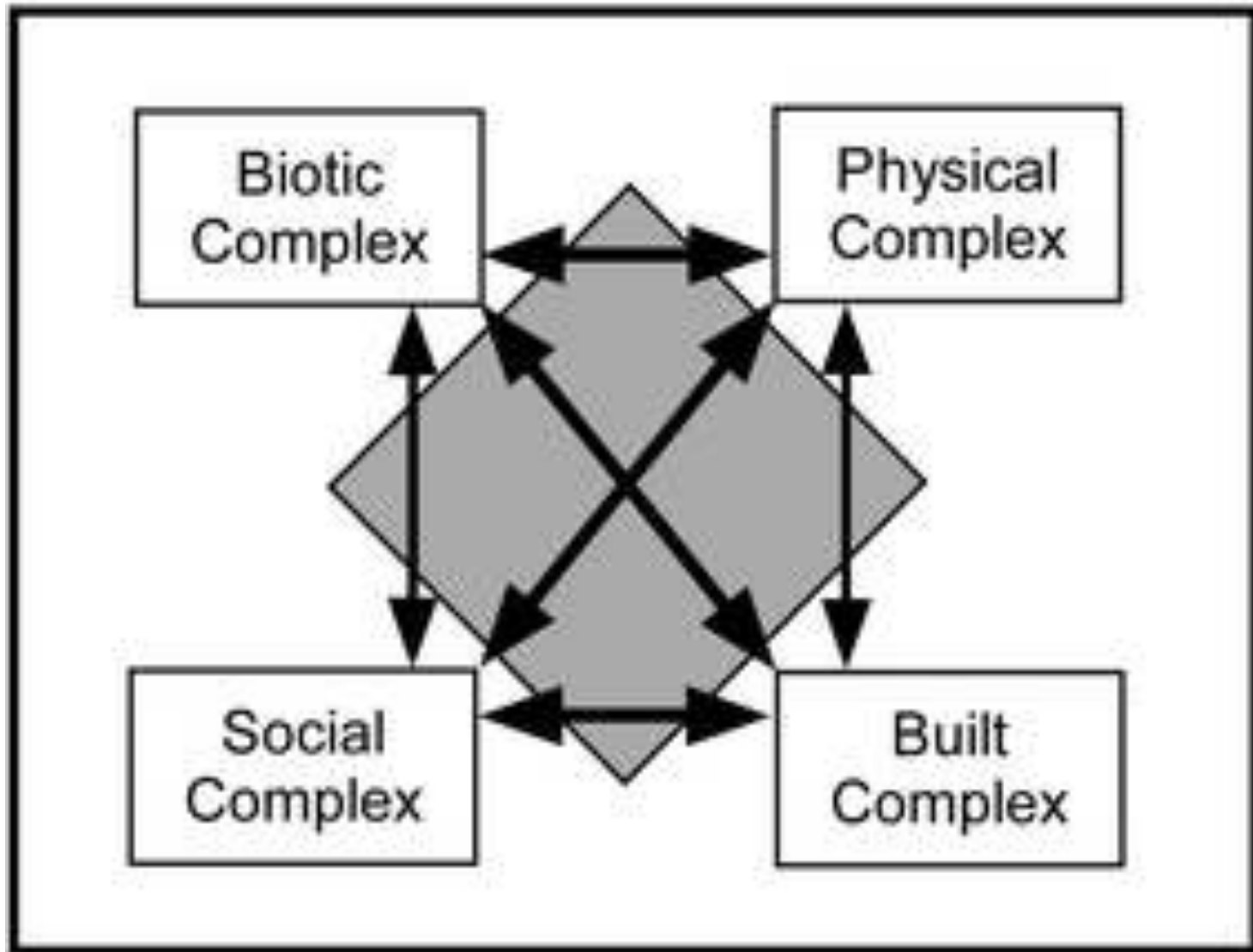


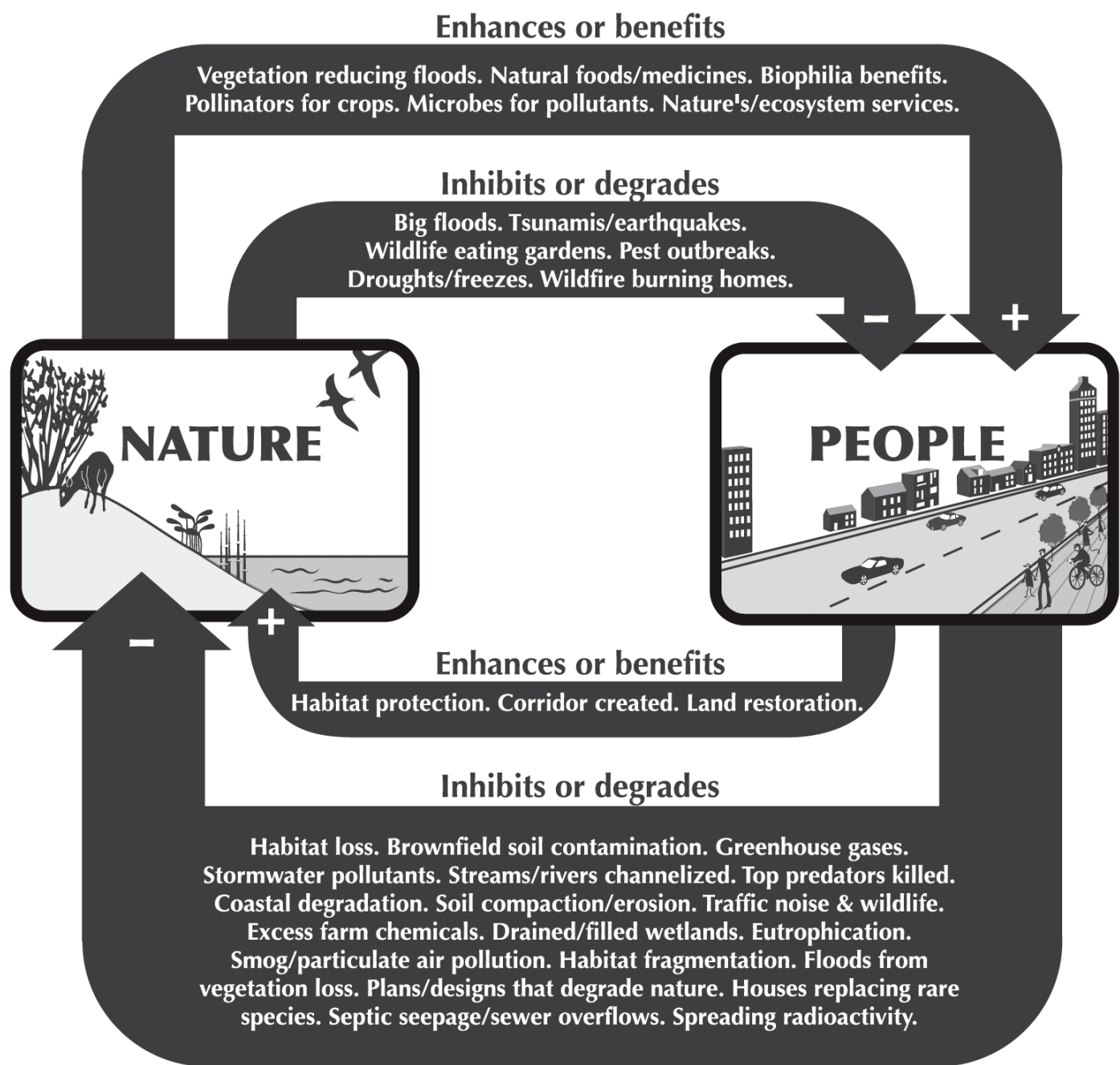
Ecologia Urbana

Aula 3 – Estrutura das áreas urbanas

- Estrutura das áreas urbanas
- Modificações do ambiente natural pela urbanização
- Padrões espaciais
- Fragmentação de habitat
 - Adaptação local
 - Populações pequenas
 - Vantagens => spread of genes promote disease resistance
 - Desvantagens => deriva ecológica

The Urban Ecosystem





Conceito de habitats “urbanos”

- Densidade de população
 - Critério muda entre países
- Densidade ou distância entre edificações
- Cidades ocupam entre 1 e 3% da superfície terrestre, áreas agricultáveis 20%
- Ambientes urbanos são diversos

Organisms as ecosystem engineers

Clive G. Jones, John H. Lawton and Moshe Shachak



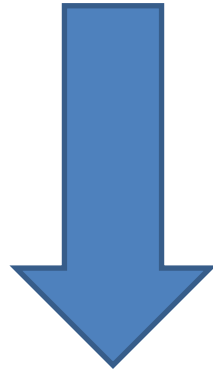
Niche Construction

THE NEGLECTED PROCESS IN EVOLUTION

F. John Odling-Smee, Kevin N. Laland,
and Marcus W. Feldman

MONOGRAPHS IN POPULATION BIOLOGY • 37

Humanos são engenheiros de ecossistemas!



Modificam seu hábitat e seu nicho

Construído

- Paredes e muros
- Edificações
- Áreas pavimentadas
- Ruas
- Manufaturas e indústrias
- Pedreiras e minas

Resíduos

- Campos abandonados
- Aterros sanitários

HÁBITATS URBANOS

Aquático

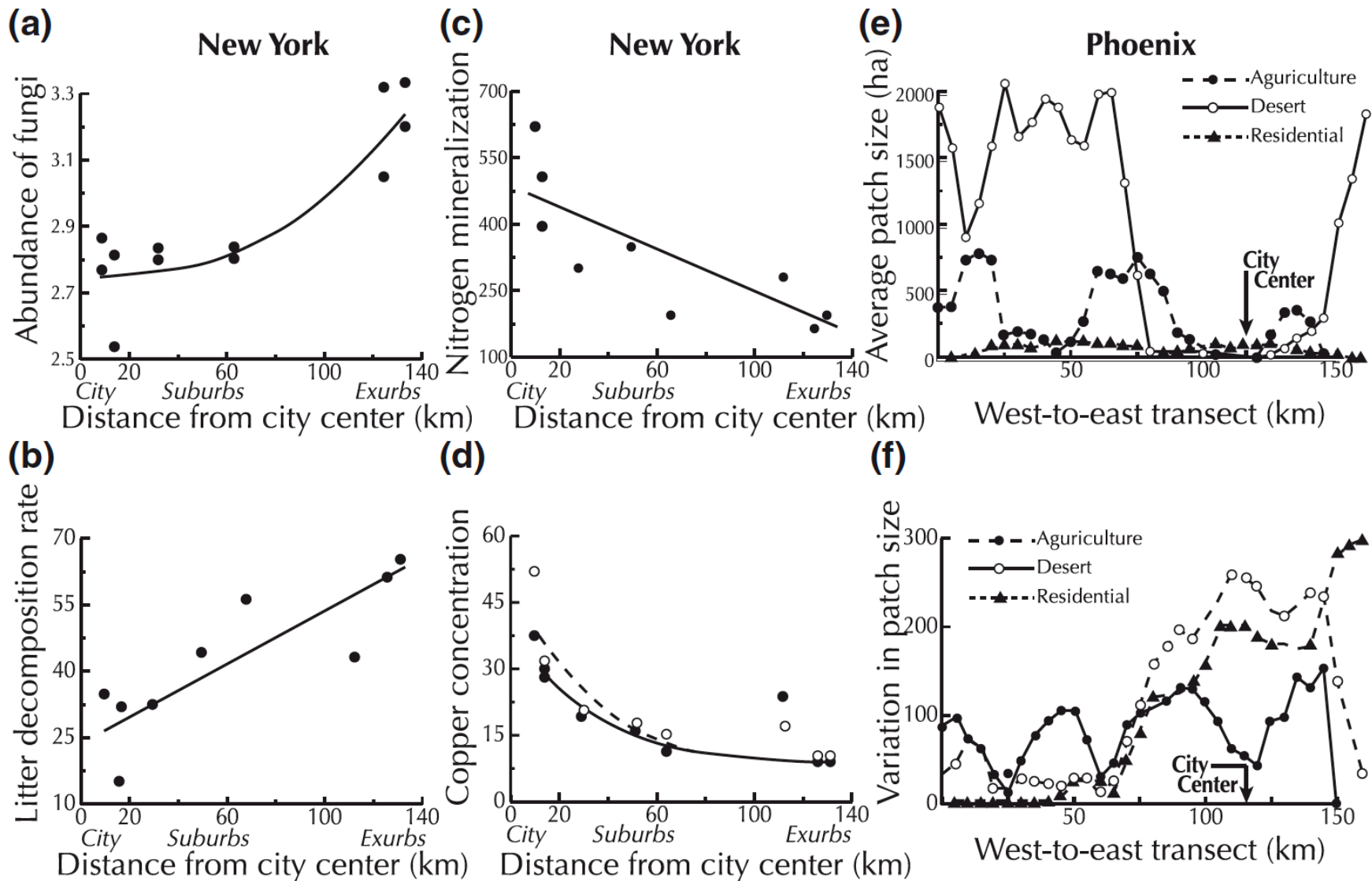
- Charcos
- Rios e cursos d'água
- Lagos e reservatórios
- Obras de esgoto

Verde

- Campos de jogo
- Gramados e jardins
- Beiras de estrada
- Árvores nas ruas
- Bosques
- Parques
- Cemitérios
- Campos de golfe

Fig. 1.4 As várias categorias de habitat urbano

Geralmente urbanização vem acompanhada de outras mudanças correlacionadas no ambiente



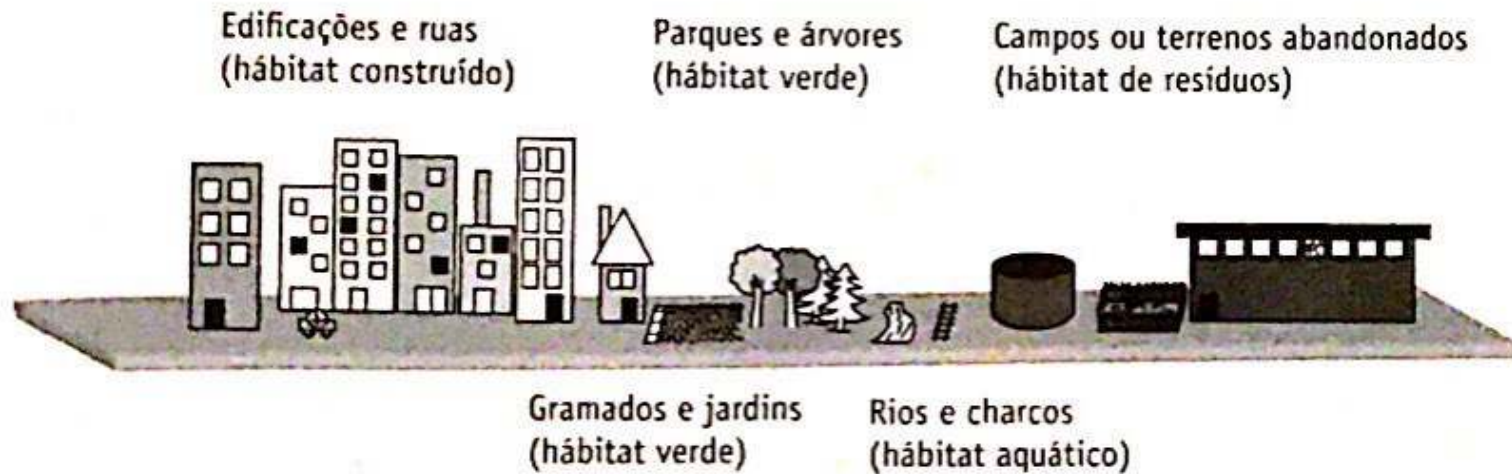


Fig. 1.7 As áreas urbanas contêm uma mistura de habitats vizinhos e contrastantes que variam de completamente construídos por seres humanos a habitats praticamente sem modificações

- Fragmentação de paisagens urbanas
 - Interpenetração de *espaços construídos* de cidades em e em torno de *espaços abertos*
- Espaços que restam são pequenos (sujeitos ao efeito de borda) e isolados
 - Estradas, ruas e infraestrutura

Table 1. Edge effects on a variety of temperate and tropical forests^a

	Higher at edge	No difference	Lower at edge
Abiotic			
Air moisture		9	(50 ^b) ⁹
Air Vapor Pressure Deficit	(20) ⁷ (50 ^b) ⁹	9	
Air temperature	(20) ⁷ (24) ⁹ (15) ¹⁸	9	
Light (PAR) ^c	(20) ⁷ (44) ⁹	9	
Soil moisture		7	(40) ⁷
Chemical substances	(50) ¹⁰ (?) ¹¹		
Vegetation			
Tree (stem) density	(15) ¹⁶ (30) ¹⁷ (20) ¹⁸ (?) ¹⁹	12,16,19	(56) ¹² (?) ¹⁹
Basal area	(15) ¹⁷	12,19	
Canopy cover			(44) ¹² (150) ²⁷
Subcanopy cover			(?) ²⁷
Understorey cover	(40) ⁹	9,18	
Liana density			(?) ²⁷
Seedling density	(?) ¹²	12,14	(?) ¹²
Plant/seedling growth	(53) ¹² (?) ^{13,14}		
Canopy damage	(150) ²⁷		
Mortality	(56) ¹² (?) ¹⁸	14	
Animals			
Bird density	(60) ²¹	21	(60) ²¹
Processes			
Seed dispersal and/or invasion from matrix	(10) ¹⁰ (80) ²⁶ (500) ²⁷		
Nest predation	(?) ^{25,29} (600) ³⁰ (?) ³⁷	22,25,29,31-33	
Brood parasitism	(?) ³⁴		
Post-dispersal seed predation		13	(?) ¹³
Seed germination			(?) ¹³
Herbivory	(?) ¹³		
Plant species composition and richness			
Species richness	(10) ¹⁵ (15) ¹⁷	15	
Species composition ^d		16,18	(?) ^{15,19} (45) ¹⁶

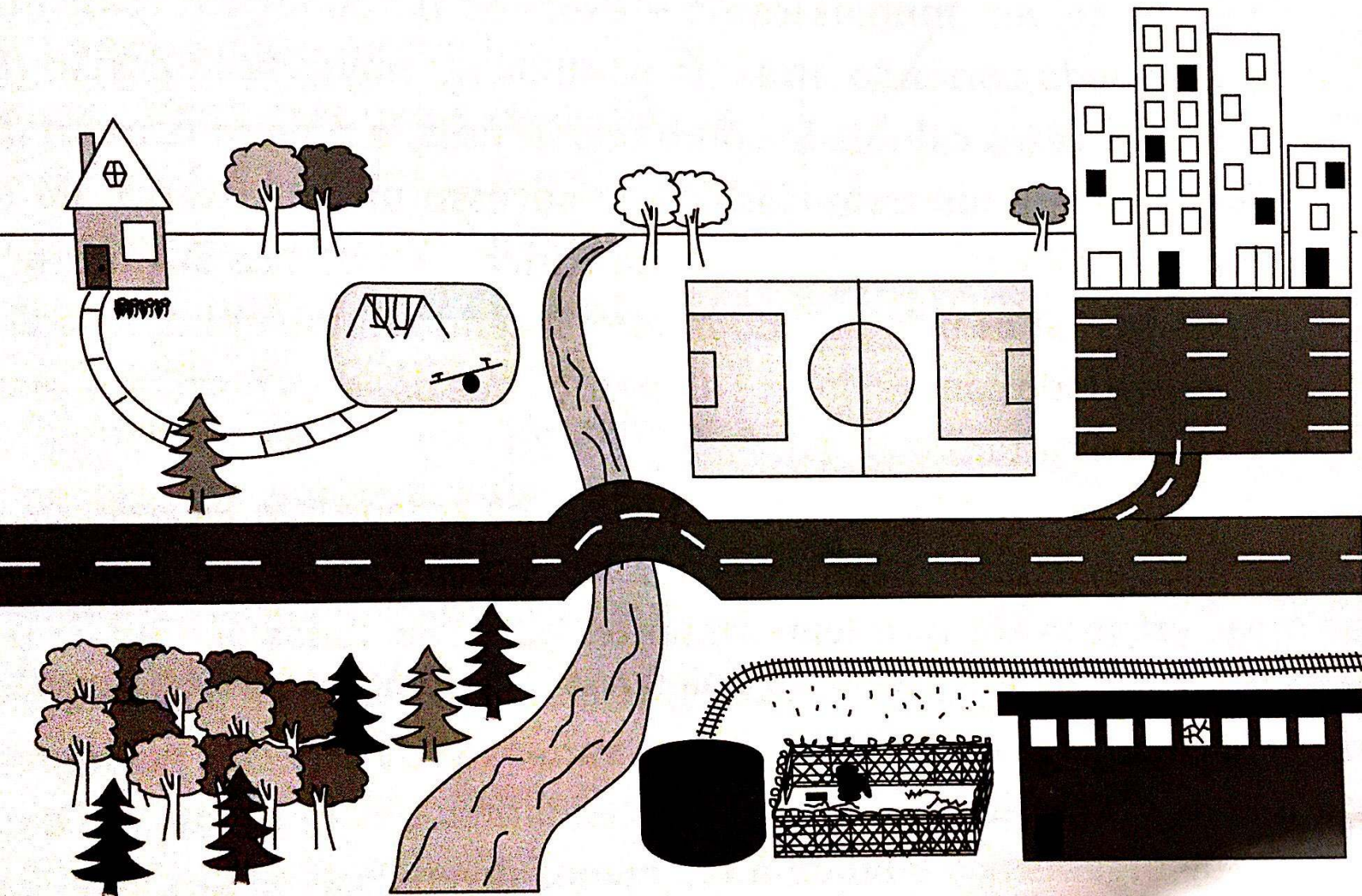


Fig. 1.15 Em áreas urbanas, hábitats muito contrastantes podem ocorrer lado a lado, e manchas adequadas de hábitat podem ser isoladas por regiões inóspitas entre si

Table 3.1 A summary of the main effects of habitat loss, fragmentation and isolation on populations and species in urban environments.

Impacts of habitat loss, fragmentation and isolation on populations and species

Habitat loss causes:

- Reduced survival of individuals
- Emigration of individuals
- Local extinction of populations

Habitat fragmentation leads to:

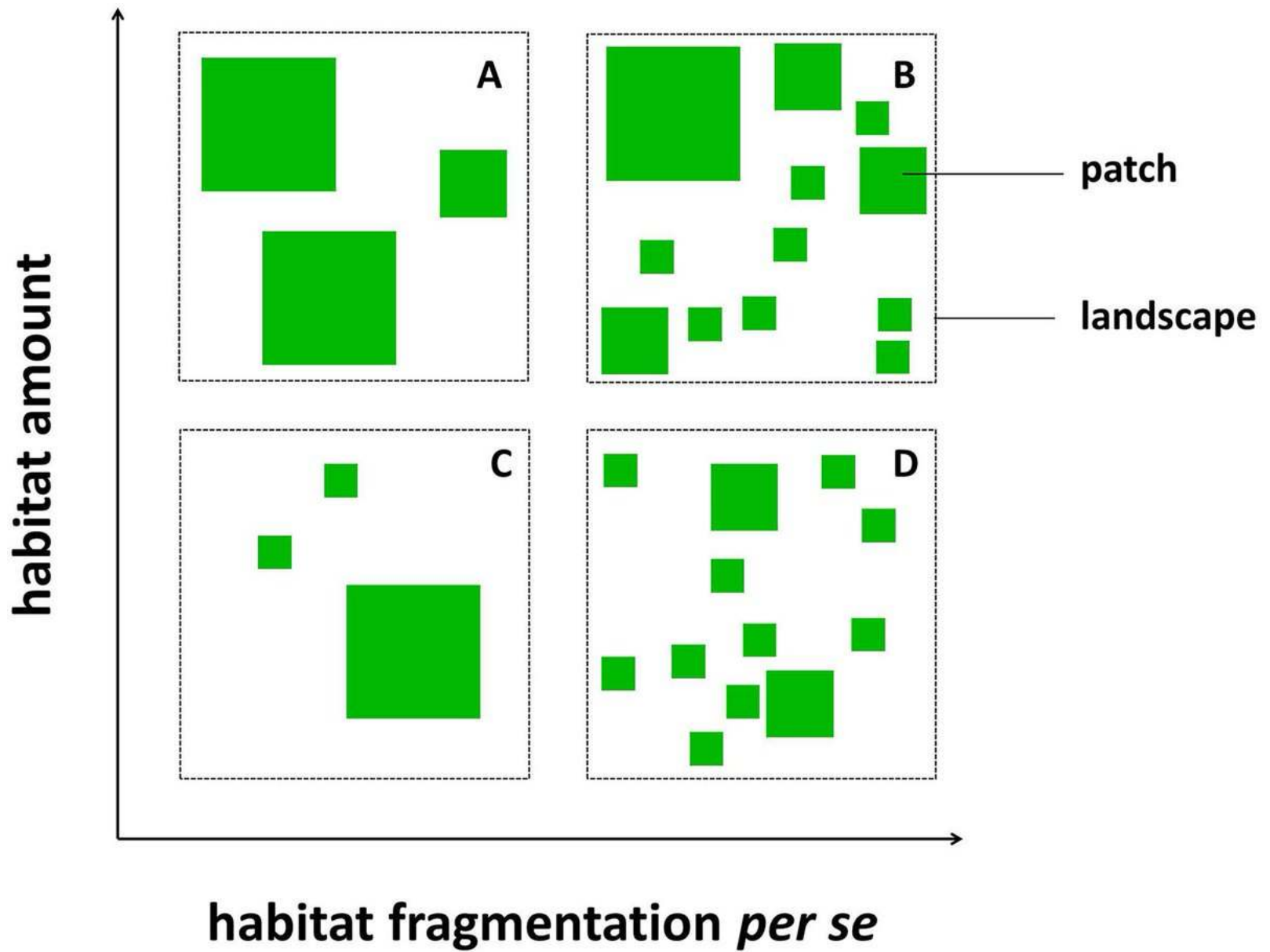
- Smaller areas of habitat that support smaller populations
- A higher probability of local extinction
- Reduced species richness

Habitat isolation leads to:

- Reduced movement of individuals between areas of habitat
 - A lower probability of colonization or re-colonization following local extinction
 - Lower rates of pollination, disrupted dispersal of seeds and spores
 - Reduced gene flow between areas of habitat and a loss of genetic diversity
-

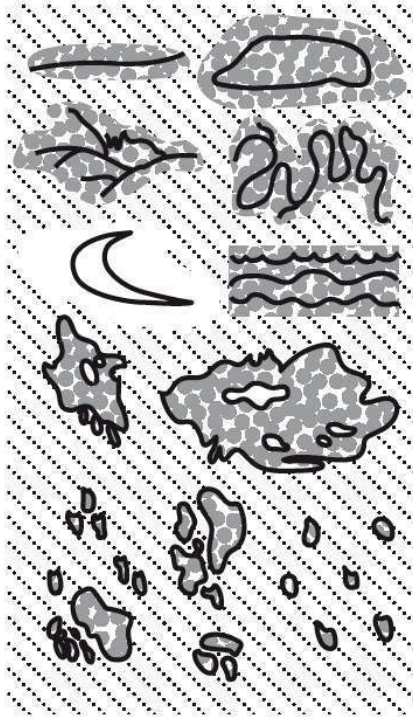
Gradiente de fragmentação de espaços verdes em Brisbane, Austrália



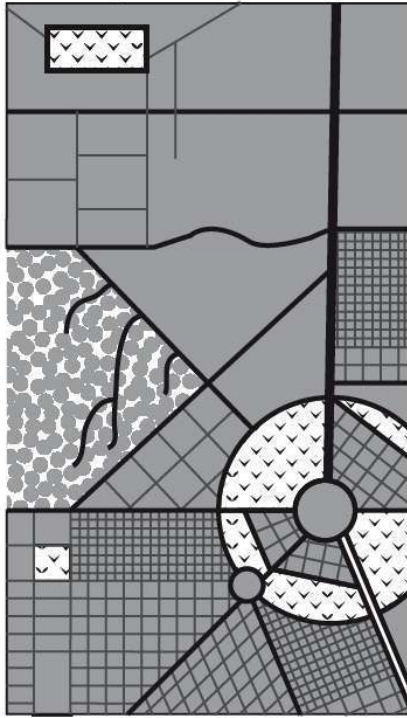


(b) Landscape patterns produced by:

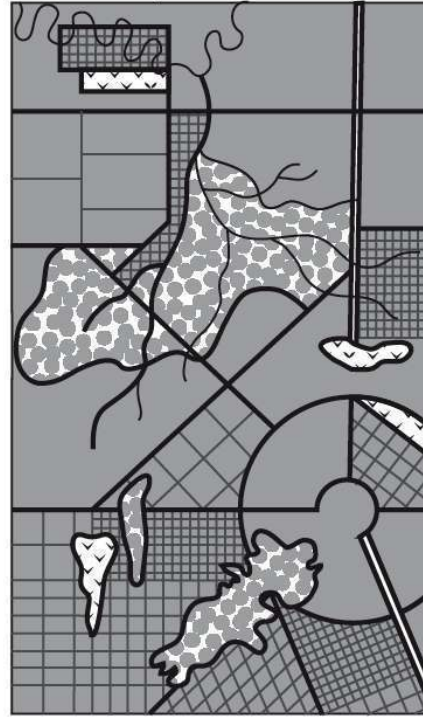
Natural processes



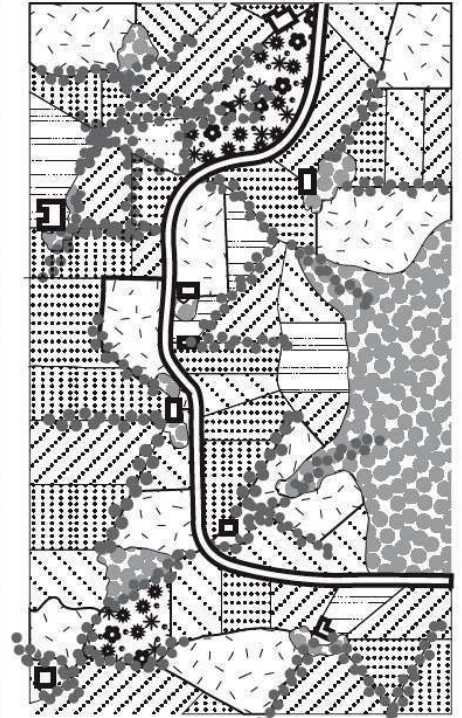
Planning and design



Unplanned development



Long-term trial-and-error



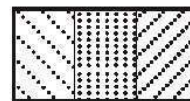
Wooded



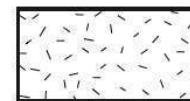
Lawn



Built



Cropland



Pasture



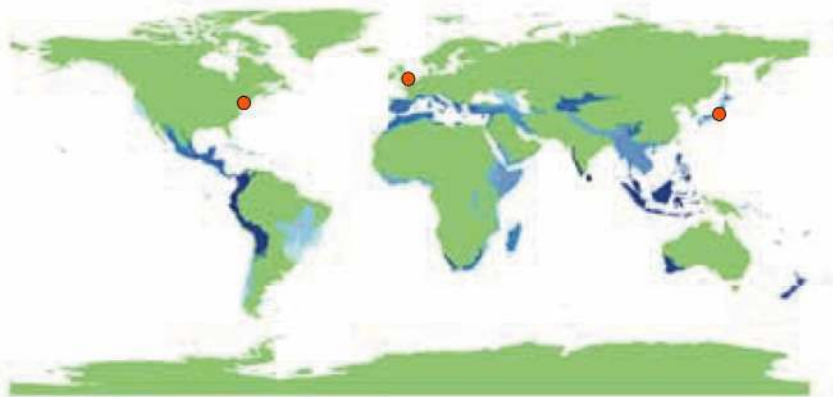
Meadow

Estrutura espacial de habitats urbanos

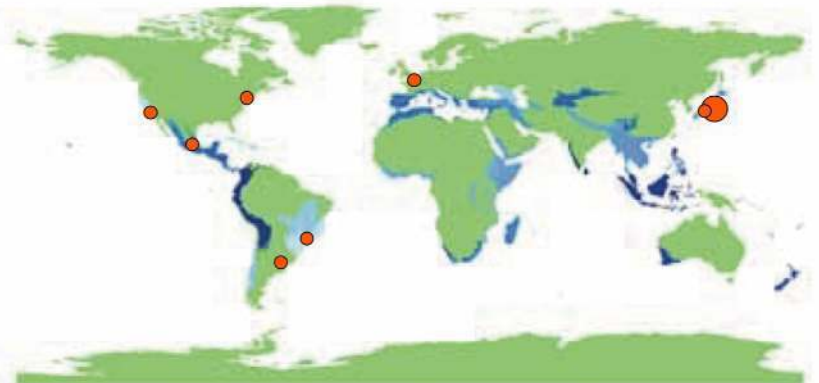
- Depende do histórico de colonização
- Geralmente centros urbanos se expandem de dentro para fora, com crescimento de infraestrutura e densidade populacional crescendo gradualmente
- Cidades são mais comuns no nível do mar até 2.300 m a.s.l.,
- Densidade populacional aumenta em regiões com altos níveis de variabilidade de precipitação, em regiões tropicais e temperadas, que tenham temperaturas médias até áreas áridas, e declina com o aumento da distância para costa e grandes rios

Estrutura espacial de habitats urbanos

- Cidades surgiram em *hotspots* de biodiversidade pré-existent no mundo
- Áreas verdes remanescentes são geralmente de vegetação nativa
 - Ao longo de rios e encostas
 - Parques e cemitérios de cidades antigas
 - Campos de futebol

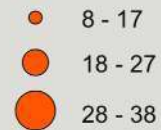


1950



1975

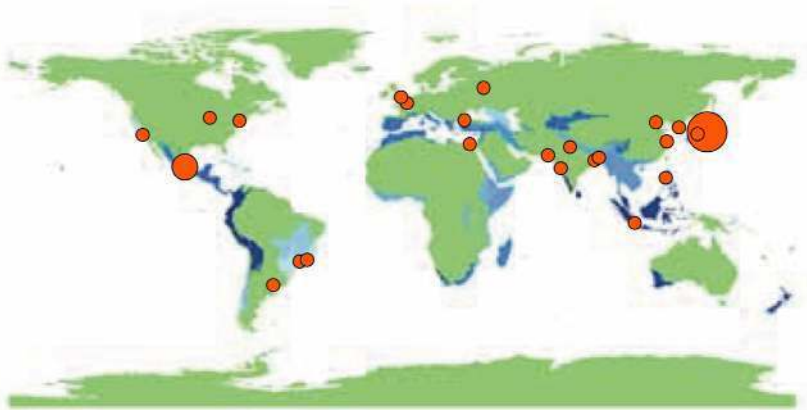
population in millions



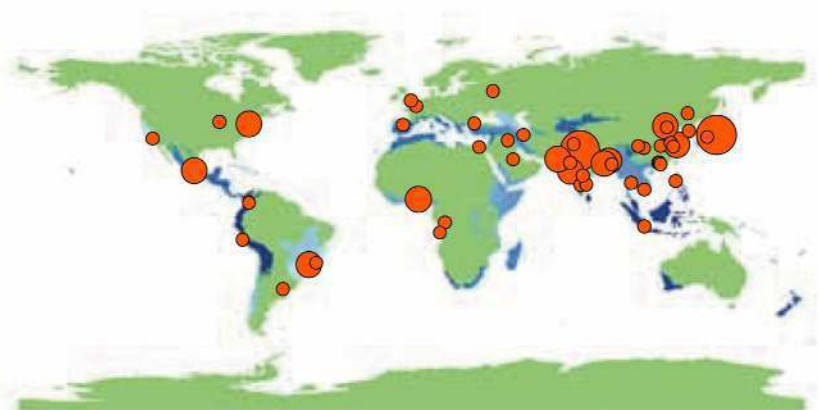
biodiversity hotspots



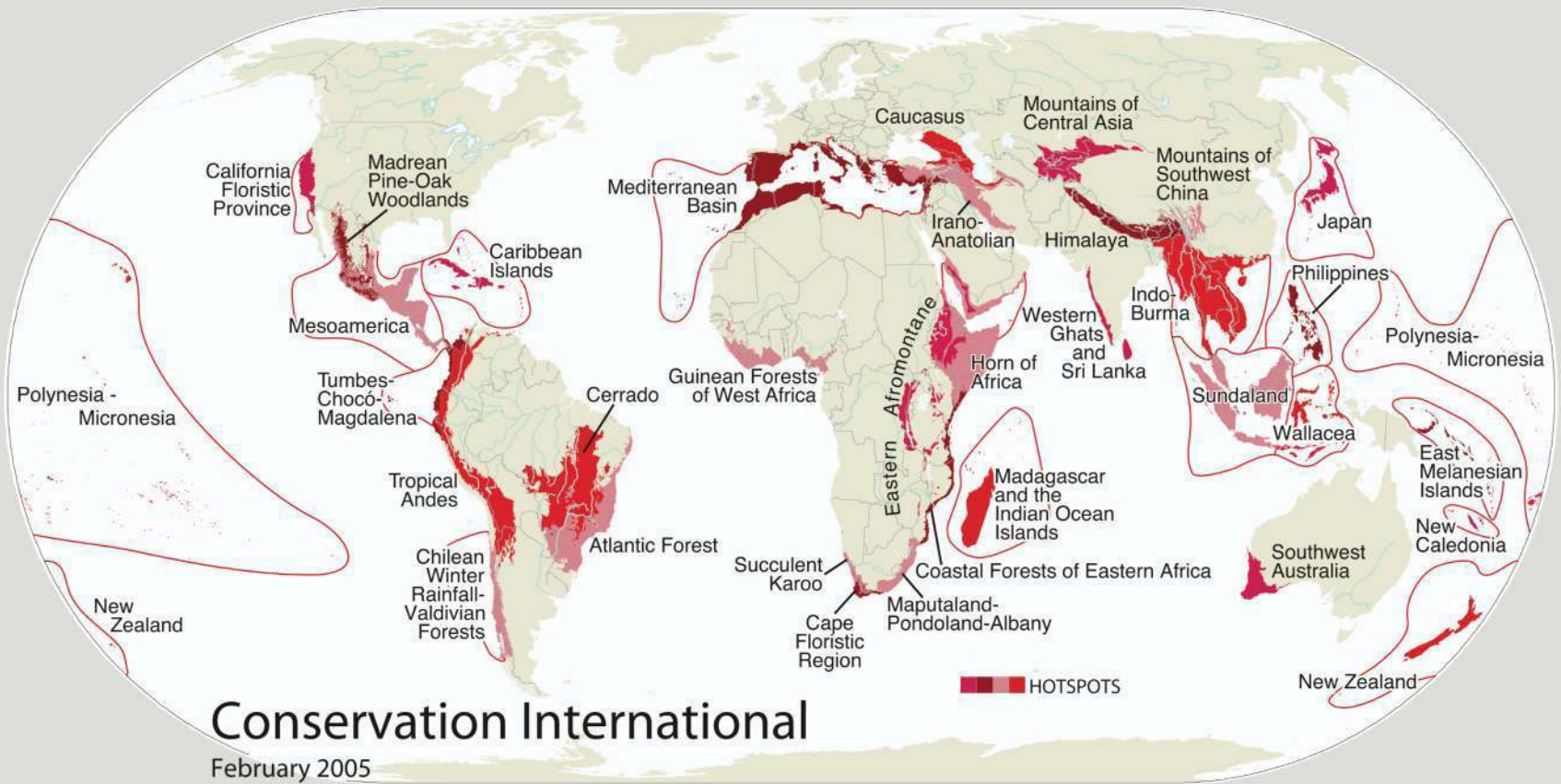
FIGURE 1. Global urbanization and biodiversity hotspots, 1950-2025. For explanation of biodiversity hotspots see p. 22

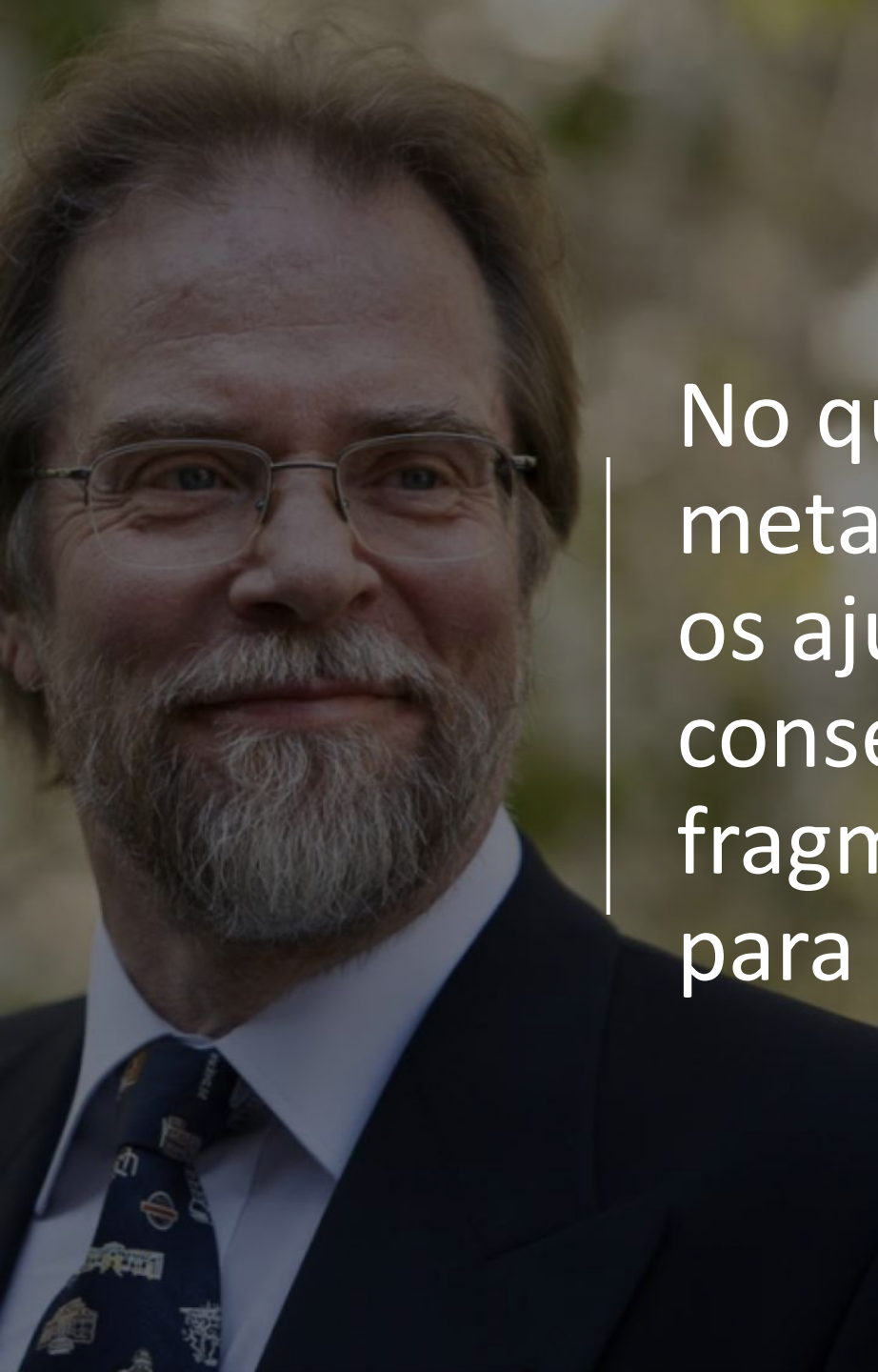


2000

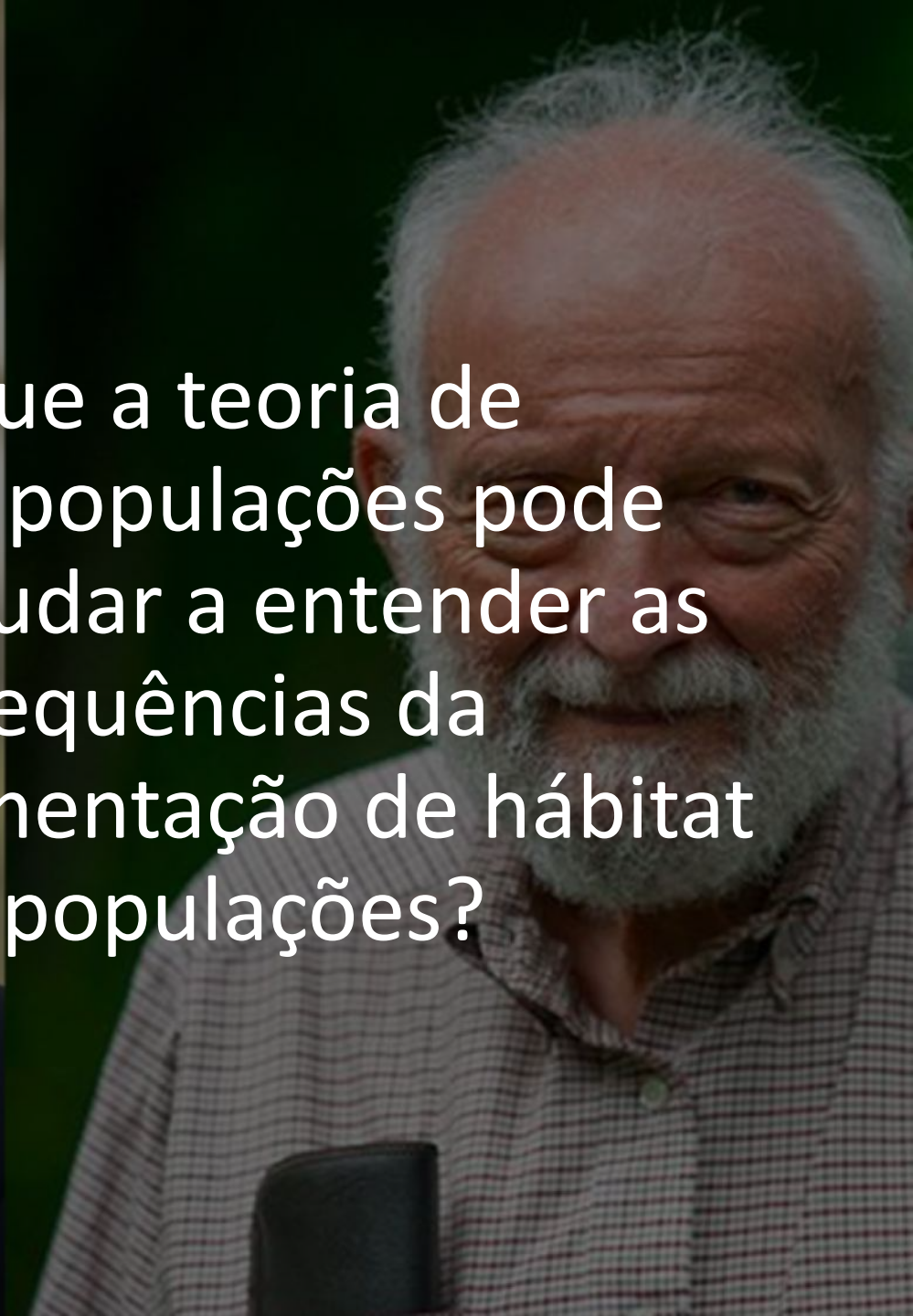


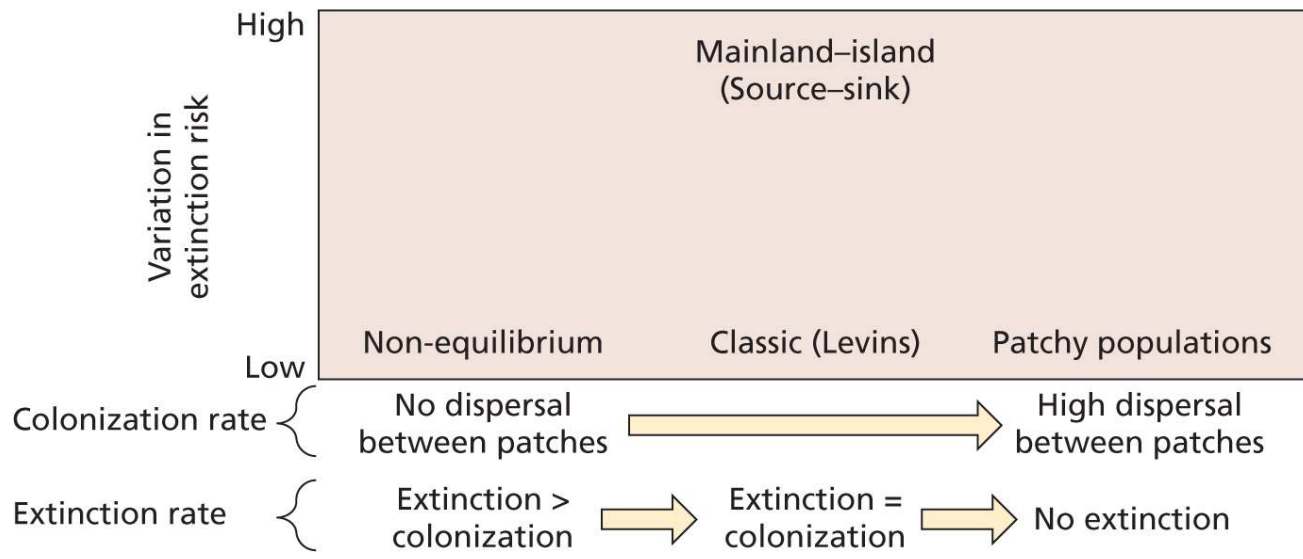
2025





No que a teoria de metapopulações pode os ajudar a entender as consequências da fragmentação de hábitat para populações?





Mittelbach & McGill 2019

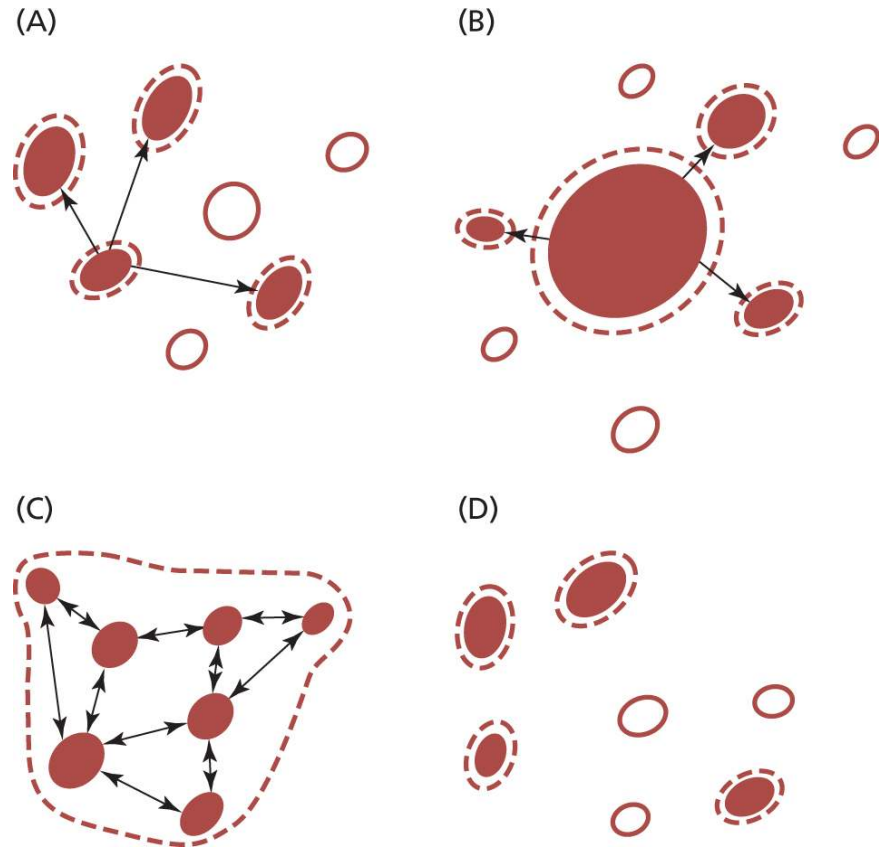
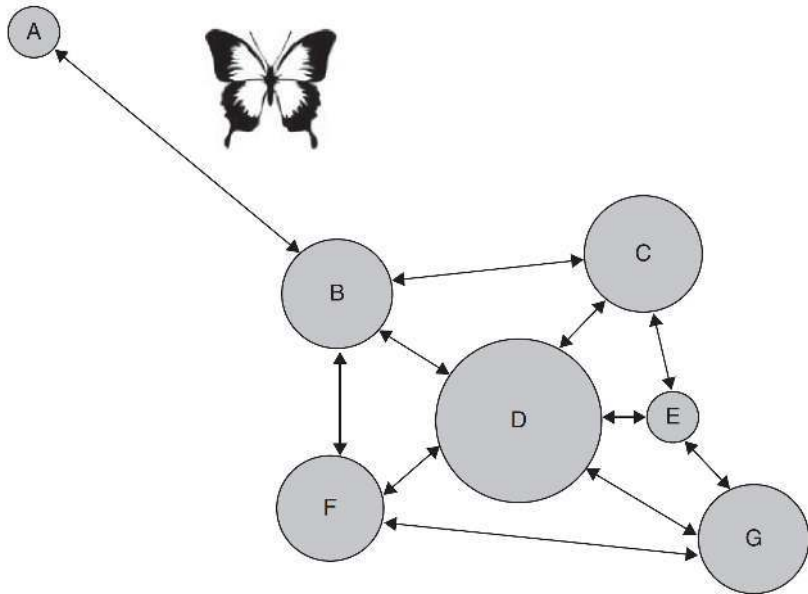
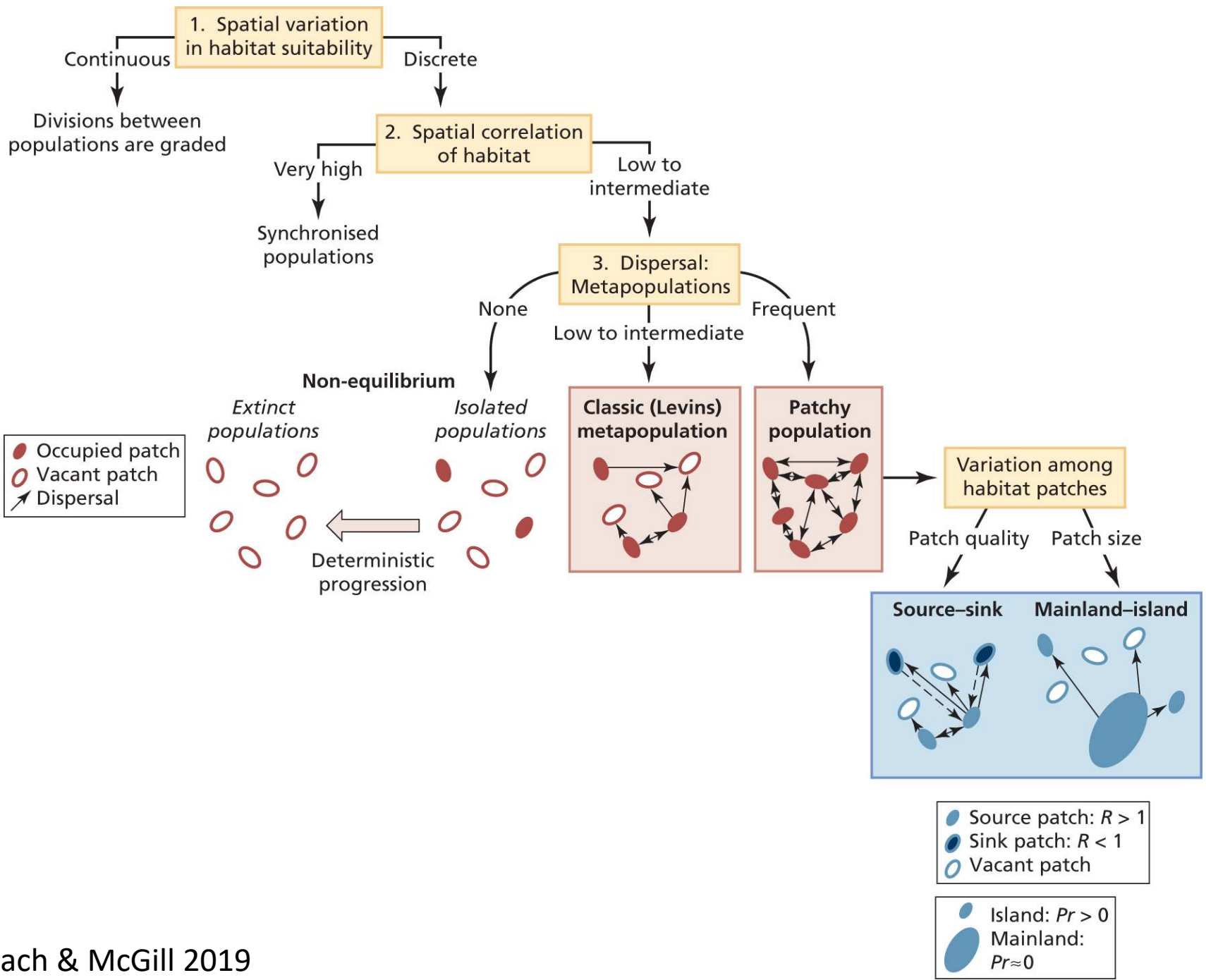


Figure 3.2 A hypothetical habitat network for a butterfly comprised of seven habitat patches of varying size and proximity to each other (circles); the arrows show potential pathways for dispersal between patches. Metapopulation theory predicts that small and/or isolated patches

Parris 2013



Teoria de Metapopulações

- Populações em manchas isoladas e pequenas têm menos chance de serem viáveis por longo tempo
 - Débito de extinção: populações não respondem imediatamente à perda/fragmentação de hábitat, existe um *time lag*

Débito de extinção de plantas em ambientes urbanos no mundo

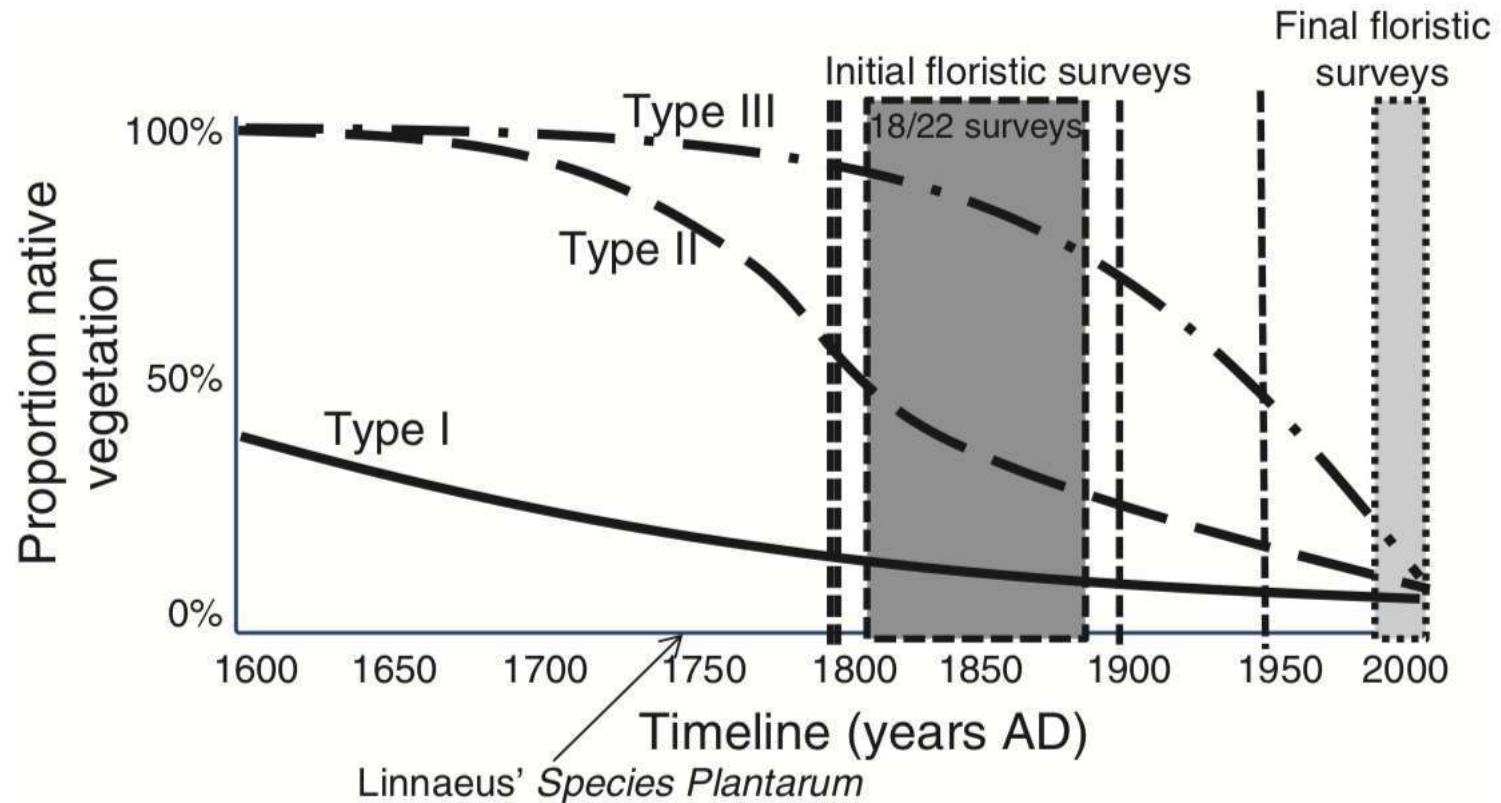


Figure 1 Heuristic model showing three trajectories for landscape

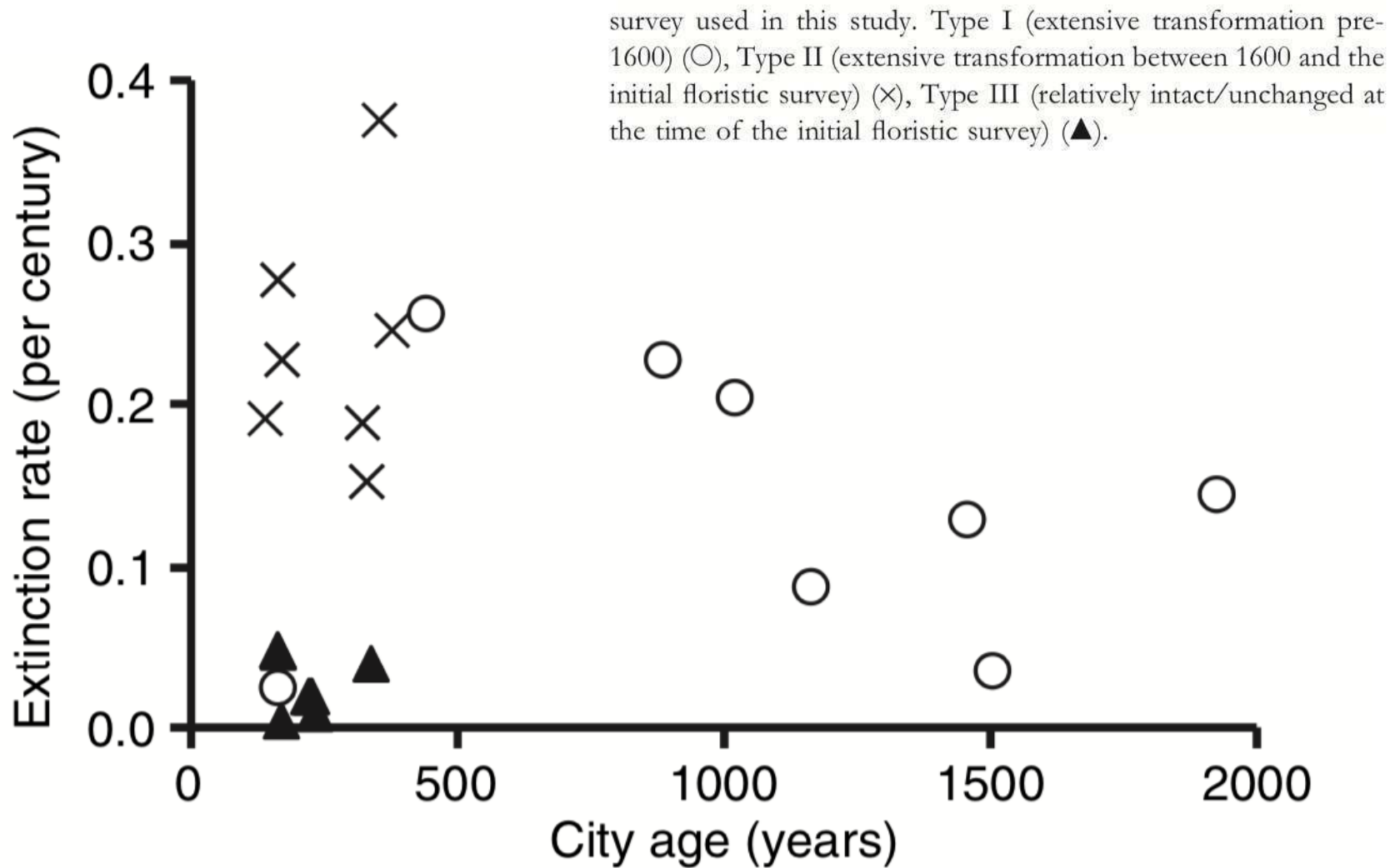
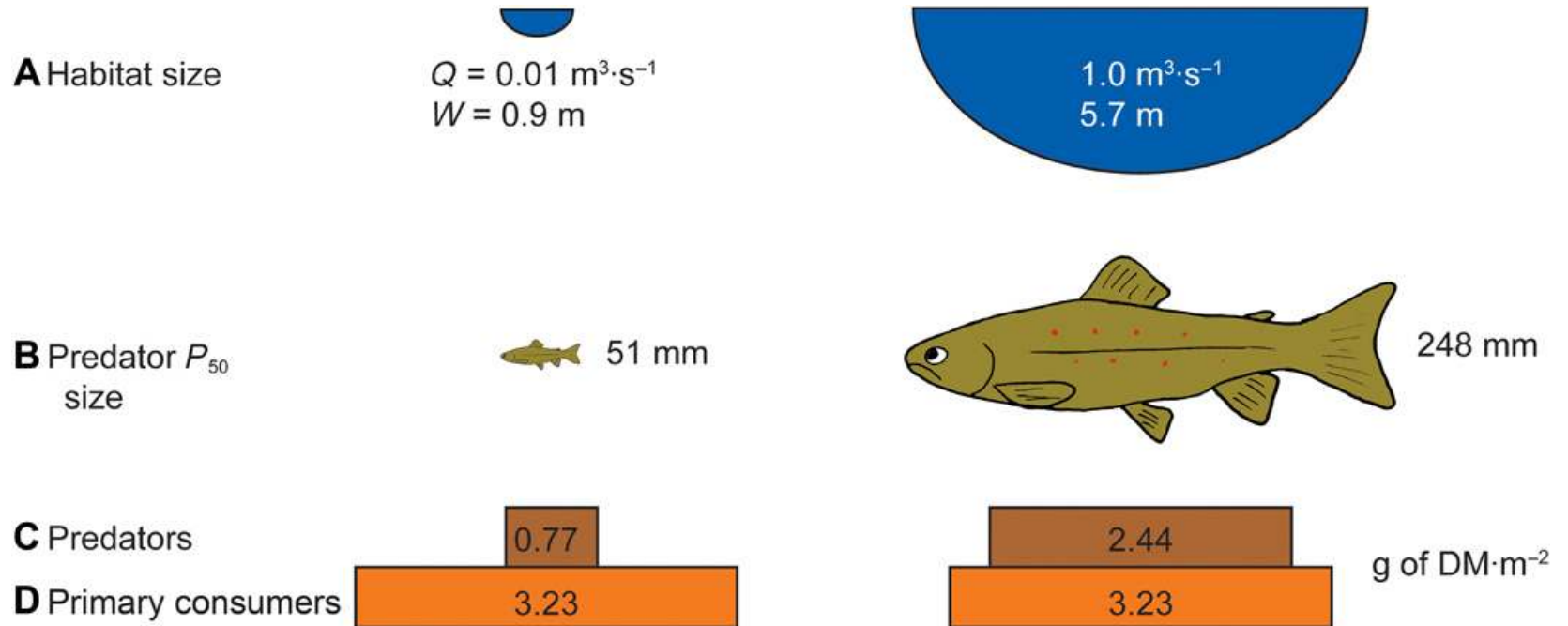


Figure 3 Extinction rate (proportion of the original flora lost per

Teoria de Metapopulações

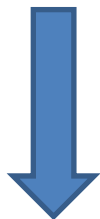
- Presença atual de espécies pode não ser bom indicador de persistência da população no futuro
 - Populações podem ainda estar na fase de *lag*
 - Espécies que vivem mais tempo são mais afetadas (e.g., árvores)
 - Espécies mais especialistas, largura de nicho estreita
- Predadores de topo de cadeia são geralmente excluídos de ambientes urbanos

Fig. 2 Overall effect of habitat-size constraints on trophic structure.

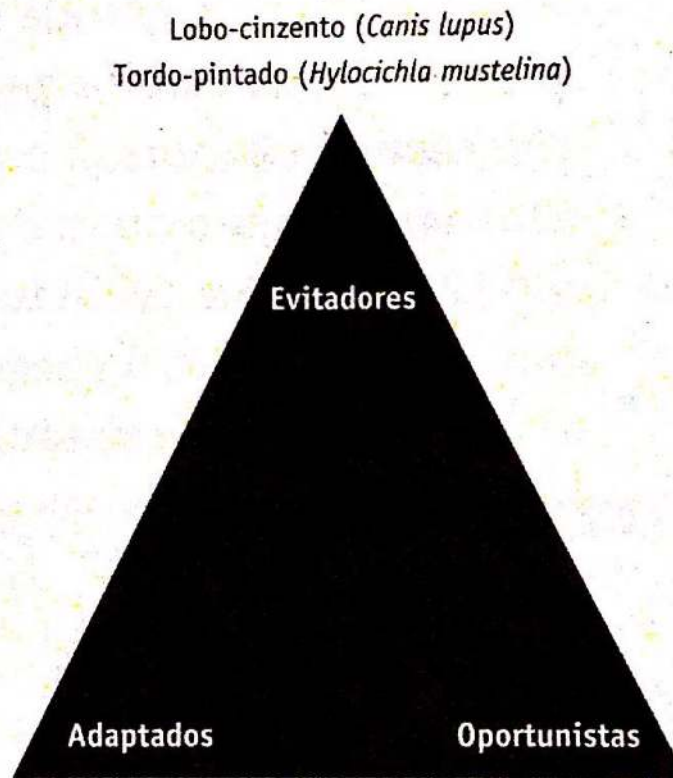


Angus R. McIntosh et al. *Sci Adv* 2018;4:eap7523

Lince no
Colorado, EUA



Leopardos
na Índia



Guaxinim (*Procyon lotor*)
Raposa-vermelha (*Vulpes vulpes*)

Pombo-comum (*Columba livia*)
Rato-marrom (*Rattus norvegicus*)

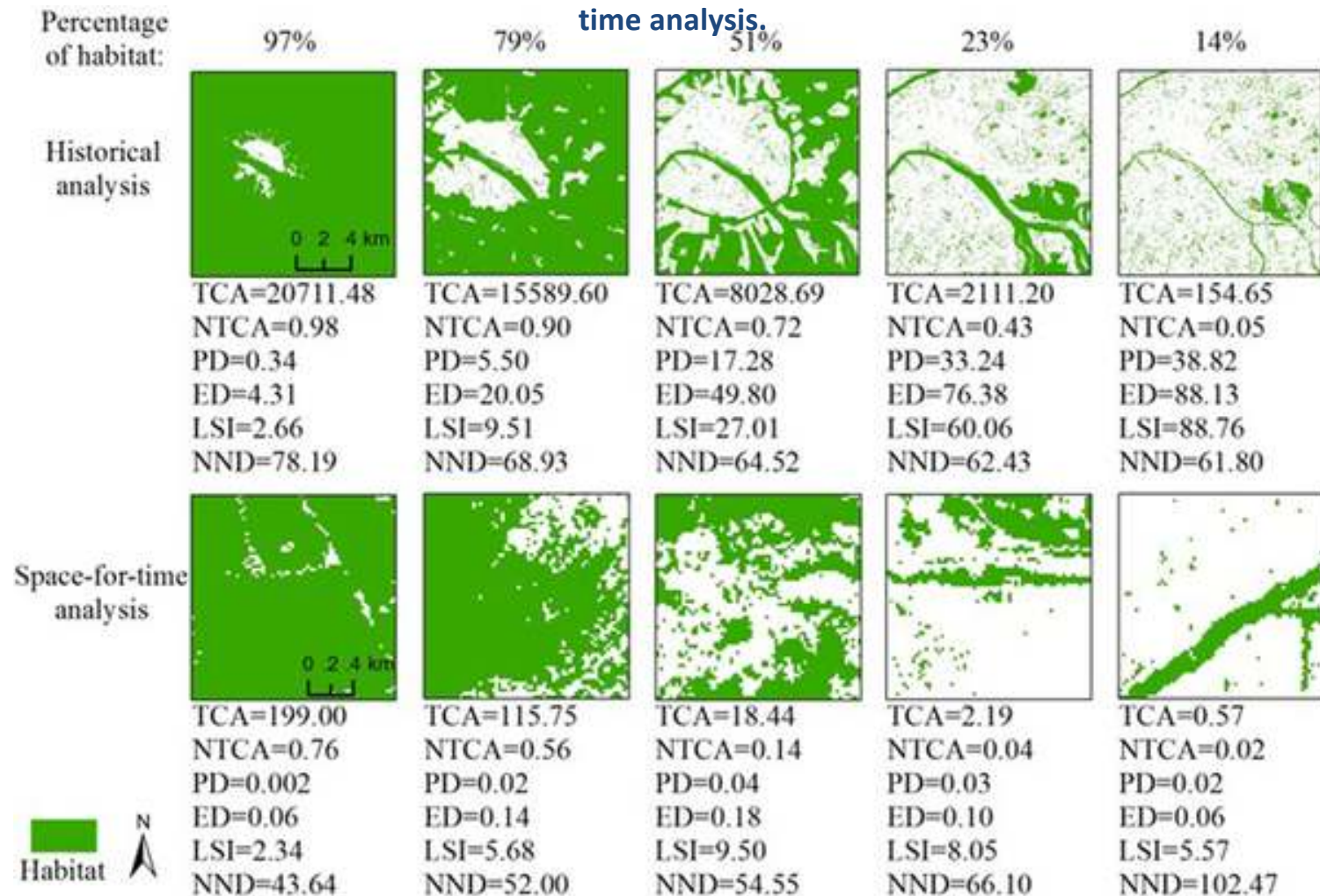
Fig. 1.21 Exemplo de três reações ao meio ambiente urbano. A maioria dos organismos fica em algum ponto entre esses extremos

Fonte: adaptado de Blair (2001).

Padrão global de urbanização

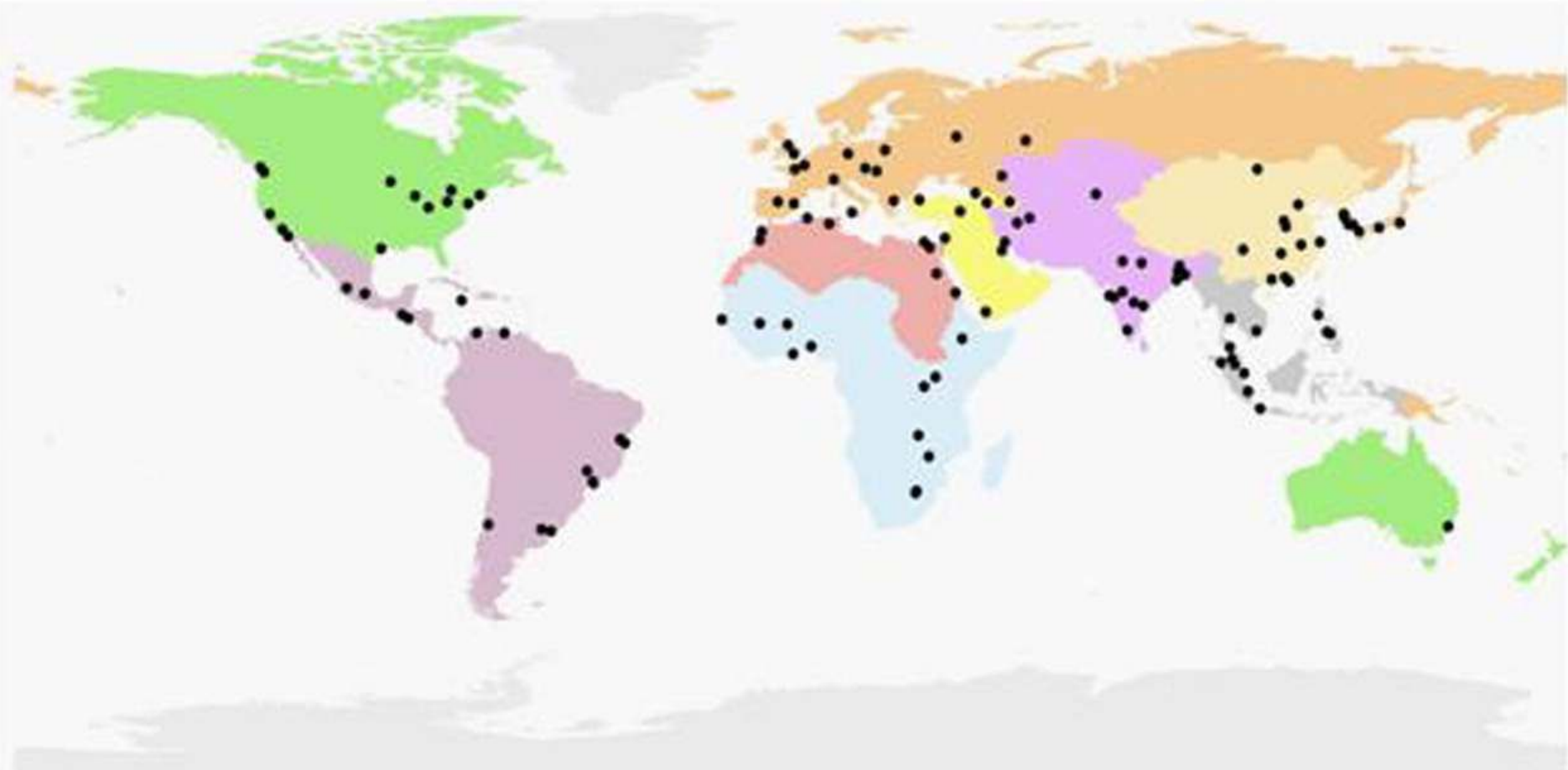
- 16 cidades (1800-2000)
- Perda e fragmentação de hábitat estão correlacionados positivamente
 - Aumentam monotonicamente, mas pode variar pra exponencial

Fig 6. Spatial patterns of habitat and corresponding values of landscape metrics with decreasing percentages of habitat in Paris, as an example, derived from both historical landscape pattern analysis and space-for-time analysis.



Liu Z, He C, Wu J (2016) The Relationship between Habitat Loss and Fragmentation during Urbanization: An Empirical Evaluation from 16 World Cities. PLOS ONE 11(4): e0154613. <https://doi.org/10.1371/journal.pone.0154613>
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0154613>

Padrão global de urbanização



Amostra de 120 cidades no mundo

Padrão global de urbanização

- Cidades parecem conter ou promover distúrbios de espaços abertos equivalentes à sua área construída
- Cidades maiores são menos fragmentadas
 - Fragmentação está em declínio
- Cidades com maior renda são mais fragmentadas

Consequências para populações

Rapid, pervasive genetic differentiation of urban white-footed mouse (*Peromyscus leucopus*) populations in New York City

JASON MUNSHI-SOUTH and KATERINA KHARCHENKO

PeerJ

Urban park characteristics, genetic variation, and historical demography of white-footed mouse (*Peromyscus leucopus*) populations in New York City

Jason Munshi-South¹ and Christopher Nagy²

BIOLOGY
LETTERS

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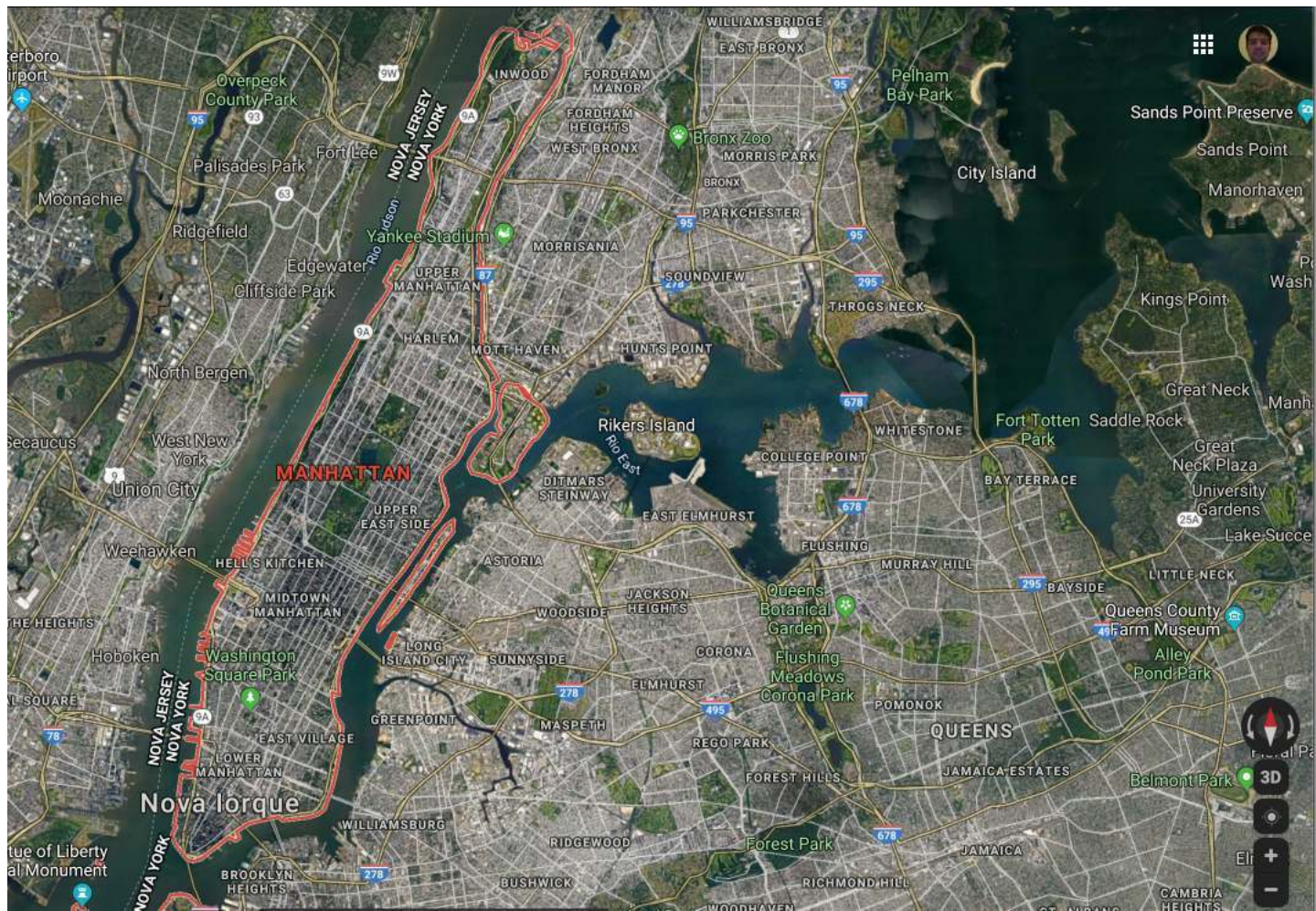
Research

Cite this article: Harris SE, Xue AT, Alvarado-Serrano D, Boehm JT, Joseph T, Hickerson MJ, Munshi-South J. 2016 Urbanization shapes the

Evolutionary biology

Urbanization shapes the demographic history of a native rodent (the white-footed mouse, *Peromyscus leucopus*) in New York City

Stephen E. Harris¹, Alexander T. Xue^{1,2}, Diego Alvarado-Serrano², Joel T. Boehm², Tyler Joseph², Michael J. Hickerson^{1,2} and Jason Munshi-South³



Uma população em praticamente cada parque de NYC!!

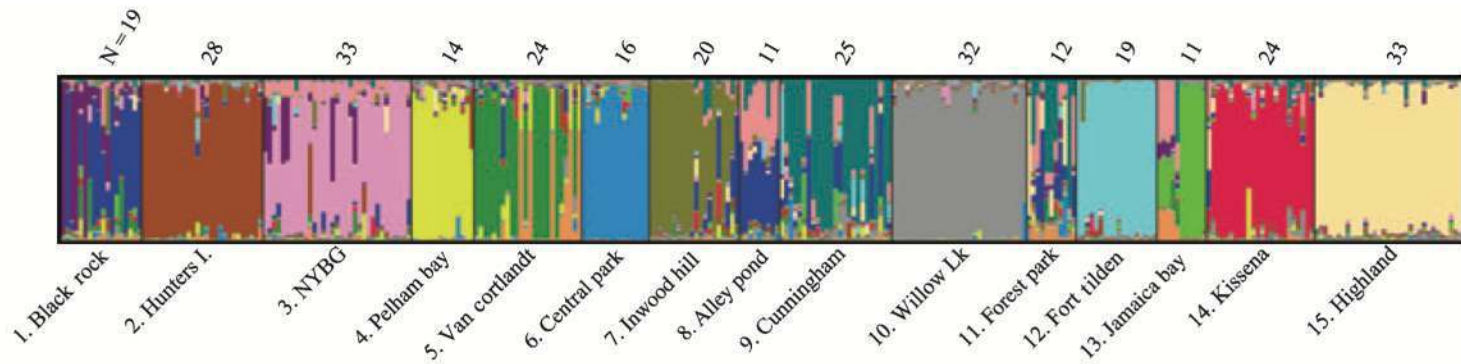
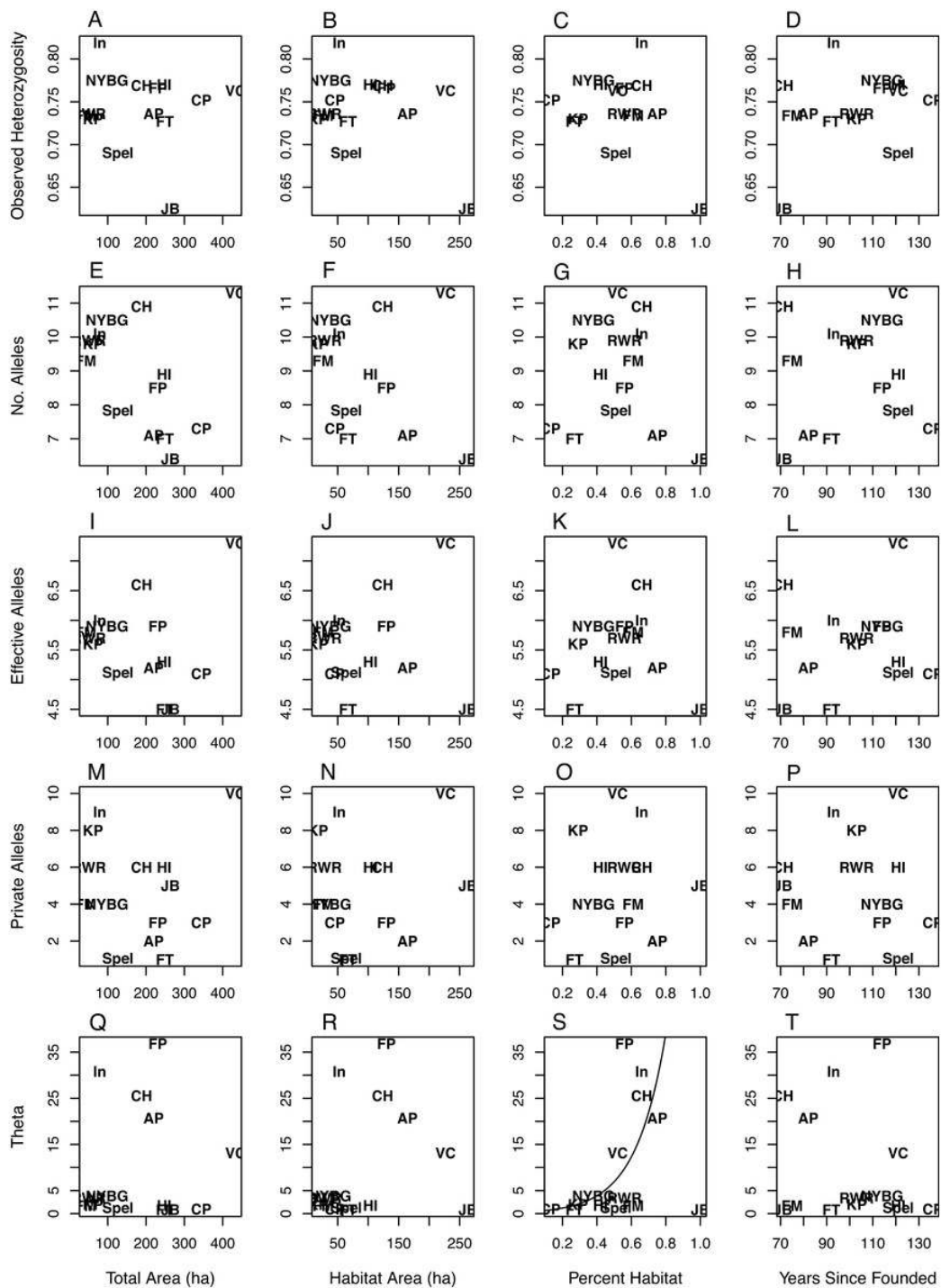


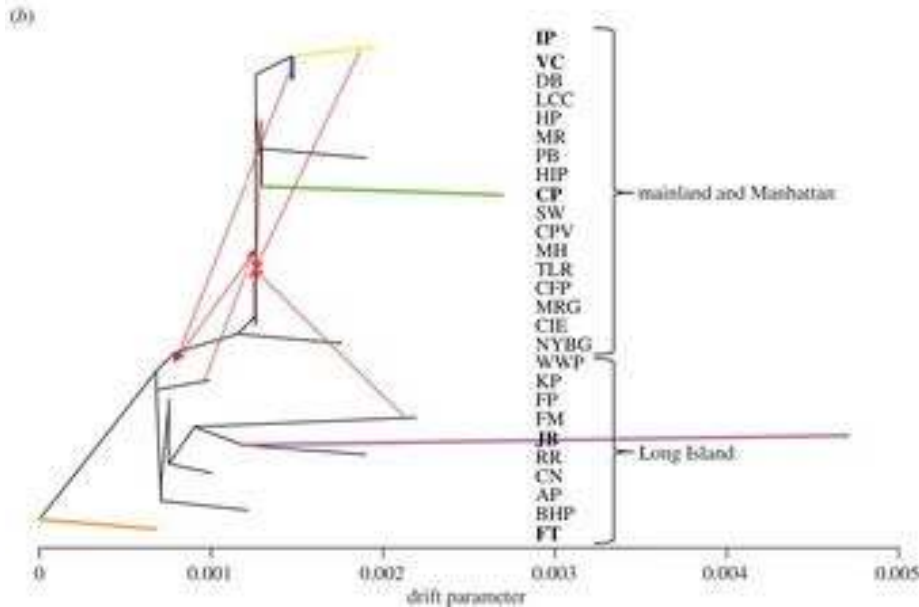
Fig. 3 Sixteen evolutionary clusters inferred from Structure analysis of 312 mice from 15 sites. Each colour represents an inferred cluster, and each individual is represented by a vertical line coloured according to its probability of assignment to each cluster. Sample sizes appear above each site, and numbers before site names correspond to locations in Fig. 1.



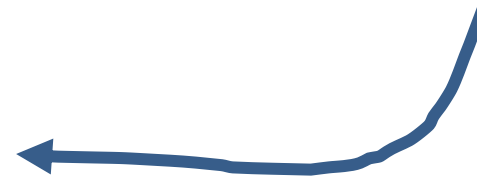
Clusters parecem ser preditos pelo tempo de criação do parque e tamanho da área



Trabalho comparando populações de ambientes rurais vs. urbanos



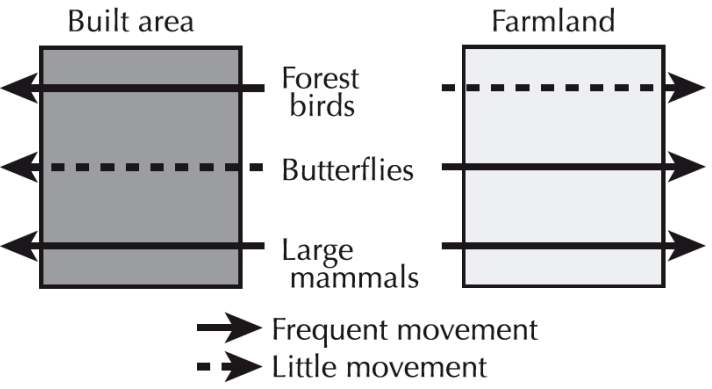
Populações urbanas são mais suscetíveis à deriva



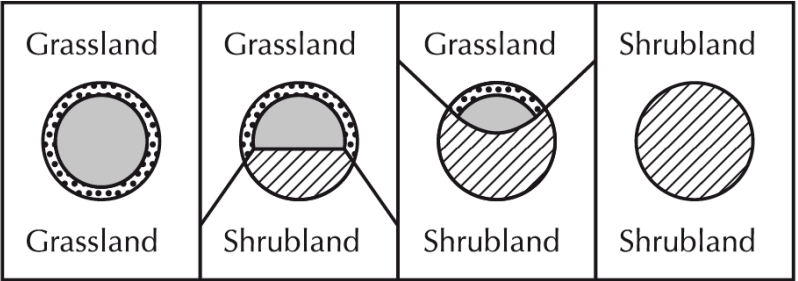
- Encontraram vários genes candidatos que estavam passando por seleção positiva em populações urbanas desses ratos
- Os genes candidatos são envolvidos em metabolismo de xenobióticos, respostas imunes inatas, atividade de demetilação, e outros fenômenos biológicos importantes em novos ambientes urbanos

Limites ao movimento de organismos

(a) Animal movement across different land uses



(b) Adjacency arrangement: plants in a wooded patch surrounded by different amounts of two land uses



Plants from grassland, farmland, or commercial area common in woods
 Plants from shrubland or residential area common in woods

(c) Expected biodiversity of wooded park in exurban /peri-urban area

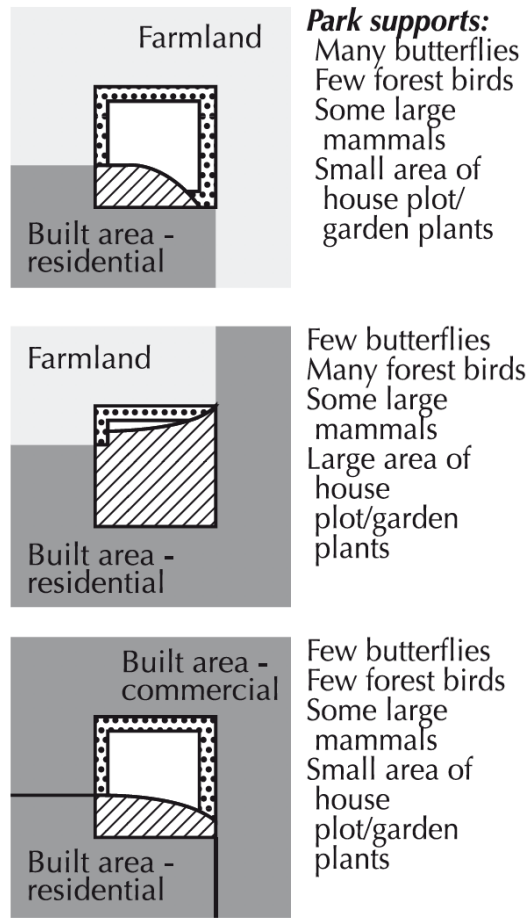


Figure 2.9. Biodiversity patterns in differing land-use adjacency arrangements. (a) Based on measurements and modeling of 3 butterfly species, 12 forest-bird species, and 1 large-mammal (deer) species in The Netherlands (Knaapen *et al.*, 1992; Forman, 1995). (b) Based on measurements in aspen (*Populus tremuloides*) patches (averaging about 0.4 ha = 1 acre) in a rural area south of Calgary (Canada) (Hersperger and Forman, 2003). (c) Expected patterns based on (a) and (b).

Moving in the Anthropocene: Global reductions in terrestrial mammalian movements

Tucker *et al.*, *Science* **359**, 466–469 (2018)

Marlee A. Tucker,^{1,2*} Katrin Böhning-Gaese,^{1,2} William F. Fagan,^{3,4} John M. Fryxell,⁵ Bram Van Moorter,⁶ Susan C. Alberts,⁷ Abdullahi H. Ali,⁸ Andrew M. Allen,^{9,10} Nina Attias,¹¹ Tal Avgar,¹² Hattie Bartlam-Brooks,¹³ Buuveibaatar Bayarbaatar,¹⁴ Jerrold L. Belant,¹⁵ Alessandra Bertassoni,¹⁶ Dean Beyer,¹⁷ Laura Bidner,¹⁸ Floris M. van Beest,¹⁹ Stephen Blake,^{20,21} Niels Blaum,²² Chloe Bracis,^{1,2} Danielle Brown,²³ P. J. Nico de Bruyn,²⁴ Francesca Cagnacci,^{25,26} Justin M. Calabrese,^{3,27} Constança Camilo-Alves,^{28,29} Simon Chamailé-Jammes,³⁰ Andre Chiaradia,^{31,32} Sarah C. Davidson,^{33,20} Todd Dennis,³⁴ Stephen DeStefano,³⁵ Duane Diefenbach,³⁶ Iain Douglas-Hamilton,^{37,38} Julian Fennessy,³⁹ Claudia Fichtel,⁴⁰ Wolfgang Fiedler,²⁰ Christina Fischer,⁴¹ Ilya Fischhoff,⁴² Christen H. Fleming,^{3,27} Adam T. Ford,⁴³ Susanne A. Fritz,^{1,2} Benedikt Gehr,⁴⁴ Jacob R. Goheen,⁴⁵ Eliezer Gurarie,^{3,46} Mark Hebblewhite,⁴⁷ Marco Heurich,^{48,49} A. J. Mark Hewison,⁵⁰ Christian Hof,¹ Edward Hurme,³ Lynne A. Isbell,^{18,51} René Janssen,⁵² Florian Jeltsch,²² Petra Kaczensky,^{6,53} Adam Kane,⁵⁴ Peter M. Kappeler,⁴⁰ Matthew Kauffman,⁵⁵ Roland Kays,^{56,57} Duncan Kimuyu,⁵⁸ Flavia Koch,^{40,59} Bart Kranstauber,⁴⁴ Scott LaPoint,^{20,60} Peter Leimgruber,²⁷ John D. C. Linnell,⁶ Pascual López-López,⁶¹ A. Catherine Markham,⁶² Jenny Mattisson,⁶ Emilia Patricia Medici,^{63,64} Ugo Mellone,⁶⁵ Evelyn Merrill,¹² Guilherme de Miranda Mourão,⁶⁶ Ronaldo G. Morato,⁶⁷ Nicolas Morellet,⁵⁰ Thomas A. Morrison,⁶⁸ Samuel L. Díaz-Muñoz,^{69,70} Atle Mysterud,⁷¹ Dejid Nandintsetseg,^{1,2} Ran Nathan,⁷² Aidin Niamir,¹ John Odden,⁷³ Robert B. O'Hara,^{1,74} Luiz Gustavo R. Oliveira-Santos,⁷⁵ Kirk A. Olson,¹⁴ Bruce D. Patterson,⁷⁶

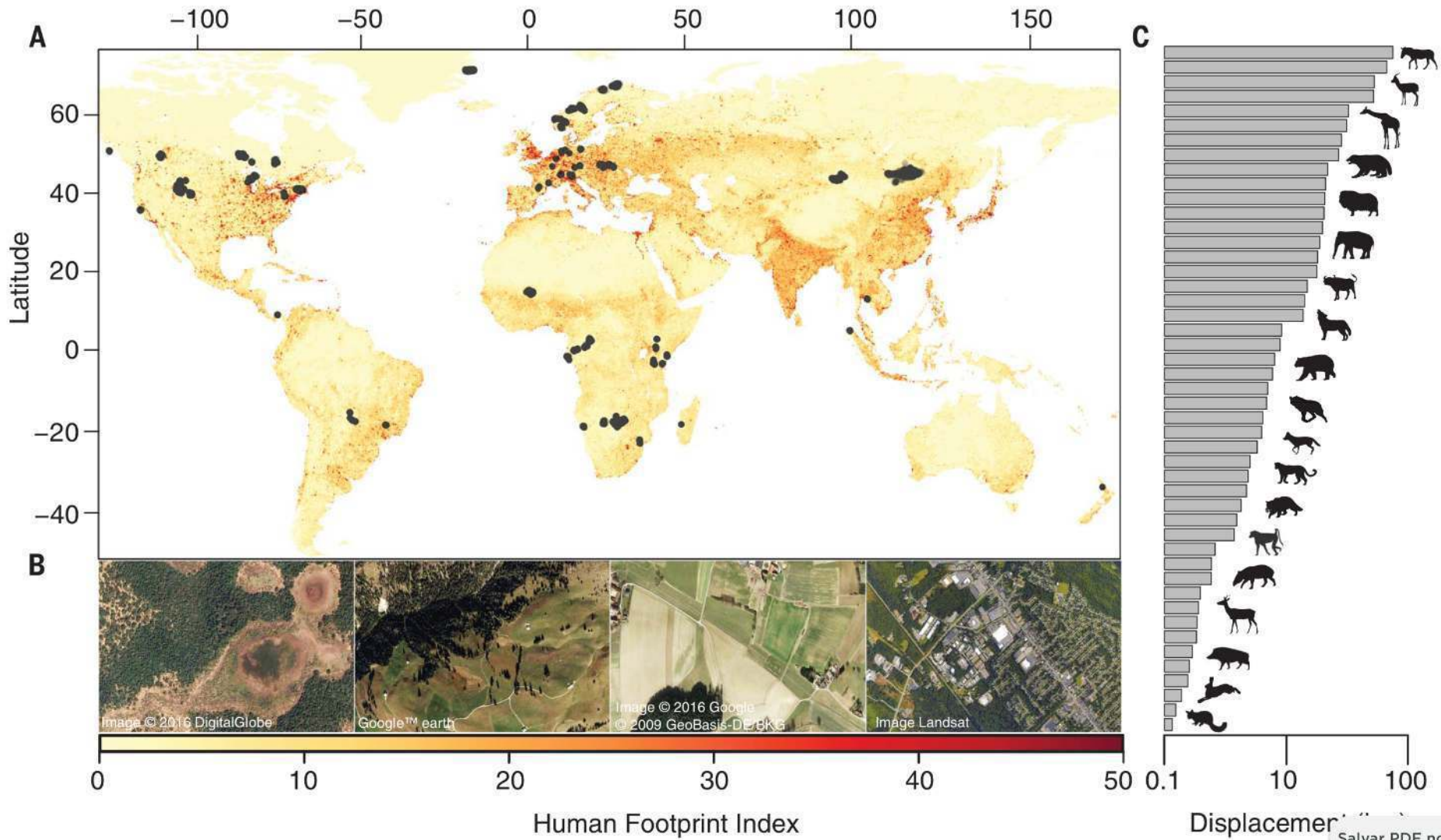
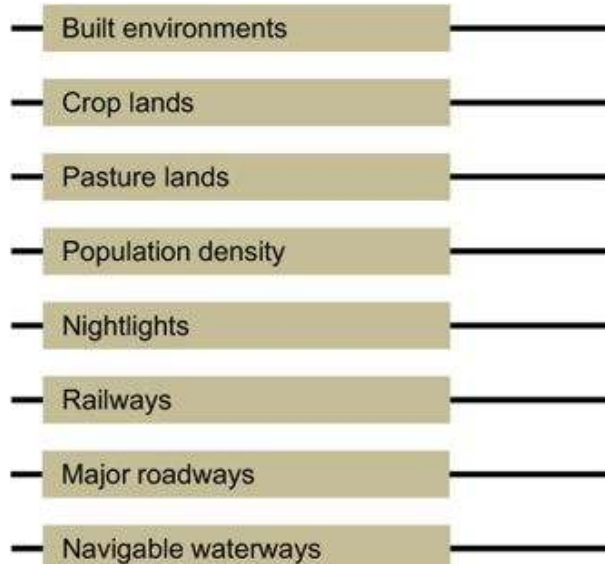


Fig. 1. Locations from the GPS tracking database and the Human

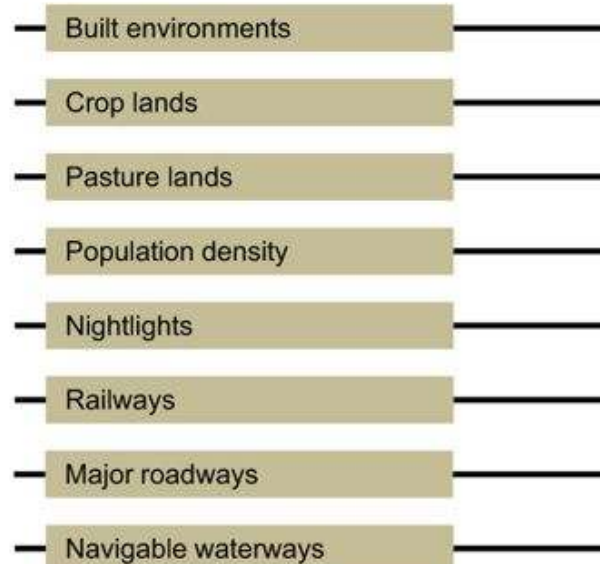
gazelle (Procapra gutturosa), giraffe (Giraffa camelopardalis), wolverine

Step 1 Acquire or develop data on individual human pressures

1993 pressure data



2009 pressure data



Step 2 Assign relative pressure scores to individual pressures

1993 pressures



2009 pressures



Step 3 Overlay individual pressures to create Human Footprint maps

1993 Human Footprint

2009 Human Footprint

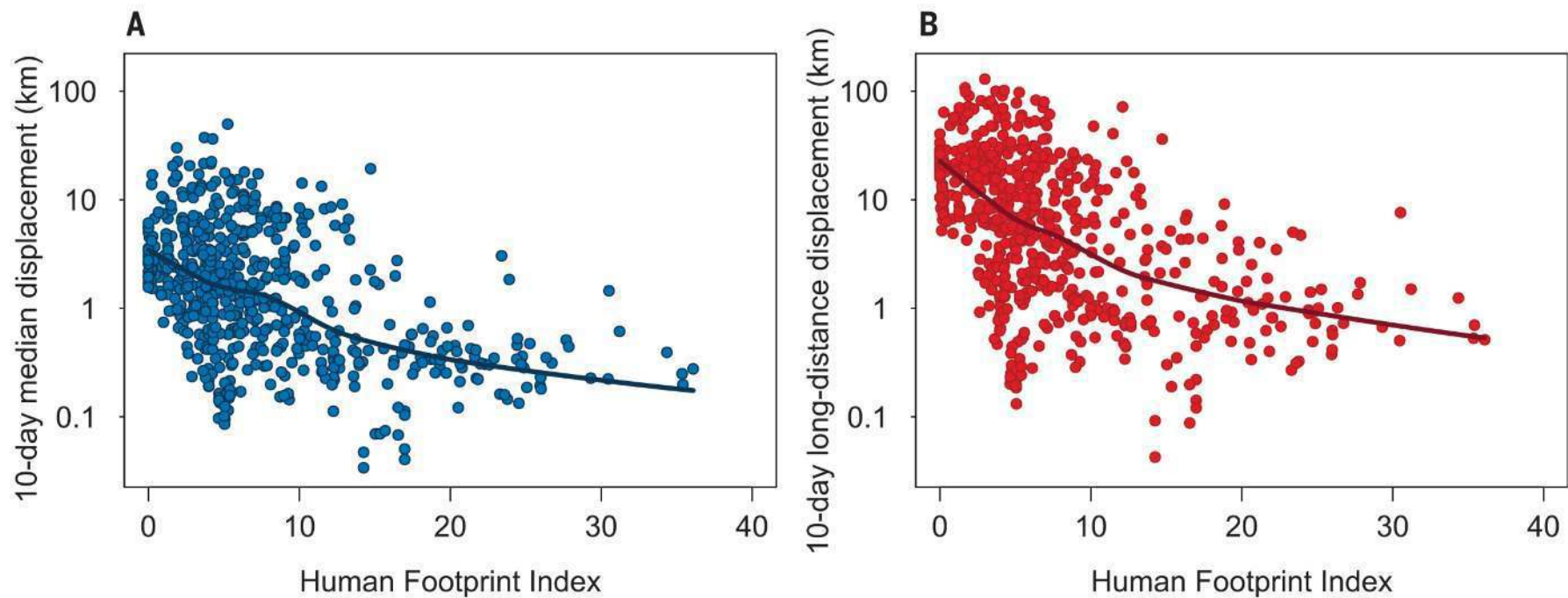
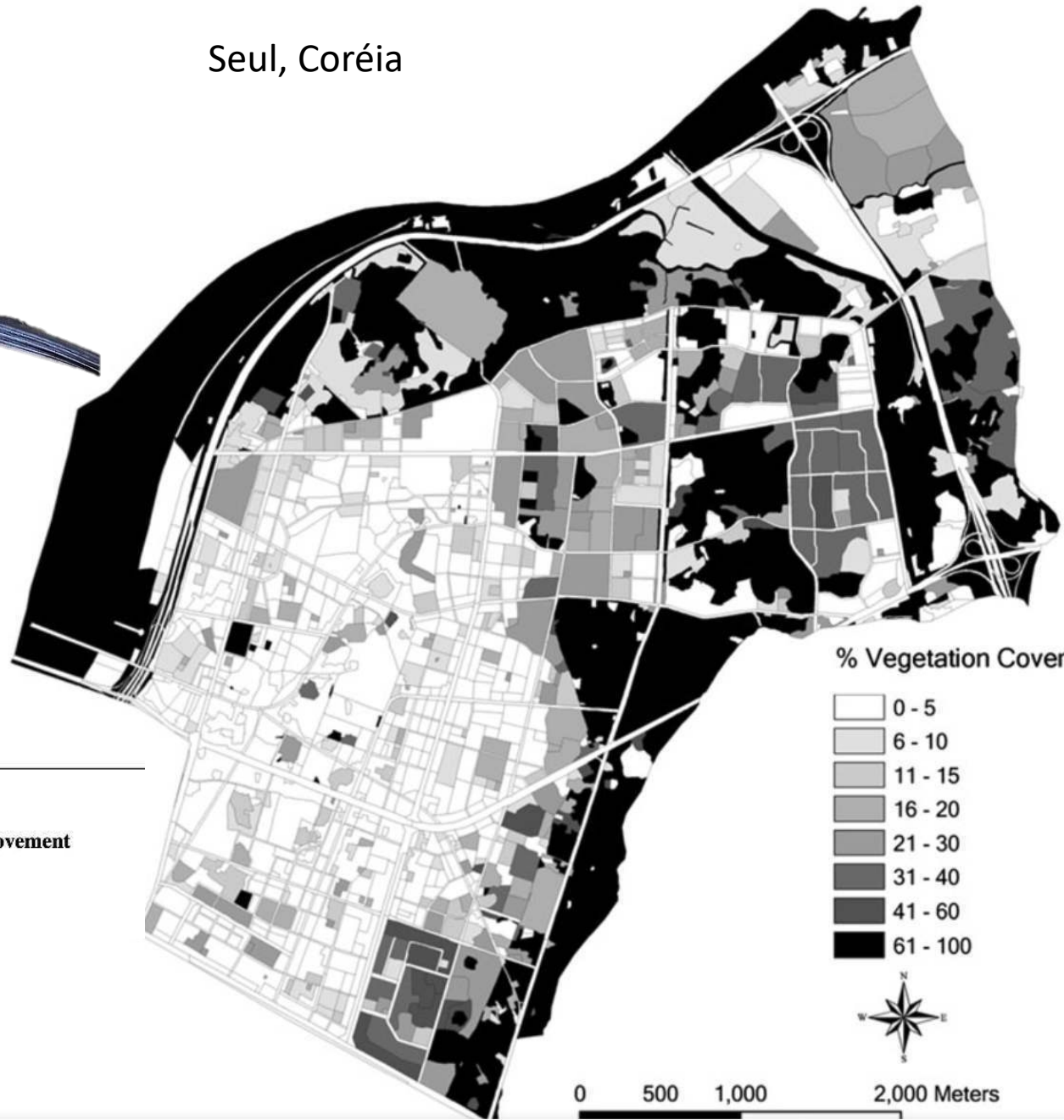


Fig. 2. Mammalian displacement in relation to the Human Footprint Index. (A) Median displacements; (B) long-distance (0.95 quantile)

Propostas de manejo/planejamento
baseado em movimento

Fig. 2 Vegetation-cover percentages of landscape patches in the study area

Seul, Coréia



Landscape Ecol Eng (2013) 9:165–174
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ORIGINAL PAPER

Planning an ecological network using the predicted movement paths of urban birds

Suk-Hwan Hong · Bong-Ho Han · Song-Hyun Choi ·
Chan Yong Sung · Kyong-Jae Lee

Fig. 5 Predicted potential movement paths (PMPs) that connect 92 locations in which *Parus major* was observed

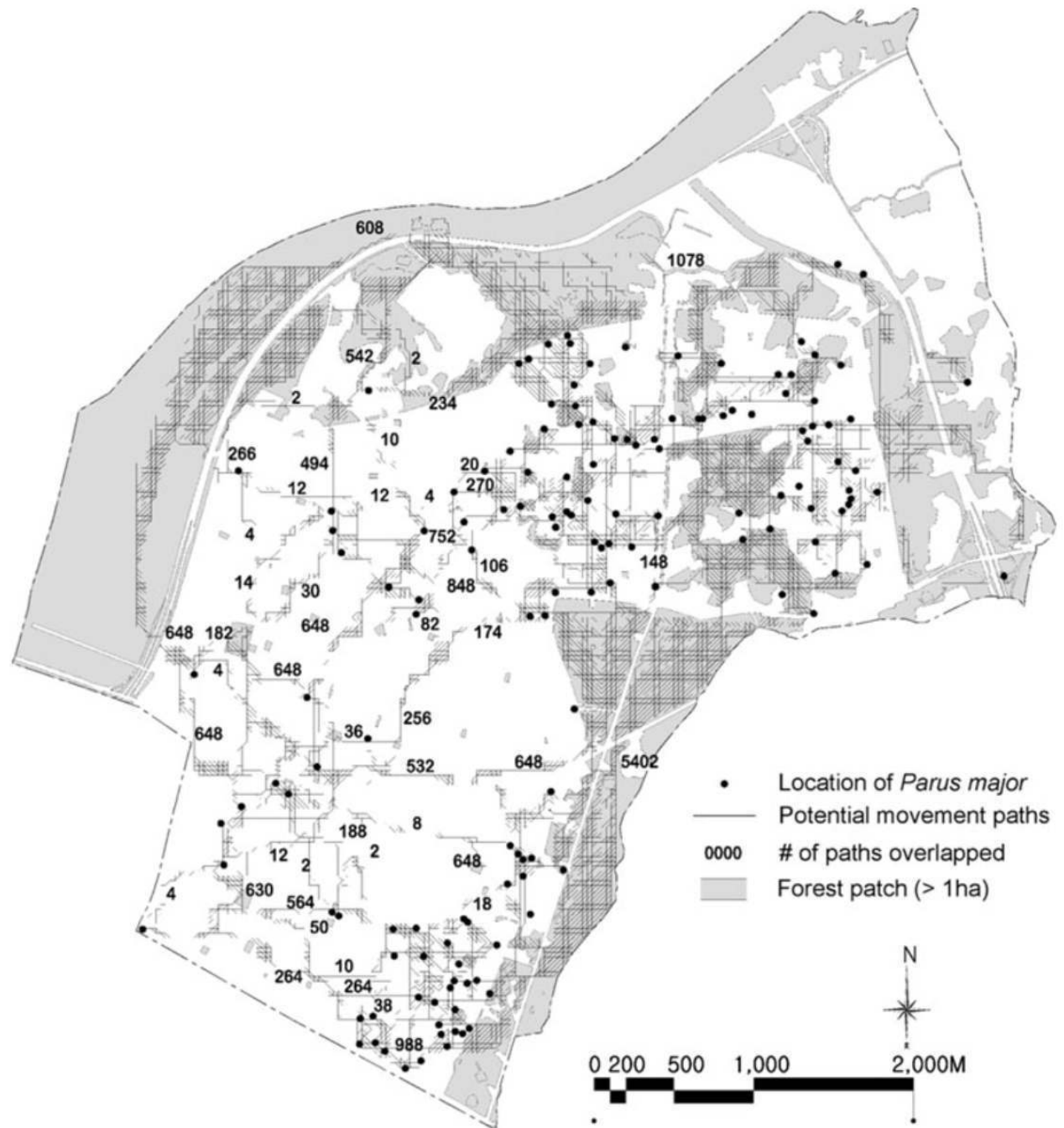
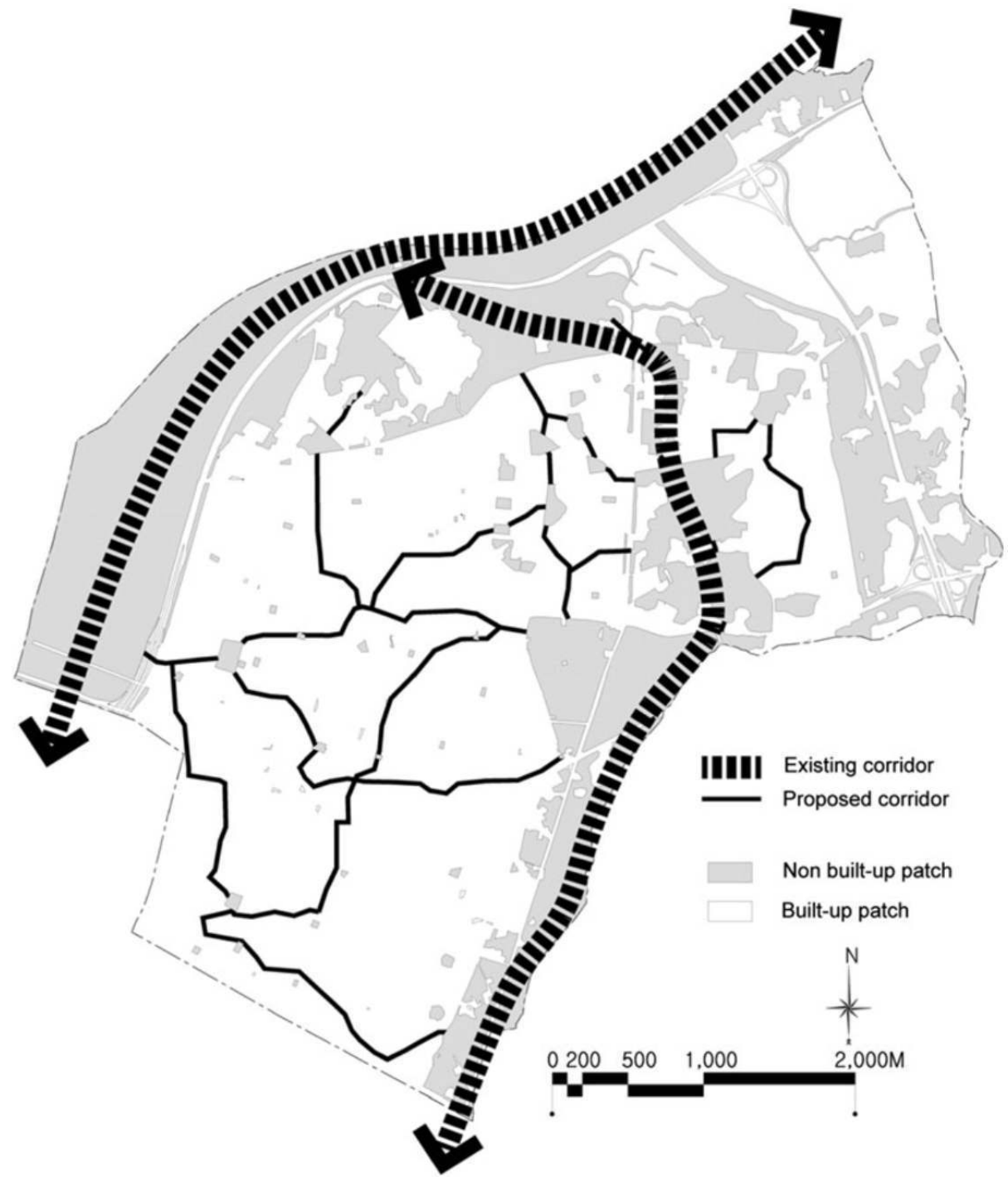
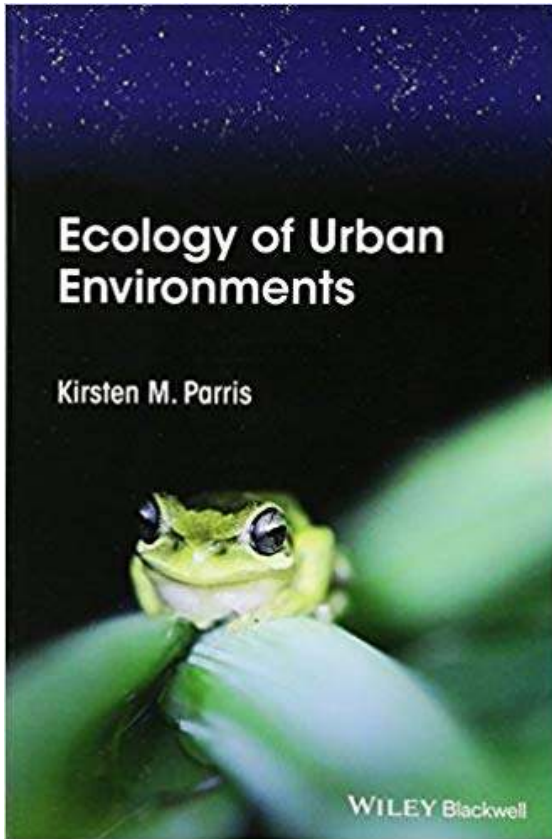
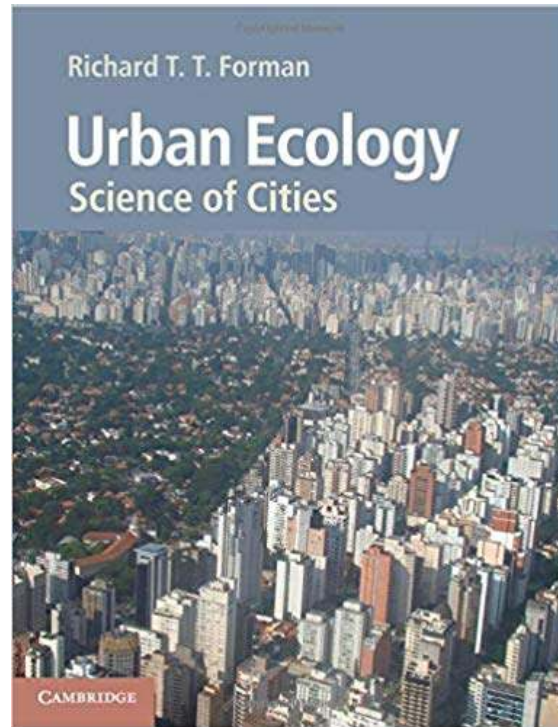


Fig. 6 The ecological network plan of the study area

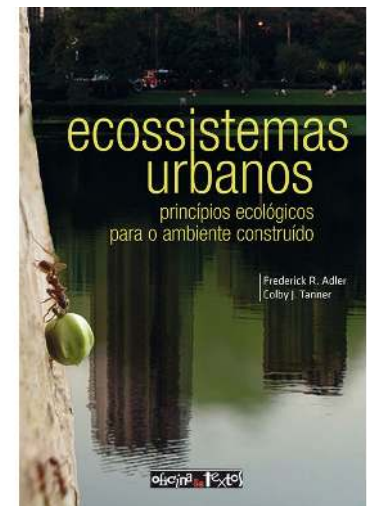




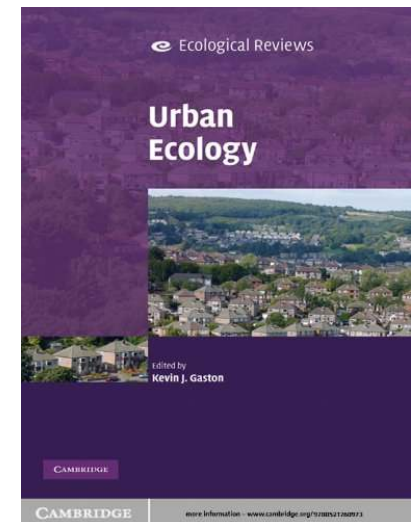
Cap. 3



Cap. 2



Cap. 1



Cap. 2