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ANTONIO FERNANDO COSTA DA SILVA

RESPOSTAS DE ANFÍBIOS E LAGARTOS À DEGRADAÇÃO DE MATAS CILIARES NA AMAZÔNIA ORIENTAL

SÃO LUÍS
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RESPOSTAS DE ANFÍBIOS E LAGARTOS À DEGRADAÇÃO DE MATAS CILIARES NA AMAZÔNIA ORIENTAL

Antonio Fernando Costa da Silva

Orientadora: Prof.ªDr.ª Gilda Vasconcellos de Andrade

Dissertação apresentada ao programa de Pós-Graduação em Biodiversidade e Conservação da Universidade Federal do Maranhão, como requisito à obtenção do título de mestre em Biodiversidade e Conservação.

Área de Concentração: Biodiversidade e Conservação em Ecossistemas de Transição

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Dissertação submetida e aprovada pela banca examinadora.

Orientadora:

_____

Profª. Drª. Gilda Vasconcellos de Andrade (UFMA)

Examinadores:

_____

Prof. Dr. Carlos David da Silva Oliveira dos Santos Titular
Universidade Federal do Maranhão (UFMA)

_____

Prof. Dr. Guarino Rinaldi Colli Titular
Universidade de Brasília (UnB)

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SUMÁRIO

RESUMO

Os vários processos atuais de transformação do hábitat por ações humanas tem sido reconhecidos como principais ameaças à biodiversidade. Neste contexto, anfíbios e répteis têm sido foco de pesquisas, algumas que observaram populações em declínio. Nosso estudo avaliou o efeito da degradação ambiental sobre anuros e lagartos em fragmentos de mata ciliar em regiões com diferentes níveis de ocupação na Amazônia Oriental. Nossa expectativa foi a ocorrência de alterações na estrutura das assembléias com a degradação. Testamos a hipótese de que a riqueza das espécies mais dependentes dos ambientes florestados estaria negativamente associada à degradação das matas. Por outro lado, a riqueza das espécies mais generalistas e capazes de utilizar as matas degradadas estaria positivamente associada ao aumento dos impactos antrópicos. As amostragens ocorreram de agosto de 2014 a setembro de 2015 no sudoeste do Amapá, AP (8 pontos amostrais) e no norte do Pará, PA (4 pontos amostrais), Brasil. A amostragem foi por procura ativa padronizada por tempo. Os níveis de degradação nos pontos amostrais, quantificamos por um índice de degradação (ID). Das 25 espécies de lagartos, 10 são heliotérmicas (H) e 15 não-heliotérmicas (nH). Das 52 espécies de anfíbios, 23 consideramos de áreas mais abertas (Aa) e 29 dependentes das áreas mais fechadas de mata (Af). O ID variou de 0,019 em uma mata ciliar mais isolada no Pará à 0,113 em uma mata da região mais próxima à área urbana do Amapá. Para lagartos, a relação negativa entre nH/H e o ID foi significativa ($F_{1,10}$ = 7.313, r^2 = 0.422 e p=0,022), assim como para anuros entre Af/Aa e ID ($F_{1,10}$ = 9.646, r^2 = 0.491 e p=0,011). As espécies de anfíbios dependentes de mata não ocorreram nas matas mais degradadas. Portanto, a composição e a estrutura das assembléias de anuros e lagartos na Amazônia Oriental está sendo afetada pela degradação das matas ciliares.

Palavras-chave: herpetofauna, degradação ambiental, Norte do Brasil.

ABSTRACT

The innumerous current processes of habitat transformation by human actions have been recognized as the main threats to biodiversity. In this context, amphibians and reptiles have been the focus of researches, some of them observing populations decline. Our study evaluated the effects of environmental degradation in anurans and lizards in riparian forest fragments in regions with different levels of occupation in the Eastern Amazonia. Our expectation was the occurrence of changes in the structure of assemblies with the degradation. We tested the hypothesis that the richness of species more dependent on forested environments would be negatively associated to forests degradation. On the other hand, the richness of more generalists species and capable of living in the degraded forests would be positively associated with the increase in the anthropic impacts. The samplings occurred between August 2014 to September 2015 in southwest Amapa, AP (8 sample points) and north Para (4 sample points), Brazil. The sampling was by active search standardized by time. The degradation levels in the sample points were quantified using a degradation index (ID). From the 25 lizard species, 10 are heliothermics (H) and 15 no-heliothermics (nH). From the 52 amphibian species, 23 we considered from more open areas (Aa) and 29 dependent on more closed forested areas (Af). The ID varied from 0.019, in a most isolated riparian forest in Para, to 0.113 in a forest of the region closest to the urban area in Amapa. For lizards, the negative relation between nH/H and the ID was significant ($F_{1,10}$ = 7.313, r^2 = 0.422 e p=0.022), as well as for anurans between Af/Aa and ID ($F_{1,10}$ = 9.646, r^2 = 0.491 e p=0.011). The amphibian species dependent on forest didn't occur in the most impacted areas. Therefore, the composition and structure of anurans and lizards assemblies in the Eastern Amazonia have been affected by degradation in the riparian forests.

Keywords: herpetofauna , environmental degradation, Northern Brazil .

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Figura 4. (em apêndice). Foto da esquerda mostrando trilha de acesso aos castanhais presentes em quase todos os pontos da área da UHE de Santo Antônio. Foto da direita mostrando clareira presente no ponto P4, evidenciando uma perturbação bem antiga.

Figura 5. (em apêndice). Foto de queimada presente no ponto P9 na APA do Curiaú, tal impacto tem sido responsável pela perda de vegetação nativa e substituição desta por pastos.

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APRESENTAÇÃO

Devido à necessidade de se entender melhor o efeito da crescente urbanização e degradação de matas ciliares sobre a herpetofauna para melhor conservá-la, desenvolvemos esta pesquisa. Para obtenção do título de Mestre em Biodiversidade e Conservação, o trabalho será apresentado e defendido perante uma banca examinadora.

O artigo que foi gerado será submetido ao periódico **"Landscape and Urban Planning"** com as suas normas em anexo.

Para facilidade de leitura da dissertação, as figuras, tabelas e legendas estão inseridas no artigo, não seguindo as normas.

Inicialmente há uma breve fundamentação teórica que nos auxiliou a embasar esta dissertação. Na sequência, o artigo.

FUNDAMENTAÇÃO TEÓRICA

Sabe-se que dentre os processos de transformação mais impactantes temos a destruição de grandes áreas de floresta tropical ao redor do mundo, principalmente para a implementação de pastos e campos agrícolas (Wright & Muller-Landau, 2006; Herrera-Montes & Brokaw, 2010). Tais impactos implicam na fragmentação e na perda de hábitats, que são considerados os principais fatores responsáveis por mudanças substanciais da estrutura e dos parâmetros de populações nativas de animais, causando a extinção e perda da biodiversidade (e.g., Laurence & Bierregaard, 1997; Law & Dickman 1998; Lovejoy *et al,* 1986; Noss, 1994; Terborgh, 1992; Dixo & Metzger, 2009; Laurance *et al*., 1997; Fahrig, 2003).

Diferentes espécies respondem de formas distintas às alterações do hábitat dependendo da sua dinâmica populacional e das suas necessidades em relação ao uso do hábitat (Fleishman *et al*., 2002). Algumas características contribuem bastante para a suscetibilidade à fragmentação, tais como pequena abundância, grande área de vida, alta flutuação populacional, baixa fecundidade, baixa habilidade de dispersão e especialização de hábitats (Henle *et al*., 2004).

Devido à relativa baixa mobilidade, requerimentos fisiológicos particulares, especificidade de hábitat e facilidade de estudo, anfíbios e lagartos são considerados modelos ideais para pesquisas sobre o efeito da fragmentação (Silvano *et al.* 2003). Estes grupos são conspícuos, o que viabiliza os estudos ecológicos e os levantamentos de biodiversidade. Além disso, ocorrem em altas densidades nos trópicos e apresentam importantes interações ecológicas (Reagan, 1996; Whitfield & Donnelly, 2006). Estudos mostram que a estrutura do hábitat, heterogeneidade e complexidade da vegetação são essenciais para a manutenção da diversidade da herpetofauna (Burbrink *et al*., 1998; Maisonneuve & Rioux, 2001).

Os processos de degradação do ambiente afetam especialmente populações de anfíbios devido às suas restrições fisiológicas, que tornam estreitas sua tolerância à temperatura e umidade (Duellman & Trueb, 1986) e provocam necessidades específicas de hábitat para reprodução (Zimmerman & Bierregaard, 1986). Muitas respostas negativas de anfíbios tropicais à fragmentação têm sido detectadas, incluindo a extinção de algumas espécies (Vallan 2000; Pineda & Hallfter 2004), a diminuição da abundância (Marsh & Pearman 1997), o afastamento das bordas dentro de fragmentos florestais (Schlaepfer & Gavin 2001; Lehtinen *et al.,* 2003), a redução da fecundidade (Funk & Mills 2003) e mudanças na composição da comunidade

(Gascon *et al.,* 1999; Pineda & Hallfter 2004). O isolamento entre locais de reprodução e os de abrigo e alimentação, expõe os indivíduos à predação e dessecação durante o deslocamento entre habitats, podendo causar declínios associados à degradação de paisagens naturais (Becker, Fonseca, Haddad, Batista & Prado, 2007).

Os squamatas não são restritos por necessidades de umidade como os anfíbios, mas dependem da termoregulação (Pough et al., 1998). Estudos mostram que o grupo encontra-se muito sujeito à perturbações e à degradação ambiental (Vitt et al., 2008; Sivervo et al., 2010). Algumas espécies de lagartos não demonstram ser afetados pela fragmentação (Jellinek et al., 2004) e podem, inclusive, preferir bordas de fragmento (Schlaepfer & Gavin 2001; Lehtinen et al., 2003). Por outro lado, fatores relacionados indiretamente à degradação como, mudanças na frequência das chuvas, podem afetar também populações de lagartos através de efeitos indiretos sobre a oferta de alimentos e habitat (Araújo et al., 2006). Por sua vez, os lagartos ocorrem em diversas posições da teia trófica e seu declínio ou extinção afeta diversas outras espécies animais (Rodrigues, 2005; Whitfield & Donnelly, 2006).

As matas ciliares ou de galeria, onde as espécies desse estudo foram amostradas, são consideradas importantes corredores biológicos, consideradas pela legislação Brasileira como Áreas de Proteção Permanente (APPs). Na região amazônica tais matas são ameaçadas pela crescente taxa de desmatamento na região, principalmente nas regiões próximas ao "Arco do Desmatamento", que se extende do sul ao leste da Amazônia (Lees & Peres, 2008). Matas de galeria oferecem uma ampla disponibilidade de recursos, servindo de refúgio para a fauna, fornecendo abrigo e alimentação facilitando o fluxo gênico entre muitas populações. Quanto aos recursos abióticos as matas ciliares têm importância fundamental na manutenção da qualidade da água dos mananciais (Lacerda & Figueiredo, 2009).

Atualmente, esses ecossistemas encontram-se frequentemente perturbados por desmatamentos, grandes queimadas ou mineração. Infelizmente, tais matas sofrem outras pressões antrópicas por conta da crescente urbanização, como por exemplo: remoção de madeira para a construção civil, a abertura de estradas em regiões com topografia acidentada e a implantação de culturas agrícolas e de pastagem (Martins, 2001). Dessa forma, são necessários estudos que mostrem os efeitos dos processos antrópicos sobre as populações nativas.

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Respostas de anfíbios e lagartos à degradação de matas ciliares na Amazônia Oriental

Antonio Fernando Costa da SILVA[a]
Gilda Vasconcellos de ANDRADE[b]
[a]Universidade Federal do Maranhão, Programa de Pós-Graduação em Biodiversidade e Conservação.Avenida dos Portugueses, 1966 - Bacanga, São Luís - MA, 65080-805. Email: antoniofernando.costadasilva8@gmail.com. Telefone:+5598986043570
[b]Universidade Federal do Maranhão, Departamento de Ciências Biológicas.

Os vários processos atuais de transformação do hábitat por ações humanas tem sido reconhecidos como principais ameaças à biodiversidade. Neste contexto, anfíbios e répteis têm sido foco de pesquisas, algumas que observaram populações em declínio. Nosso estudo avaliou o efeito da degradação ambiental sobre anuros e lagartos em fragmentos de mata ciliar em regiões com diferentes níveis de ocupação na Amazônia Oriental. Nossa expectativa foi a ocorrência de alterações na estrutura das assembléias com a degradação. Testamos a hipótese de que a riqueza das espécies mais dependentes dos ambientes florestados estaria negativamente associada à degradação das matas. Por outro lado, a riqueza das espécies mais generalistas e capazes de utilizar as matas degradadas estaria positivamente associada ao aumento dos impactos antrópicos. As amostragens ocorreram de agosto de 2014 a setembro de 2015 no sudoeste do Amapá, AP (8 pontos amostrais) e no norte do Pará, PA (4 pontos amostrais), Brasil. A amostragem foi por procura ativa padronizada por tempo. Os níveis de degradação nos pontos amostrais, quantificamos por um índice de degradação (ID). Das 25 espécies de lagartos, 10 são heliotérmicas (H) e 15 não-heliotérmicas (nH). Das 52 espécies de anfíbios, 23 consideramos de áreas mais abertas (Aa) e 29 dependentes das áreas mais fechadas de mata (Af). O ID variou de 0,019 em uma mata ciliar mais isolada no Pará à 0,113 em uma mata da região mais próxima à área urbana do Amapá. Para lagartos, a relação negativa entre nH/H e o ID foi significativa ($F_{1,10}$ = 7.313, r^2 = 0.422 e p=0,022), assim como para anuros entre Af/Aa e ID ($F_{1,10}$ = 9.646, r^2 = 0.491 e p=0,011). As espécies de anfíbios dependentes de mata não ocorreram nas matas mais degradadas. Portanto, a composição e estrutura das assembléias de anuros e lagartos na Amazônia Oriental está sendo afetada pela degradação das matas ciliares.

Palavras-chave: herpetofauna, degradação ambiental, Norte do Brasil.

Highlights

A degradação ambiental afeta as assembléias de lagartos e anuros em matas ciliares.

Lagartos e Anuros podem ser utilizados como indicadores de qualidade ambiental na Amazônia.

Áreas com intensos impactos ambientais tem especialmente a anurofauna de mata ameaçada.

1. INTRODUÇÃO

A crescente destruição e a redução dos hábitats naturais por ações antrópicas vem sendo consideradas as maiores ameaças à biodiversidade (McDonnell & Pickett, 1993; Hamer & McDonnell, 2010). Entre os principais exemplos estão a destruição das florestas tropicais para a criação de pastos e campos agrícolas (Wright & Muller-Landau, 2006; Herrera-Montes & Brokaw, 2010). Além disso, a introdução de espécies exóticas como plantas ornamentais e animais domésticos afetam as populações nativas, levando algumas espécies à extinção (Pickett, Cadenasso, Grove, Nilon, Pouyat, Zipperer & Costanza, 2001; McKinney, 2006).

Com esse constante aumento da degradação ambiental, populações da herpetofauna têm sido especialmente ameaçadas (Bell & Donelly, 2006). Anfíbios, em virtude do seu complexo ciclo de vida (Duellman & Trueb,1994); dependência da água, do hidroperíodo e de características da paisagem para a reprodução (Lescano, Bellis, Hoyos & Leynaud, 2015); e o deslocamento de indivíduos para sítios reprodutivos isolados pela fragmentação, o que expõe os indivíduos à predação e dessecação (Becker, Fonseca, Haddad, Batista & Prado, 2007).

Os lagartos de ambientes mais fechados tem suas populações afetadas por alterações no habitat em virtude da fragmentação de ambientes naturais (Gibbons, Scott, Ryan, Buhlmann, Tuberville & Metts, 2000; Araújo, Thuiller & Pearson, 2006). A entrada de espécies de áreas abertas pode excluir competitivamente as espécies nativas (Huey, Deutsch, Tewksbury, Vitt, Hertz, Perez & Garland Jr, 2009; Logan, Fernandez & Calsbeek, 2015) ou levar ao declínio destas populações, que afetam as interações tróficas devido às diversas posições que estes organismos ocupam (Rodrigues, 2005; Whitfield & Donnelly, 2006).

Em manchas de Savana Amazônica, Carvalho Jr, Lima, Magnusson & Albernaz (2008) encontraram uma relação negativa entre a abundância dos lagartos *Gonatodes humeralis* e *Coleodactylus amazonicus* e a fragmentação da floresta. Na Mata Atlântica foi observado que os efeitos de borda podem afetar positivamente na abundância de algumas espécies generalistas, como *Tropidurus torquatus*, sem no entanto afetar outras espécies nativas (Dixo & Martins 2008). A existência de corredores de mata e a estrutura e tamanho dos fragmentos florestais podem afetar a estrutura das espécies de lagartos, sem no entanto afetar significativamente a riqueza ou a abundância em fragmentos com diferentes tamanhos ou níveis de conectividade (Dixo & Metzger, 2009).

Os ambientes de matas ciliares, importantes para várias espécies da herpetofauna, mesmo protegidos pela legislação brasileira, ainda são áreas constantemente ameaçadas (Lacerda & Figueiredo, 2009). Mesmo respeitando-se os valores de tamanho estabelecidos por lei, alguns trabalhos têm mostrado que essas áreas destinadas à proteção ainda são insuficientes para a manutenção de populações viáveis de algumas populações animais (Lees & Peres, 2008).

Nosso estudo ocorreu em matas ciliares em ambientes próximos a ocupações humanas na Amazônia Oriental. Se houvesse variação na utilização e degradação das matas, esperávamos a ocorrência de alterações na estrutura das assembléias. Assim, nossa hipótese foi que a riqueza de espécies de anfíbios e lagartos associada aos ambientes florestados estaria negativamente associada à degradação das matas e a das mais generalistas, positivamente. Tais relações para cada grupo foram medidas por meio de razões entre as espécies de áreas florestadas e as espécies mais tolerantes à degradação (de áreas abertas). Além disso, adaptamos um Índice para medir e comparar a degradação das matas. Guias, guarda-parques e interessados em conservação poderão utilizar essa ferramenta simples e funcional, que não necessita de equipamentos.

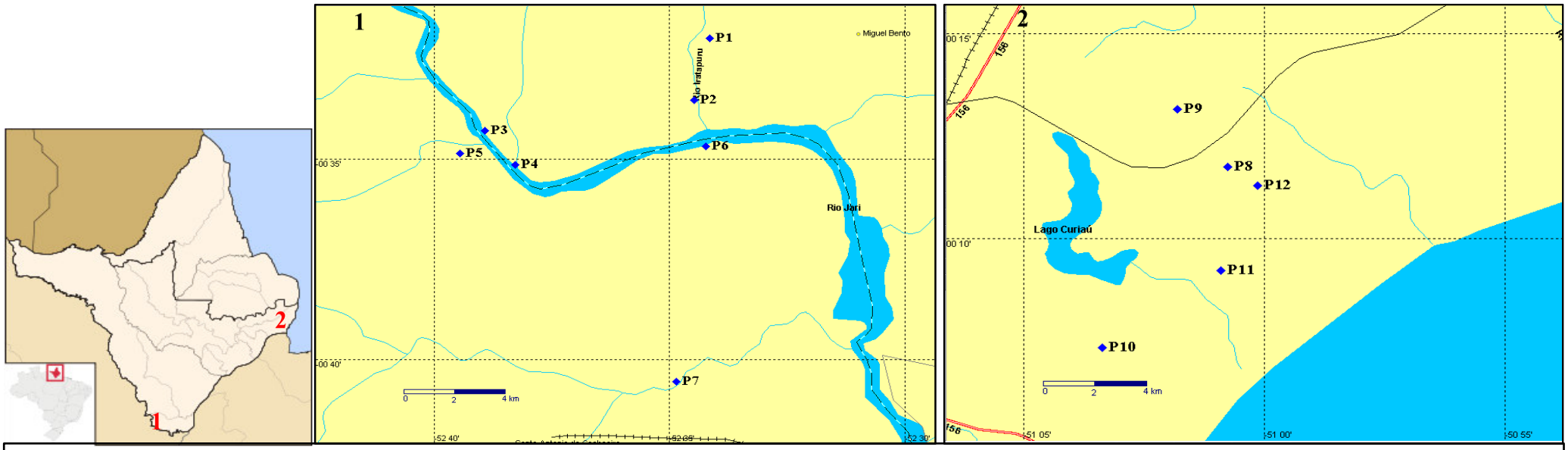
2. METODOLOGIA

2.1. Áreas de estudo

Foram realizadas amostragens da herpetofauna em matas ciliares de agosto de 2014 a setembro de 2015 em três municípios, dois situados no estado do Amapá (AP) e um no estado do Pará (PA). Para o estado do Amapá escolhemos os municípios de Macapá, também capital do estado e o município de Laranjal do Jarí localizado na porção sudoeste do Amapá. Os pontos amostrais escolhidos no estado do Pará foram no munícipio de Almeirim, situado na porção norte do estado, este fazendo fronteira com o município de Laranjal do Jarí, tendo o rio Jarí os separando.

O ambiente na região do Jarí (municípios de Laranja do Jarí-AP e Almerim-PA) que possui sete pontos (P1 a P7) é caracterizado pela presença de castanhais com florestas densas de alto porte (Figura 01, em apêndice). O relevo na parte sul de Laranjal do Jari caracteriza-se por uma faixa de planície amazônica, sujeita a inundações periódicas (IEPA, 2008). Na capital do estado do Amapá foram escolhidos cinco pontos amostrais (P8 a P12) na Área de Proteção Ambiental do Rio Curiaú localizada a cerca de 5 km ao norte do centro de Macapá (Figura 01, em apêndice). A APA possui uma área de 21.676,00 ha, a vegetação é caracterizada por formações de Cerrado, Campos Inundáveis, Florestas de Várzea, além de ilhas de Mata e Matas

de Galeria associadas a lagoas (Lima e Silva, Freitas, Santos & Souto, 2013), a distribuição dos pontos estudados pode ser vista na figura 01.



Quadro 1: pontos inseridos na UHE de Santo Antônio (P1 a P7), estados do Amapá (Laranjal do Jarí) e Pará (Almeirim) ;
Quadro 2: pontos inseridos na APA do Curiaú (P8 a P12), estado do Amapá (Macapá).

Figura 01. Localização dos pontos de amostragem pontos amostrais no Sudoeste do estado do Amapá no município de Laranjal do Jarí e no distrito de Monte Dourado no município de Almeirim, norte do estado do Pará (P1 a P7), vistos no quadro 1. Distribuição dos pontos amostrais localizados na APA do Curiaú (P8 a P12), estado do Amapá, situada dentro da capital Macapá e presentes no quadro 2.

2.2.Medida da degradação ambiental (Índice de degradação - ID)

Os níveis de perturbação antrópica encontrados em cada fragmento de mata ciliar amostrado foram quantificados por meio de um índice de degradação (ID) que desenvolvemos com base em outros dois índices similares. O primeiro foi utilizado em restingas do estado do Rio de Janeiro (Rocha, Bergallo, Sluys, Alves & Jamel, 2007). Por sugestão do primeiro autor, substituímos os dados de ausência (0), presença baixa (1) e presença alta (2) de impactos observados, utilizados no índice original, pela soma dos dados da presença (1) ou ausência (0) de cada tipo de impacto observado em 50 pontos amostrados aleatoriamente em cada mata ciliar. Nas proximidades do corpo d'água principal de cada mata ciliar, os 50 pontos foram sorteados de 5 a 100 metros da margem, ao longo de um percurso linear que cruzava os mesmos pontos de amostragem das espécies.

Também nos baseamos no índice desenvolvido por Cardoso, Rigal, Fattorini, Terzopoulou & Borges (2013) em um estudo na Ilha Terceira, Açores, Portugal, para atribuir pesos diferentes a cada categoria de impacto. Assim, o menos impactante foi o deixado por humanos, mas de rápida degradação (lixo orgânico) e o mais impactante o que causava dano, isolamento e/ou destruição imediata na mata (como retirada de madeira). Cada uma das cinco categorias de impacto que estabelecemos, subdividimos (tabela 1 em apêndice) para o preenchimento em uma planilha de campo da presença/ausência dos diferentes itens de impacto que observávamos.

Após a aferição de cada impacto nos 50 pontos amostrais de cada mata ciliar, calculamos o índice de degradação (ID) pela soma dos impactos observados em cada categoria (**C**), considerando-se os pesos atribuídos do menos até o mais impactante:

$$ID = \mathbf{C_1} + 2\mathbf{C_2} + 3\mathbf{C_3} + 4\mathbf{C_4} + 5\mathbf{C_5}$$

Para o cálculo de **C**, utilizamos o somatório das subcategorias (**Sc**) padronizadas: $\mathbf{C} = \sum (\mathbf{S}c/i)$, onde i = número de itens por subcategorias. A presença ou ausência de cada item destas subcategorias nos 50 pontos amostrais foi anotada, somada e dividida por 50 para o cálculo de **Sc** de cada categoria. Os valores de ID podem variar de 0 para ausência total de degradação à 15 que seria uma área completamente impactada, optamos por padronizar os valores nas análises para obtermos valores entre 0 e 1 dividindo todos os valores por 15.

2.3. Amostragem, classificação das espécies e análise

A amostragem ocorreu entre agosto de 2014 e setembro de 2015 por procura ativa padronizada por tempo (Campbell & Christman, 1982), com as buscas sendo realizadas das 15 às 20 horas por dois pesquisadores (ou um acompanhado de aluno previamente treinado). Todas as espécies foram identificadas com uso de guias e chaves específicos para anfíbios e répteis (Ávila-Pires, 1995; Vitt, Magnusson, Ávila-Pires & Lima, 2008; Lima, Magnusson, Menin, Erdtmann, Rodrigues, Keller & Hodl, 2006) e comparação com exemplares de Coleções Herpetológicas.

Para lagartos, discriminamos as espécies em heliotérmicas (H) e não-heliotérmicas (nH) segundo Brandão e Araújo (2001) e Vitt *et al*. (2008). Como as espécies heliotérmicas ocupam naturalmente ambientes abertos, inclusive com presença humana, nós as consideramos na mata ciliar, como mais tolerantes aos impactos antrópicos, tais como trilhas abertas na mata e clareiras. As não-heliotérmicas dependem de sombreamento para termorregular e as consideramos menos tolerantes aos impactos antrópicos.

Os anuros foram divididos em espécies de áreas fechadas (Af), encontradas principalmente em ambientes de matas conservadas ou pouco impactados e espécies de áreas abertas (Aa), encontradas em ambientes muito antropizados ou relativamente degradados (Silva e Andrade, dados não publicados). Para tanto, nos baseamos em observações pessoais, nos seus modos reprodutivos (Haddad & Prado, 2005), bem como em suas características particulares, como a tolerância a ambientes abertos (Frost, 2013; La Marca, Reynolds, Azevedo-Ramos, 2004; La Marca, Coloma, Ron, Azevedo-Ramos, Silvano, Hardy, 2010; Martins, 1988; Rodrigues, Caramaschi & Mijares, 2010; Rodrigues, Azevedo-Ramos & Hoogmoed, 2010; Solís, Ibáñez, Hammerson, Hedges, Diesmos, Matsui, Hero, Richards, Coloma, Ron, La Marca, Hardy, Powell, Bolaños, Chaves, & Ponce, 2009).

Após as amostragens, foram calculados os valores de riqueza de espécies de lagartos heliotérmicos (*H*), não heliotérmicos (*nH*), a riqueza total, a abundância por área, bem como a razão *nH/H* para cada mata, para representar a estrutura da assembleia de lagartos, que posteriormente foram relacionados com os valores de degradação dos seus respectivos pontos. A riqueza de anuros de áreas abertas (*Aa*), anuros de áreas fechadas (*Af*), riqueza total, abundância por área, e também uma razão *Af/Aa*, para representar a estrutura das assembleias de anuros, foi relacionada à degradação dos ambientes em que se encontravam. Todas a variáveis citadas para as populações de lagartos e anuros foram relacionadas ao índice de degradação

desenvolvido (ID), por meio de uma análise de regressão linear por meio do programa PAST 3.01 (Hammer, Haper & Ryan, 2001).

3. RESULTADOS

3.1.Índice de degradação nas matas ciliares

Os valores do índice de degradação (ID) após a padronização variaram de 0,019 a 0,113, embora tal variação de valores pareça relativamente baixa, os extremos aqui apresentados foram suficientes para mostrar alterações na composição de espécies em cada área estudada (Tabela 1).

Tabela 1. Índice de degradação (ID) encontrado em cada uma das matas ciliares amostradas, com os respectivos valores da Razão nH/H obtida a partir do quociente do número de espécies de lagartos não-heliotérmicos (nH) pelo número de espécies heliotérmicas (H) e Razão Af/Aa obtida a partir do quociente do número de espécies de anuros de áreas fechadas (Af) pelo número de espécies de áreas abertas (Aa), bem como os valores de riqueza de lagartos (Riq. L) e de anuros (Riq. A) em todos os pontos amostrados.

Área	ID	Riq (L)	Spp H (L)	Spp nH (L)	nH/H (L)	Riq (A)	Spp Aa (A)	Spp Af (A)	Af/Aa (A)
P1	0,0343	6	1	5	5	10	2	8	4
P2	0,0292	8	1	7	7	9	1	8	8
P3	0,0342	9	2	7	3,5	16	3	13	4,333333333
P4	0,0462	5	2	3	1,5	14	2	12	6
P5	0,0358	12	3	9	3	26	7	19	2,714285714
P6	0,0213	7	2	5	2,5	13	1	12	12
P7	0,02	18	6	12	2	19	5	14	2,8
P8	0,0903	13	8	5	0,625	7	7	0	0
P9	0,05	2	2	0	0	2	2	0	0
P10	0,1051	5	3	2	0,666666667	4	4	0	0
P11	0,0987	7	4	3	0,75	6	6	0	0
P12	0,1135	3	3	0	0	4	4	0	0

3.2. Respostas dos lagartos à degradação

Ao longo do estudo encontramos 25 espécies de lagartos, 10 consideradas heliotérmicas e 15 não-heliotérmicas (Figura 2, em apêndice). A riqueza de lagartos não variou significativamente entre as áreas de estudo com o aumento dos valores de ID ($r^2 = 0.128$; $F = 1.468$ e $p = 0.254$), bem como os valores de abundância ($r^2 = 0.002$; $F = 0.021$ e $p = 0.887$). Quanto à composição de espécies, o número de espécies heliotérmicas não apresentou nenhuma relação com os valores de degradação ($r^2 = 0.12$; $F = 1.365$ e $p = 0.27$), no entanto a riqueza de lagartos não-heliotérmicas apresentou uma relação significativa negativa ($r^2 = 0.431$; $F = 7.588$ e $p = 0.02$) aos valores crescentes de ID (figura 02). A razão entre espécies de lagartos não-heliotérmicas e heliotérmicas em cada uma das áreas diminuiu significativamente ($r^2 = 0.422$; $F = 7.313$ e $p = 0.022$) com o aumento dos impactos ambientais (figura 03).

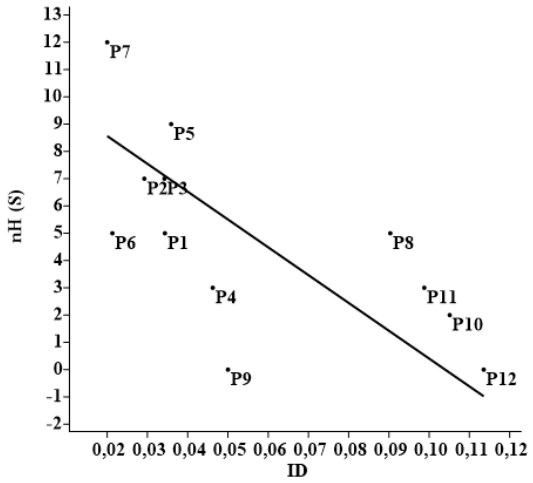


Figura 02. Riqueza de espécies de lagartos não-heliotérmicas em relação valores crescentes de ID ($r^2 = 0.431$; F = 7.588 e p = 0.02).

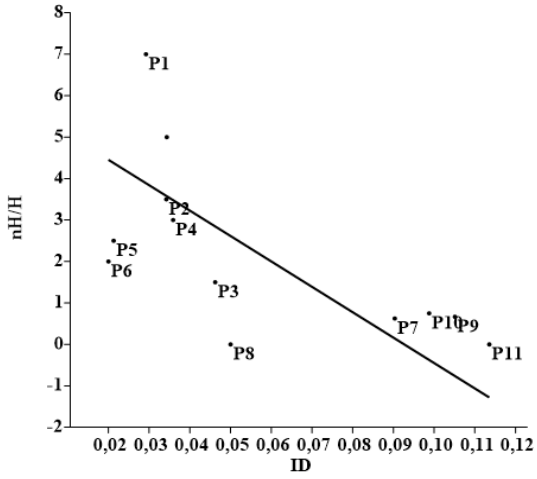


Figura 03. Proporção entre espécies de lagartos não-heliotérmicas e heliotérmicas representada pela razão nH/H em cada uma das áreas variou significativamente com o aumento dos impactos ambientais ($r^2 = 0.422$; F = 7.313 e p = 0.022).

3.3. Respostas dos anuros à degradação.

Foram encontradas 52 espécies anuros em todas as áreas estudadas, destas 23 consideradas anuros de áreas abertas e 29 anuros de áreas fechadas (Figura 3, em apêndice). A riqueza de anuros diminuiu significativamente ($r^2 = 0.42$; F = 7.255 e p = 0.023) com o aumento da degradação (figura 04). A abundância de anuros não variou significativamente ($r^2 = 0.091$; F = 1.005 e p = 0.34). Avaliando a composição de espécies, não houve relação significativa entre os anuros de áreas abertas ($r^2 = 0.2$; F = 2.494 e p = 0.145) com os valores de ID. No entanto, anuros de áreas fechadas diminuiram significativamente ($r^2 = 0.649$; F = 18.501 e p = 0.002) com o aumento da degradação (figura 05). A razão entre espécies de áreas fechadas e espécies de

áreas abertas de anuros também apresentou uma relação negativa significativa ($r^2 = 0.491$; F = 9.646 e p = 0.011) com os valores crescentes de impactos ambientais (figura 06).

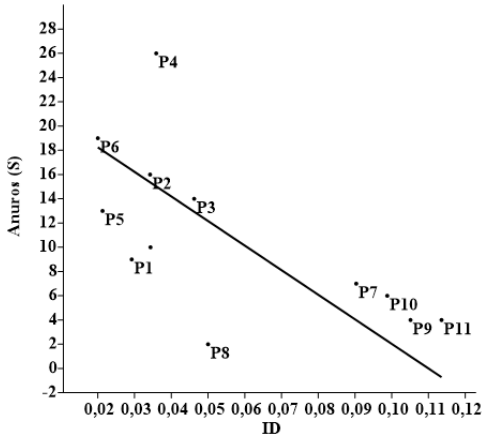


Figura 04. Riqueza de espécies de anuros em relação ao aumento dos valores de ID ($r^2 = 0.42$; F = 7.255 e p = 0.023).

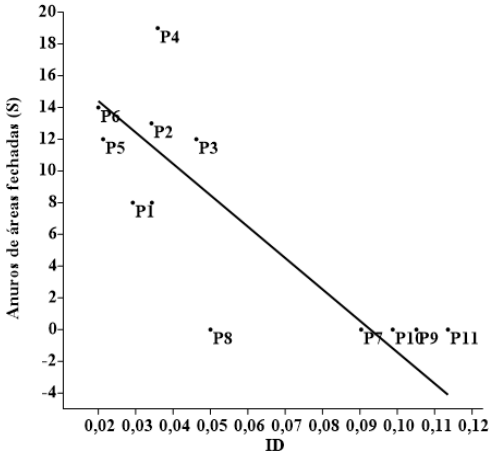


Figura 05. Riqueza de espécies de anuros de áreas fechadas em relação valores de ID ($r^2 = 0.649$; F = 18.501 e p = 0.002).

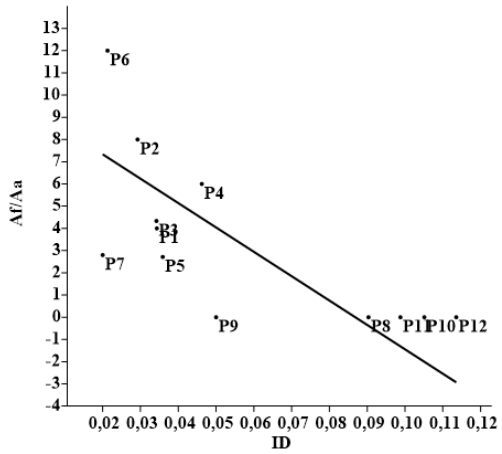


Figura 06. Proporção entre espécies de espécies de anuros de áreas fechadas e de áreas abertas representada pela razão Af/Aa em cada uma das áreas variou significativamente com o aumento dos impactos ambientais ($r^2 = 0.491$; F = 9.646 e p = 0.011).

4. DISCUSSÃO

As matas amostradas na região do Jarí (Sudoeste do Amapá e Norte do Pará) apresentaram baixos valores do índice de degradação, o que reflete o bom estado de conservação nessa região. Apenas algumas trilhas ocorrem nestas matas (figura 4 em apêndice), destinadas à coleta de castanha-do-Brasil (*Bertholletia excelsa* Bonpl.), nos castanhais existentes nessas regiões. Tais matas apresentaram também alguns pequenos pontos de desmatamento, destinados à agricultura de subsistência. No ponto P4 registramos uma área abandonada há muito tempo, em avançado grau de sucessão ecológica, apresentando uma capoeira com árvores altas e uma pequena clareira (figura 4 em apêndice). O ponto P7 apresentou o mais baixo valor de ID (0,019) das amostradas no Pará, se encontrava em um lugar de acesso restrito às pessoas que trabalham na UHE de Santo Antônio, bem como às equipes de pesquisa que trabalham na região. Os principais impactos encontrados, consistiam apenas de pequenas trilhas feitas por pesquisadores.

As matas na capital do Amapá estavam em área urbana, em uma área de proteção ambiental (APA do Curiaú), mas apresentaram valores de ID iguais ou superiores à 0,05. O menor valor foi o do ponto P9, em virtude de apresentar menor incidência de presença humana, lixo e trilhas. Por sua vez o P12 apresentou o maior valor (0,113), com muitas trilhas, grandes áreas desmatadas e queimadas contínuas para a criação de novas áreas de pasto (figura 5 em apêndice). Nossos dados corroboraram a hipótese, pois a riqueza de espécies de anfíbios e lagartos associada aos ambientes de mata foi negativamente associada à degradação ambiental. A degradação foi maior em região mais urbanizada, mesmo sendo uma Área de Proteção Ambiental.

Os efeitos da degradação antrópica sobre assembléias de lagartos foram vistos claramente por Germaine & Wakeling (2001), que mostraram como a proximidade com as cidades e consequentes mudanças na paisagem oriundas de intervenções humanas afetaram a distribuição, ocupação do hábitat e organização da assembleia de espécies. No estudo de Herrera-Montes & Brokaw (2010) em áreas de pastagem e de florestas em diferentes estágios de sucessão na Costa Rica, foram mostradas também claras mudanças na estrutura da herpetofauna nas diferentes paisagens. Tais diferenças foram atribuídas à fatores bióticos como a estrutura da vegetação e fatores abióticos como umidade relativa e temperatura. Cardoso *et al*. (2013) mostraram como as condições da paisagem afetavam os padrões de distribuição de espécies endêmicas, nativas e exóticas de artrópodes ao longo da ilha Terceira em Portugal.

Resultados similares envolvendo degradação, estrutura do hábitat e assembléias de lagartos foram encontrados também em estudos que analisam o efeito da fragmentação e do efeito de borda sobre populações de lagartos de folhiço (Dixo & Martins, 2008). Assim como a presença de corredores e tamanho de fragmentos em relação às comunidades de lagartos em áreas com grande impacto antrópico e remanescentes de Mata Atlântica (Dixo & Metzger, 2009).

Com base nos valores do índice de degradação (ID) das áreas estudadas foi possível perceber um aumento dos impactos antrópicos a medida que o ponto de amostragem se localizava em áreas próximas a locais de ocupação humana (vilas, comunidades ribeirinhas ou cidades). Tal proximidade traz consigo uma pressão sobre as populações nativas de répteis e anfíbios, representada por uma alteração significativamente relacionada com os valores de ID.

As assembléias de anuros, em geral, foram mais afetadas que as de lagartos nas matas degradadas, em virtude principalmente da ausência de espécies de áreas fechadas em áreas com maiores valores de degradação. Trabalhos realizados na região neotropical têm mostrado que a degradação dos ambientes naturais tem levado muitas populações nativas à extinção local devido às queimadas (Papp & Papp, 2000). A presença de pastos e a entrada de gado em áreas de mata, que por sua vez pisoteiam e alteram microhábitats no interior desta, prejudicam a reprodução de muitas espécies de áreas fechadas (Colombo, Kindel, Vinciprova & Krause, 2008). Estudos como o de Dixo & Metzger (2009) mostraram também que as alterações e efeitos da fragmentação afetam diretamente as populações de anuros de serapilheira, em paisagens fragmentadas da mata Atlântica.

O índice de degradação ID utilizado se mostrou útil para mostrar os efeitos das perturbações humanas sobre as assembléias de anfíbios (anuros) e de répteis (lagartos), em áreas de mata ciliar. Não necessita de equipamentos, e basta o treinamento de uma pessoa para preenchimento de uma planilha padronizada. Pode ser muito prática para utilização por guias, guardas-parques, estagiários e outros em áreas de conservação para registros e monitoramento ambiental.

5. CONCLUSÃO

A degradação ambiental afetou negativamente as assembléias de anuros e lagartos de matas ciliares na Amazônia Oriental, especialmente os anuros nas proximidades de regiões com maior ocupação humana.

O índice de degradação (ID) é uma ferramenta útil para mensurar quantitativamente os impactos antrópicos no ambiente. Gestores podem utilizar o ID, sem a necessidade de equipamentos, para monitoramento ambiental por guias, guarda-parques ou pessoas treinadas.

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APÊNDICE

Tabela 1. Principais categorias e subcategorias usadas nesse trabalho, com alguns exemplos de impactos relacionados a cada uma delas, bem como seus respectivos pesos.

Categoria	Subcategoria	Exemplos
Lixo Orgânico (peso 1)	Lixo Orgânico	Cascas de Frutas, restos de comida.
Lixo Doméstico (peso 2)	Sacola Plástica	Sacolas de transporte de compras em geral.
	Material Plástico	Copos descartáveis ou pedaços de objetos de plástico.
	Papel	Embalagens de papel, papelão, guardanapos e etc.
	Madeira	Pedaços de móveis, madeira cortada.
	Vidro	Copos, fragmentos de louças, partes de eletrodomésticos.
	Porcelana	Vasos sanitários e utensílios domésticos.
	Tecidos	Roupas, revestimentos de móveis (sofás).
	Isopor	Caixas de isopor e embalagens.
Lixo Inorgânico (peso 3)	Espuma	Espumas oriundas de colchões, sofás etc.
	Fibra	Fibra de vidro.
	Alumínio	Latinhas de refrigerantes, panelas ou partes de objetos ou veículos.
	Ferro	Latinhas de refrigerantes, partes de objetos ou veículos.
	Borracha	Pneus de carros, motos ou bicicletas, mangueiras de jardim.
	PVC	Canos hidráulicos
	Material Eletrônico	Placas internas de eletroeletrônicos (televisões, computadores etc.).
	Nylon	Redes de pesca, linhas ou cordas.
	Material de Construção	Cimento, concreto, areia ou barro depositados no local.
Contaminação (peso 4)	Fezes Humanas	Presença de fezes humanas no local de estudo.
	Fezes de Animais	Presença de fezes de animais domésticos no local de estudo.
	Esgoto	Lançamento de esgoto não tratado no local.
Degradação (peso 5)	Erosão	Assoreamento ou carreamento do solo por chuvas em virtude de solo exposto.
	Estrada Pavimentada	Vias com pavimentação asfáltica dentro da área estudada.
	Construção a menos de 500m	Construções humanas em um raio de menos de 500 metros do ponto amostrado.
	Desmatamento	Retirada da cobertura vegetal para extração de madeira.
	Queimada	Queimadas ilegais ou para obtenção de pastos.
	Trilha Humana	Trilhas com trânsito de pessoas na mata.

Figura 01. Fotografias de alguns dos pontos de amostragem na região do Jarí (Sudoeste do estado do Amapá, e Norte do Pará) P3**(A)**, P6**(B)**, P5 **(C)** e P7 **(D)**, P1**(E)** e em uma mata na APA do Curiaú: P8 **(F)**.

Figura 2. Fotos de algumas das espécies de lagartos encontradas nas áreas de estudo, algumas consideradas não-heliotémicas (nH) e outras consideradas heliotérmicas (H): **A**. *Norops fuscoauratus* (nH), **B**. *Plica plica* (nH), **C.** *Dactyloa punctata* (nH), **D.** *Leposoma guianense* (nH), **E.** *Cnemidophorus criptus* (H) e **F.** *Tropidurus hispidus* (H).

Figura 3. Fotos de algumas das espécies de anuros encontradas nas áreas de estudo, algumas consideradas espécies de áreas fechadas (Af) e outras consideradas espécies de áreas abertas (Aa): **A.** *Rhinella castaneotica* (Af), **B.** *Atelopus hoogmoed* (Af), **C.** *Rhinella margaritifera* (Af), **D.** *Allobates femoralis* (Af), **E.** *Adenomera hylaedactyla* (Aa) e **F.** *Rhinella marina* (Aa).

Figura 4. Foto da esquerda mostrando trilha de acesso aos castanhais presentes em quase todos os pontos da área da UHE de Santo Antônio. Foto da direita mostrando clareira presente no ponto P4, evidenciando uma perturbação bem antiga.

Figura 5. Foto de queimada presente no ponto P9 na APA do Curiaú, tal impacto tem sido responsável pela perda de vegetação nativa e substituição desta por pastos.

ANEXO

GUIDE FOR AUTHORS

Introductory Note: This Guide for Authors for Landscape and Urban Planning includes revisions to the Aims and Scope, Article Types, and Special Issue policies discussed in editorials published in Vols. 105-106 (2012) of the journal. These can be individually accessed free of charge through the Editor's Choice link on the journal's web page: http://www.journals.elsevier.com/landscape-and-urban-planning/ or as a compiled package available from the Editorial Office by contacting LAND@Elsevier.com. Authors seeking further information about the journal's broad policy directions should consult these editorials, but for up-to-date details on specific aspects of manuscript submissions should rely on the online version of this Guide for Authors. -The Editors

1. Aims and Scope

Landscape and Urban Planning is an international journal aimed at advancing conceptual, scientific, and applied understandings of landscape in order to promote sustainable solutions for landscape change. Landscapes are visible and integrative social-ecological systems with variable spatial and temporal dimensions. They have expressive aesthetic, natural, and cultural qualities that are perceived and valued by people in multiple ways and invite actions resulting in landscape change. Landscapes are increasingly urban in nature and ecologically and culturally sensitive to changes at local through global scales. Multiple disciplines and perspectives are required to understand landscapes and align social and ecological values to ensure the sustainability of landscapes. The journal is based on the premise that landscape science linked to planning and design can provide mutually supportive outcomes for people and nature.

Landscape science brings landscape ecology and urban ecology together with other disciplines and cross-disciplinary fields to identify patterns and understand social-ecological processes influencing landscape change. Landscape planning brings landscape architecture, urban and regional planning, landscape and ecological engineering, and other practice-oriented fields to bear in processes for identifying problems and analyzing, synthesizing, and evaluating desirable alternatives for landscape change. Landscape design brings plans, designs, management prescriptions, policies and other activities and form-giving products to bear in effecting landscape change. The implementation of landscape planning and design also generates new patterns of evidence and hypotheses for further research, providing an integral link with landscape science and encouraging transdisciplinary collaborations to build robust knowledge and problem solving capacity.

2. Article Types

Landscape and Urban Planning publishes original, empirical research on important international and regional issues in landscape science, with an emphasis on applied work that provides solutions for landscape design. Most manuscript submissions take the form of full-length Research Papers. Shorter Research Notes are also encouraged as described below. To facilitate the discourse of landscape science and design, a limited number of articles of other types will

also be considered for peer review upon approval by one of the Co-Editors-in-Chief prior to submission.

2.1. Research Papers

Given the problem-driven nature of landscape science and the journal's commitment to linking research and practice, most Research Paper submissions will fall within the area of applied research. Purely conceptual or theoretical work will be considered on a limited basis under the Perspective Essay article type (see below). Otherwise, Research Papers focused on modeling and other "basic" research efforts should include at least a small sample of data to demonstrate proof-of-concept. Whether basic or applied, all Research Papers should describe the relevance of the work and its implications for landscape and urban planning, design, management and/or policy. Research Papers are typically between 4000 and 8000 words, including manuscript text and references (use 25-60 references as a guideline). Some exceptions to the upper length limit may be allowed for reports of large-scale interdisciplinary and transdisciplinary projects or for qualitative research where in-text quotations provide evidence in lieu of tables and figures. An abstract (250 words or less), keywords (3-6), and research highlights (3-5) are also required. Tables and figures should be used with economy to convey essential aspects about study concepts and findings. One or two contextual photos may be optionally included as figures to convey to readers the essential nature of the landscape and issues examined in the article. Other informative materials may also be optionally submitted, including Appendices, Acknowledgments, short Author Biographies, Graphical Abstracts, Google Maps (KML files), Embedded Audio and Video files, and Supplementary Material for online-only publication (see Section 3.8 below).

2.2. Research Notes

A Research Note is a concise but complete description of a limited investigation that will not be included in a later paper. It provides one of the following functions: (1) presenting initial proof-of concept results on new ideas, timely issues, or innovative approaches; (2) reporting replications or extensions of previously published research that does not merit another full-length treatment yet provides results that contribute to a greater understanding of the phenomena under study. Research Notes should typically be limited to 2000 words and a total of 3 tables and figures, yet be sufficiently documented, both by reference to the essential literature and description of methods employed, for readers to be able to assess the scholarly rigor of the research. A Research Note should include a brief (150 words or less) abstract, keywords (3-6), and research highlights (3-5). The title of the submission should be prefaced with the words "Research Note."

2.3. Review Articles

Review Articles examine a coherent and comprehensive set of published research studies or other works (e.g., policies, reports, case studies) covering a subject area of current or emerging interest. They can take one of two forms: (1) Narrative Reviews identify, synthesize, and/or offer critical assessments of the state-of-the-art in knowledge about a subject, highlighting important concepts, variables, and theories under study, problems and knowledge gaps yet to be addressed, and guidance for future research. (2) Analytical Reviews involve systematic assessments of the literature, often using bibliographic database search and retrieval systems such as Scopus or Web

of Science, alone or in combination with full-text searching, mining, and analysis software. These include Systematic Reviews and meta-analyses that follow a standardized format aimed at building a base of knowledge for evidence-based design (e.g., http://www.environmentalevidence.org/EBConservation.htm). They also include quantitative, bibliometric techniques such as citation analysis and qualitative analyses of content themes aimed at identifying the structure of and trends in knowledge about an area of inquiry. Review Articles are typically between 6000 and 10,000 words in length, including references and tables. Please include an abstract (250 words or less), keywords (3-6), and research highlights (3-5), and follow APA 6th Edition guidelines (Section 6.26) for referencing documents included in your analysis. Review Articles may be invited or offered but must be approved by one of the CoEditors-in-Chief prior to submission. Those considering submitting a Review Article to the journal are encouraged to send a prospectus or attach a cover letter with their submission outlining the topic and scope of coverage; originality and need for the review; number, type (i.e., peer-reviewed journals vs. other document types), and international range of citations included; and a brief assessment of previously published reviews related to the topic.

2.4. Perspective Essays

Perspective Essays present new ideas or frameworks; challenge current thinking, policies, or approaches; or otherwise offer thoughtful reflections aimed at improving our understanding of the interactions between people and natural and built environments and their implications for landscape planning, design, management, and policy. Perspective Essays should be grounded in the existing literature and adequately referenced but with an emphasis on original thought rather than an exhaustive accounting of the ideas of others. Perspective Essays may range from 2000 to 8000 words in length with a limited number of tables and figures. Except for short essays, submissions should be structured with section headings that convey to readers key themes and a logical flow of ideas. An abstract (250 words or less), keywords (3-6), and highlights (3-5) are required. Perspective Essays may be invited or proposed but must be approved by one of the Co-Editors-in-Chief prior to submission.

2.5. Comments and rejoinders

A Comment is a critical or explanatory note on an article published in Landscape and Urban Planning. It may be invited or proposed but must be approved by one of the Co-Editors-in-Chief prior to submission. Comments should typically be of 2000 words or less with a limited number of references. Please include a short abstract (150 words or less), 3-5 highlights, and 3-6 keywords. The title of the submission should be prefaced with the words: "Comment on", followed by the title of the previously published article and the authors' names. Should one or more Comments be accepted for publication, the handling editor may invite the author(s) of the previously published article to write a Rejoinder, which may be published along with the Comments.

2.6. Editorials

The Co-Editors-in-Chief, Associate Editors, Editorial Board members, and invited guests may occasionally provide brief commentaries on significant issues of relevance to the journal's aims

and scope, introductory essays to special issues, as well as news and information relevant to the journal and its readers.

2.7. Book Reviews

The editorial team is not accepting books for review at this time. Please consult the online Guide for Authors for future updates.

2.8. Special Issues

A Special Issue (SI) in Landscape and Urban Planning is a coherent collection of 10-15 papers on a specific theme of research and scholarship that falls within the aims and scope of the journal and has a broad international appeal. Research Papers form the core of a Special Issue, but SIs are also given breadth and depth by an introductory Editorial and other article types which may include a Perspective Essay, Review Article, Research Notes, and Comments. SIs are proposed and orchestrated by a guest editor under the guidance of a member of the journal's editorial team, and are selected for development through a competitive process of proposal submission and evaluation. The journal's editors welcome innovative proposals of high quality and relevance from prospective individuals or teams, and may publish up to four SIs per year. Proposals are due July 1st of each year with selections announced in October. Information and proposal guidelines are available on the journal's web page: http://www.journals.elsevier.com/landscape-and-urban-planning/policies/.

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Basic reference list examples –

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Reference to a journal publication:
Van der Geer, J., Hanraads, J. A. J., & Lupton, R. A. (2010). The art of writing a scientific article. *Journal of Scientific Communications*, 163, 51–59.
Reference to a book:
Strunk, W., Jr., & White, E. B. (2000). *The elements of style*. (4th ed.). New York: Longman, (Chapter 4).
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