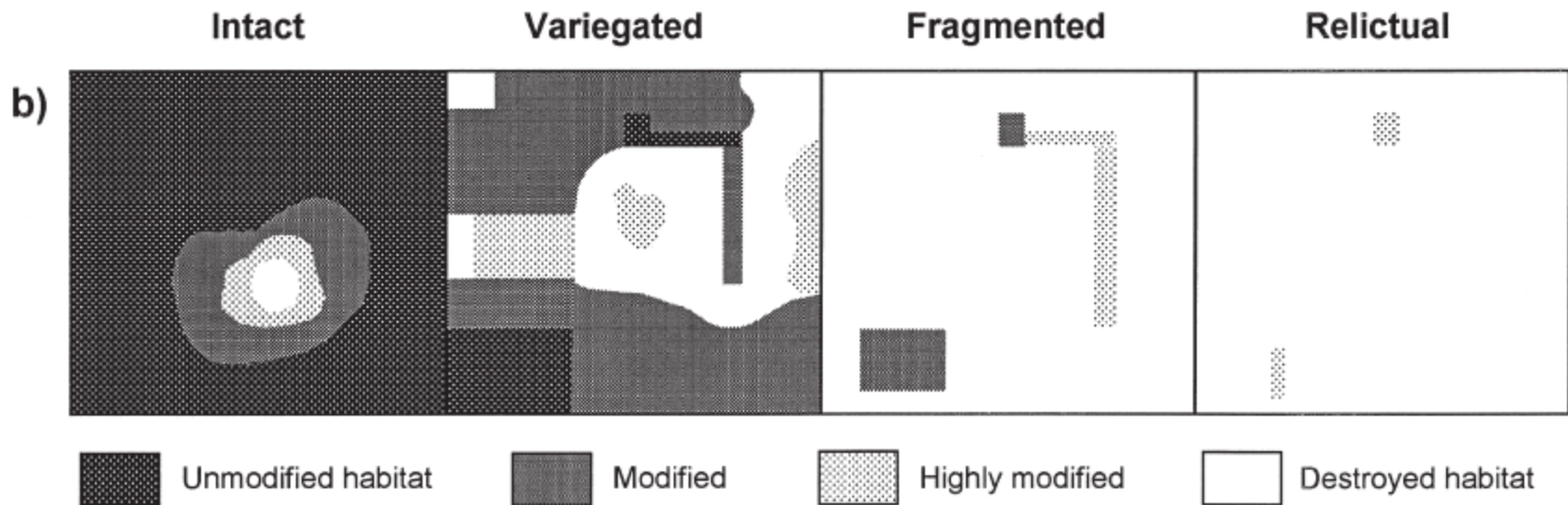
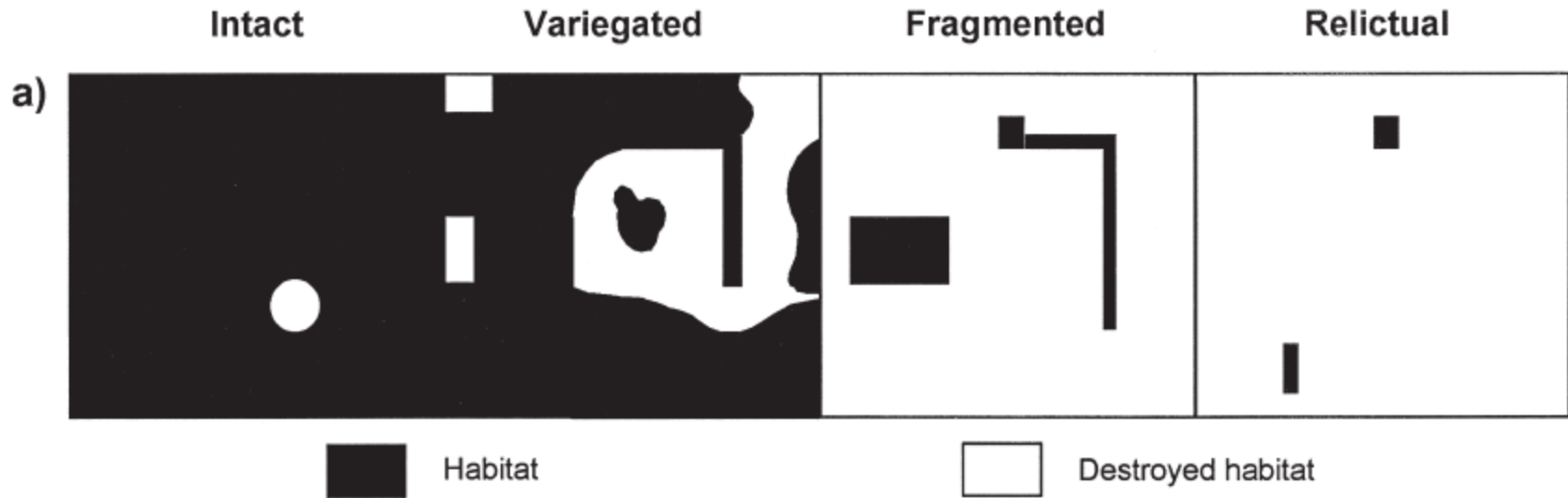


Padrão → Características Funcionais



*Figure 1. Patterns of landscape alteration in southwestern Western Australia seen as gross effects of human activities on tree distribution: (a) intact *Eucalyptus marginata* forest; (b) *E. marginata* forest partially cleared for grazing, representing a variegated landscape; (c) fragmented woodland of mixed eucalypt species, mostly cleared for cropping and grazing; (d) relictual mixed eucalypt woodland heavily cleared for cropping and grazing. Photos by R. Hobbs.*

(McIntyre & Hobbs 1999)



(McIntyre & Hobbs 1999)

Continuum model

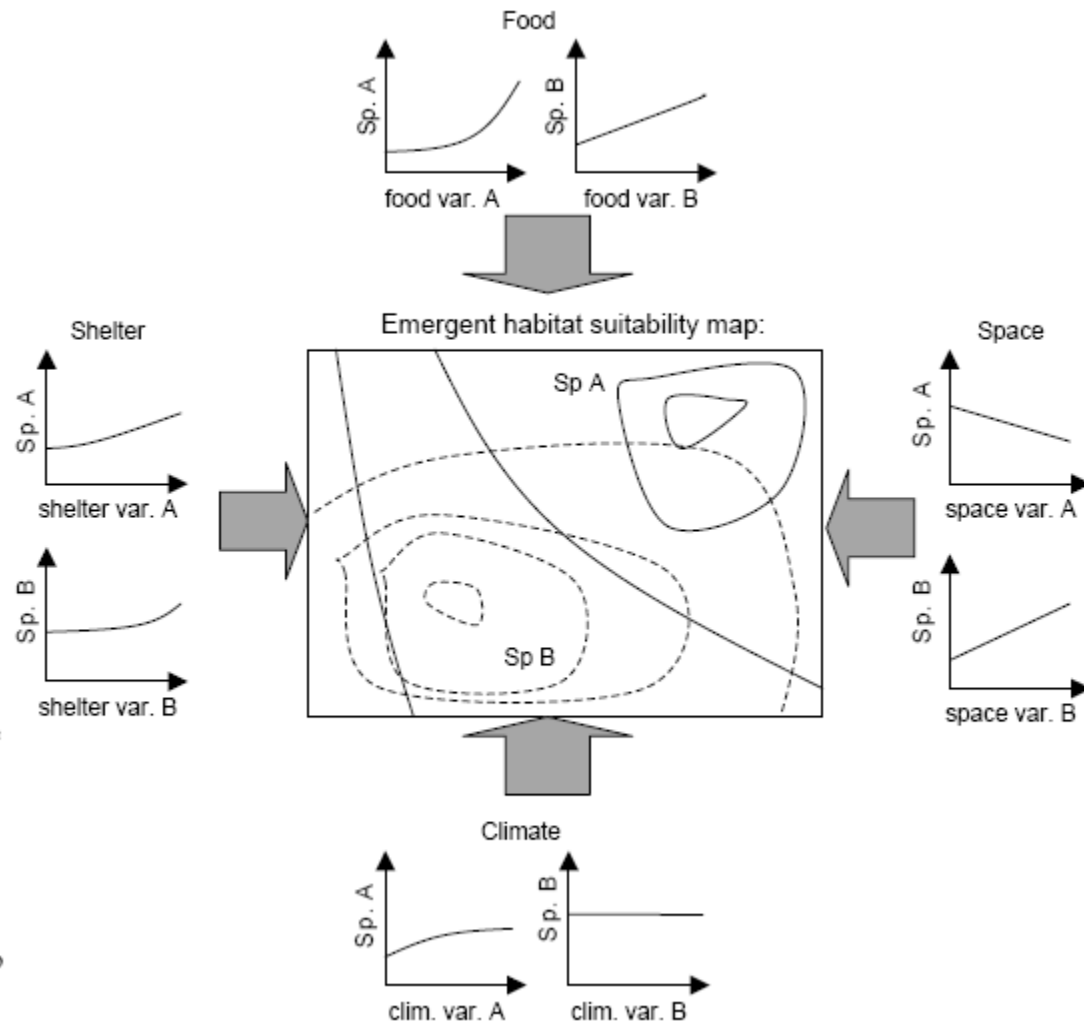
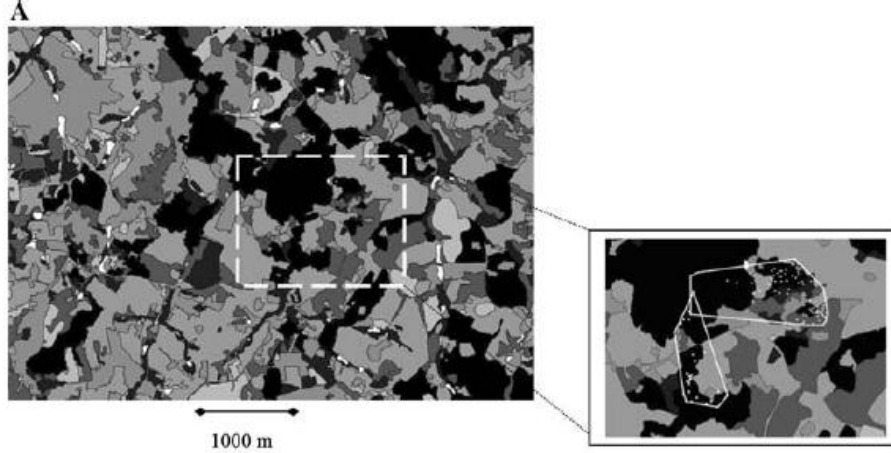


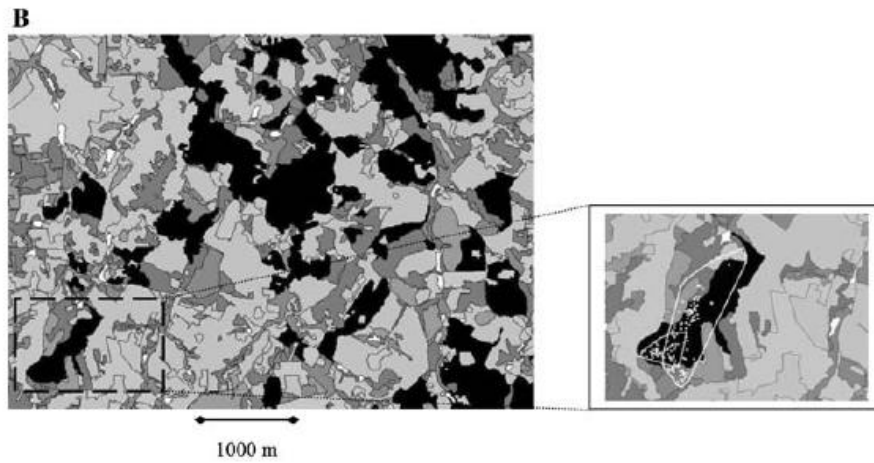
Fig. 1. Schematic summary of the continuum model. Availability of food, shelter, space and suitable climatic conditions are assumed to give rise to patterns of species distribution and abundance (depicted as habitat contour maps). Hypothetical relationships for two species (A, B) are used as examples. Interspecific processes like competition and predation also may influence species distribution patterns.

(Fischer & Lindenmayer 2006)

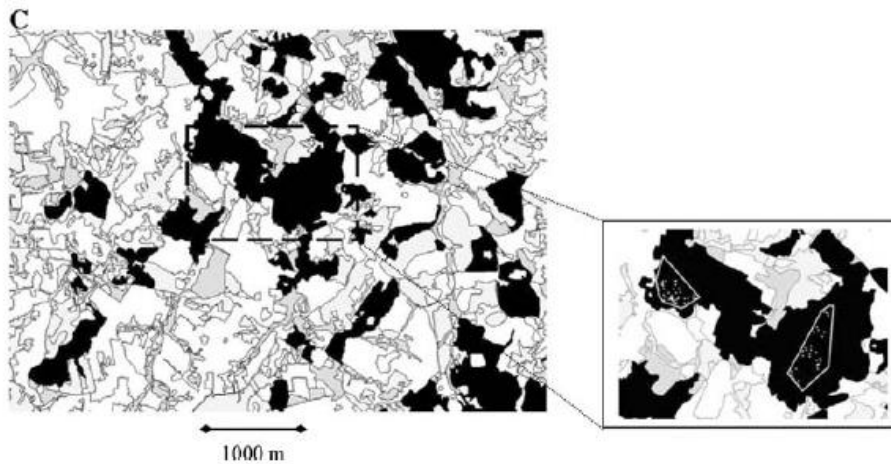
P. leucoptera



C. caudata



S. scansor



*Hansbauer et al. 2009,
Landscape Ecology*

Fragmentation vs Continuum model

	Mancha-Corredor-Matriz	Continuum
Padrão	Assume contraste	Gradiente
Definição	Arbitrária e igual p/ todas spp (<i>habitat</i>)	Spp por Spp
Ênfase	Habitat – Não-habitat	Mosaico
Foco	Padrão espacial	Processo ecológico

(Fischer & Lindenmayer 2006)

Observação 2

Quando a estrutura/perspectiva da paisagem não importa?

Segundo Fahrig (1998), ela não importa quando:

- i) Há muito habitat
- ii) O habitat é efêmero e dinâmico
- iii) O padrão de deslocamento não difere entre as diferentes unidades da paisagem (percepção da heterogeneidade)
- iv) A capacidade de deslocamento da espécie estudada é maior do que a distância entre manchas de habitat (percepção da fragmentação)

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O que é Ecologia de Paisagens

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2. Metzger, J.P. 2001. O que é ecologia de paisagens? Biota Neotropica (<http://www.biotaneotropica.org.br/v1n12>).
3. Turner M.G., Gardner R.H. & O'Neill R.V. 2001. Landscape ecology in theory and practice: pattern and process. Springer, New York.
4. Wiens J. & Moss M. (eds.). 2005. Studies in landscape ecology: issues and perspectives in landscape ecology. Cambridge University Press, Cambridge.
5. Wu, J. & Hobbs, R. (eds). 2007. Key topics in landscape ecology. Cambridge University Press, Cambridge, UK