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**CONECTIVIDADE EM MANCHAS FLORESTAIS NA
PAISAGEM HETEROGÊNEA: ESTUDO DE CASO
DA COMUNIDADE DE MAMÍFEROS NÃO
VOADORES DA ILHA DE SANTA CATARINA**

CAMILA REZENDE AYROZA

Dissertação apresentada à Universidade do Estado de Mato Grosso, como
parte das exigências do Programa de Pós-graduação em Ciências Ambientais
para a obtenção do título de Mestra.

**CÁCERES, MT
MARÇO DE 2023**

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“ka’aeté
de costas para o Atlântico,
sonhei por ser tiê-sangue
circulei por restingas
me entranhei entre mangues
fingi ser muriqui
mergulhei na mata
nadei pela serra que abraça o mar
em braçadas de primata
guarapuvu
jequitibá
juçara
jacarandá
com mais de vinte mil paus
mas sem nada a derrubar
fiz canoa
para Mares de Morro navegar
saíra-diamante
borboleta-malaquita
pingo-de-ouro
estrelinha-ametista
descobri riqueza em árvores
enriqueci o olhar
fui um desbandeirante
sem nada a cobiçar
na cumeeira da serra
fui araucária bailarina
de braços erguidos
dancei com neblina
utopia verde
delírio tropical
miragem viva
“caos de encanto”
ka’aeté
existes?
será verdade
a floresta verdadeira? ”*

Poema de Luciano de Lima
(Retirado do livro “30 anos de Conservação do Hotspot de Biodiversidade da Mata Atlântica: desafios, avanços e um olhar para o futuro”)

* *ka’aeté*, em tupi, significa “mata verdadeira”: é a forma como muitos povos indígenas do litoral brasileiro se referem a Mata Atlântica intocada.

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Para agradecer quase que me confundo com o sentimento de estar em uma mata fechada pela primeira vez, e me perco no meio de tantos agradecimentos que me fizeram chegar até aqui, como uma vontade de caminhar floresta adentro sem parar.

Os passos de uma caminhada, apesar de às vezes parecer, nunca são sós. Percorremos os caminhos que percorremos, por muitas histórias, coisas e pessoas que vieram antes, que cruzaram nossas vidas de diversas formas, que nos afetam todos os dias e afetarão. Nesse percurso, aprendemos e também desaprendemos um pouco (ou muito), e que, para mim, o mais incrível é que desses encontros e travessias podemos construir sonhos, se arriscar. Como o próprio Raul Seixas já dizia “Sonho que se sonha só. É só um sonho que se sonha só. Mas sonho que se sonha junto é realidade”. Sonhos, trabalhos, criações, transformações acontecem porque de uma forma ou outra são coletivas, de que muita coisa já passou. Digo isso, porque provavelmente aqui, irei deixar de agradecer muita gente, assim como no meu trabalho deixei de abordar muitas questões, que são como partes da vida, tão grandes que não tem como e nem faz sentido tentar colocá-las em uma caixinha (espero que lembremos sempre disso enquanto fazemos ciência).

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Leve como os passos dos povos da floresta, mas aí acho que voltei a falar de sonho... então que essa vida sonho seja repleta de florestas diversas, que não sejam vazias e nem iguais, que sejam as florestas verdadeiras.

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RESUMO GERAL

AYROZA, Camila Rezende. **CONECTIVIDADE EM MANCHAS FLORESTAIS NA PAISAGEM HETEROGÊNEA: ESTUDO DE CASO DA COMUNIDADE DE MAMÍFEROS NÃO VOADORES DA ILHA DE SANTA CATARINA**. Cáceres: UNEMAT, 2022. 76 p. (Dissertação – Mestrado em Ciências Ambientais).

A fragmentação de habitats devido a urbanização e expansão da agropecuária, vem se tornando uma das principais causas da destruição de áreas naturais e consequentemente de perda da biodiversidade e qualidade de vida das pessoas. Atualmente, o mundo vem experienciando uma das maiores ondas de crescimento urbano na história. Assim, estudos de fragmentação nesses ambientes são necessários para se alcançar um desenvolvimento mais sustentável que oriente a gestão territorial, considerando os impactos sobre a biodiversidade e em nossas vidas. Neste trabalho, foi avaliado a paisagem da Ilha de Santa Catarina quanto às alterações da matriz entre nove manchas florestais e sua influência sobre a comunidade de mamíferos não voadores que apresentaram variações estruturais (riqueza, abundância e composição) e nos atributos funcionais a fim de inferir os padrões de conectividade estrutural e funcional. A comunidade de mamíferos não voadores foi amostrada por armadilhas fotográficas em 22 pontos independentes dentro de unidades de conservação (UCs) e remanescentes florestais durante 26 meses. A riqueza foi maior ($p > 0,05$) em manchas maiores e menos isoladas de outras áreas. Manchas menores e isoladas apresentaram menor riqueza e maior abundância de espécies generalistas, como *Didelphis aurita* e pequenos mamíferos não voadores. As principais métricas de paisagem responsável pelas variações a) de riqueza foi a área urbanizada do entorno; b) de abundância foram a distância do centroide, o formato das manchas florestais, e também a área urbanizada do entorno; e c) de composição foram a distância do centroide, o formato das manchas florestais, e o estágio sucessional do ponto amostrado. Os principais atributos funcionais relacionados com as variáveis ambientais analisadas foram herbívoros x área (ha) e formato da mancha de modo positivo, terrestres x área urbanizada de modo negativo, escansoriais x estágio sucessional de modo negativo. Projeções do mapa de uso e cobertura do solo na Ilha de Santa Catarina, com as áreas definidas como críticas de conservação e recuperação pelo Plano Municipal da Mata Atlântica que não sobrepueram as UCs existentes- representam 5922.86 ha do município. Dessas, se as áreas forem alteradas para classes de uso urbanizada levaria a redução de 2922.4 ha de remanescentes florestais, enquanto se forem recuperados e alterados para classes de floresta representaria o aumento de 2989.4 ha de área de floresta, e uma diminuição de apenas 725.4 ha de área urbanizada no cenário atual. Os modelos preditores apresentaram bom ajuste ($AUC > 0.7$) para os três cenários investigados. Das áreas adequadas para gambás (*Didelphis aurita*) no cenário urbano, foi possível observar um menor impacto potencial, em uma área crítica para a conservação e recuperação sobre a conectividade entre áreas protegidas. Na Ilha de Santa Catarina remanescentes florestais estão inseridos áreas protegidas delimitadas em UCs ou fora destas. A conservação dessas áreas,

bem como da matriz no entorno, necessita de manejo adequado a fim de preservar e recuperar a integridade ecológica desses ecossistemas, bem como manter a qualidade de vida a partir de um desenvolvimento urbano ordenado.

Palavras-chave: mastofauna, ecologia da paisagem, modelos preditores

ABSTRACT

AYROZA, Camila Rezende. **CONECTIVIDADE EM MANCHAS FLORESTAIS NA PAISAGEM HETEROGÊNEA: ESTUDO DE CASO DA COMUNIDADE DE MAMÍFEROS NÃO VOADORES DA ILHA DE SANTA CATARINA** . Cáceres: UNEMAT, 2022. 58 p. (Dissertation – Master in Environment Science).

Habitat fragmentation due to urbanization and expansion of agriculture has become one of the main causes of the destruction of natural areas and, consequently, the loss of biodiversity. Currently, the world is experiencing one of the greatest waves of urban growth in history. Thus, fragmentation studies in these environments are necessary to achieve a more sustainable development that guides territorial management, considering the impacts on biodiversity and quality of life. In this work, we evaluated the influence of the heterogeneous landscape on the non-volant mammal community among nine forest patches on Santa Catarina Island (ISC) that presented variations in their structure (richness, abundance proxy and composition) and in the functional attributes to infer the patterns of structural and functional connectivity. The non-flying mammal community was sampled by camera traps along 22 sampling points in conservation units (UCs) and forest remnants during the period from October 2019 to December 2021. Richness was statistically higher in larger patches and in proximity to other areas. However, smaller, and isolated patches showed lower species richness and higher abundance. of generalist species, such as *Didelphis aurita* and small non-flying mammals. The main landscape metrics responsible for the variations were a) for richness was the surrounding urbanized area; b) for abundance proxy was the distance from the centroid, the patches shape, and the surrounding urbanized area; and c) for composition were the distance from the centroid, the patches shape, and the successional stage of the sampled point. The main functional attributes related to the analysed environmental variables were herbivores x area (ha) and patch shape positively, terrestrial x urbanized area in a negative way, and scansorial x successional stage in a negative way. Map projections of land use and land cover on the Island of Santa Catarina, with the areas defined as critical for conservation and recovery by the Municipal Plan of the Atlantic Forest -which did not overlap the existing UCs- representing 5922.86 ha of the municipality. If those areas were changed to urbanized use classes, it would lead to a reduction of 2922.4 ha of forest remnants, while if they were recovered and changed to forest use classes, it would represent an increase of 2989.4 ha of forest area and a decrease of only 725.4 ha of urbanized area in the current scenario. Our models predicted were significant for the three scenarios investigated. Of the suitable areas in an urban scenario, for possums (*Didelphis aurita*), was possible to observe the less potential impact of a critical protected area connectivity. Protected areas delimited in UCs and forest remnants are included on the Island of Santa Catarina, their exploitation, as well as the use of the surrounding matrix, must have adequate management to preserve and recover the integrity of these ecosystems, as well as maintain the quality of life through orderly urban development.

Key words: mastofauna, landscape ecology, predictive models

INTRODUÇÃO GERAL

A Mata Atlântica representa um dos biomas terrestres mais biodiversos do planeta sendo responsável pela prestação de serviços ecossistêmicos essenciais à manutenção de todas as formas de vida, como a regulação do microclima, o controle da erosão e assoreamento, a manutenção do volume e qualidade da água, o turismo, entre outros (GUEDES e SEEHUSAN, 2014). Ao mesmo tempo é um dos biomas mais ameaçado pela ação antropogênica, chegando a restar cerca de 8% de sua cobertura original, sendo dessa maneira, considerado um dos *hotspots* de biodiversidade do planeta (MYERS *et al.*, 2000; MITTERMEIER *et al.*, 2004). Nos últimos 50 anos, devido aos esforços de diversos trabalhos na área de conservação, esse cenário é um pouco otimista, resultando em cerca de 28% de sua cobertura original (PINTO e HIROTA, 2022), com novos desafios, e ainda um longo percurso para se recuperar.

A vegetação de Mata Atlântica e seus ecossistemas associados formavam anteriormente áreas contínuas, que ao longo do tempo foram progressivamente transformados em pequenos remanescentes, isolados uns dos outros e mergulhados em paisagens em mosaico alteradas pelo ser humano. Este processo é conhecido como perda e fragmentação de habitats, e é associado diretamente como uma das maiores ameaças à manutenção da integridade ecológica e saúde dos ecossistemas (PIRES *et al.*, 2006; UN ENVIRONMENT, 2019).

A fragmentação de habitats é um processo de ruptura da continuidade espacial de habitats naturais, onde pode ocorrer perda e modificação destes em consequência da redução do tamanho do habitat original e seu isolamento devido ao uso da terra na matriz que circunda o fragmento (ODUM e BARRETT, 2008; MILAN e MORO, 2016). Esse processo gera uma paisagem heterogênea com diferentes níveis de conectividade (Metzger, 2003). Dessa forma, estas alterações também se refletem na composição e riqueza da fauna e suas interações. A distribuição das espécies num ambiente reflete o nível de adaptabilidade frente às diversas pressões seletivas, uma vez que devem existir condições essenciais à sobrevivência para que ocorra a ocupação e a colonização de determinado local (RIDLEY, 2006; *apud* LIMA-RIBEIRO, 2008).

Neste contexto, corredores ecológicos têm sido considerados fundamentais para a manutenção da conectividade da paisagem, facilitando o deslocamento das espécies na paisagem entre fragmentos e aumentando as áreas de habitat (PARDINI et al., 2005; ROCHA, et al., 2011). Porém, para garantir sua efetividade é necessária uma maior compreensão de como espécies com diferentes requerimentos de habitat são afetadas por outros componentes da fragmentação (UMETSU, 2005).

Diante da urgência por uma ocupação racional da paisagem, visando à conservação ambiental e consequente manutenção da qualidade de vida, é necessário um conhecimento mais preciso a respeito dos efeitos de borda dos fragmentos florestais e a matriz de fundo da urbanização (GODEFROID e KOEDAM, 2003; FIGUEIRÓ e NETTO, 2007). Questões que vem ganhando cada vez mais atenção nos últimos anos nos estudos de ecologia de paisagem. Nessa direção, o presente trabalho busca aprimorar a compreensão do desencadeamento desses processos ecológicos a partir da análise da conectividade entre manchas florestais e sua permeabilidade de fundo, entre áreas urbanas e usos múltiplos da terra, na Ilha de Santa Catarina (ISC), Brasil.

Assim como observado ao longo da Mata Atlântica, o processo de regeneração florestal natural foi ainda mais rápido na Ilha de Santa Catarina, apresentando 68,27% da vegetação nativa em estágio sucessional secundário (NEVES *et al.*, 2017). Apesar da importância deste processo, sabe-se que seus habitats depauperados perderam muitas espécies da mastofauna importantes para a manutenção de interações ecológicas (GRAIPEL et al., 2001). Não obstante, observa-se continuamente o esgarçamento do tecido urbano sobre as áreas legalmente protegidas deste território. Esse processo contemporâneo de produção do espaço urbano, permitido através de instrumentos legais, vem causando forte deterioração da qualidade de vida em decorrência da degradação dos habitats originais que hoje estão inseridos nesse ambiente antropizado, e comprometendo a integridade ecológica (BEIROZ, 2015).

Mamíferos não voadores vêm sendo amplamente utilizados como indicadores biológicos para avaliação da qualidade ambiental, visto que seus

padrões de resposta ao desmatamento e a degradação ambiental são idiossincráticos (WIENS *et al.*, 1993). Principalmente, tanto por sua ecologia, como pelos padrões de uso de habitats que são diversos, incluindo desde espécies de pequeno a grande porte, diferentes guildas tróficas de herbívoros à carnívoros com estratégias distintas (de generalistas à especialistas), e espécies com diferentes capacidades de dispersão (EISENBERG e THORINGTON JR., 1973). Ainda, a tolerância ecológica pelos diversos usos antropogênicos da terra é também extensamente variável neste grupo, visto que algumas espécies conseguem livremente se deslocar, e até utilizar recursos, pela matriz modificada, enquanto outras espécies estão estritamente nas florestas (especialistas) e dificilmente utilizam as áreas degradadas (PARRY *et al.*, 2007). Desse modo, a diversidade ecológica deste grupo pode refletir tanto nas respostas das espécies frente à perda de habitat, como nos efeitos associados às funções ecossistêmicas desempenhadas por essas espécies, que vão desde à dispersão até a predação de sementes e à ausência do controle *top-down* das populações de presas devido à extirpação de predadores especialistas (AHUMADA *et al.* 2011; PAVOINE e BONSALL, 2011).

Atualmente é aceito que a gestão territorial deve tratar os espaços naturais concomitantemente aos espaços ocupados pelo ser humano. Estes dois tipos de espaços são complementares e interdependentes. A qualidade de um, condiciona a qualidade do outro (QUEIROZ *et al.* 2002; SILVA, 2019). Dessa forma, para assegurar a qualidade de vida, informações científicas devem ser disponibilizadas aos gestores públicos de forma clara e objetiva direcionadas à resolução de problemas para embasar decisões sobre o manejo e a conservação de áreas naturais e seus bens e serviços para a sociedade. Com o advento de sistemas de coordenadas geográficas e da tecnologia, modelagens espaciais com o uso de indicadores biológicos podem ser grandes aliados para auxiliar nessas informações.

Modelos de distribuição de espécies são um dos métodos mais utilizados na ecologia para avaliação de similaridades ambientais entre regiões e, consequentemente, estimular a distribuição de espécies (PETERSON e SOBERON, 2012). Também, são importantes ferramentas utilizadas para o

desenvolvimento de estratégias de gestão e conservação com aplicações que vão desde a identificação de características biofísicas do hábitat de uma certa espécie, até a detecção de mudanças ambientais e projeções de cenários futuros (PETERSON *et al.*, 2011).

É neste cenário que se desenvolve o Projeto Fauna Floripa (PFF) através da elaboração conjunta entre a Universidade Federal de Santa Catarina (UFSC), Fundação Municipal do Meio Ambiente de Florianópolis (FLORAM) e Instituto do Meio Ambiente de Santa Catarina (IMA), a fim de garantir que os resultados da pesquisa acadêmica sejam aplicados no planejamento territorial pelos órgãos competentes para conservação da natureza, o qual o presente trabalho de pesquisa está inserido. Assim, os resultados aqui levantados irão subsidiar diretrizes para tomadas de decisão fortalecendo as políticas públicas em prol da conservação da biodiversidade.

OBJETIVOS

OBJETIVO GERAL

Avaliar como os processos de mudança no uso do solo em paisagens heterogêneas da Mata Atlântica influenciam a estruturação da comunidade e a condição funcional de mamíferos não voadores.

OBJETIVOS ESPECÍFICOS

O presente trabalho foi desenvolvido no formato de dois artigos (Artigos 1 e 2), os quais apresentam os respectivos objetivos específicos:

- I. Avaliar se a estrutura e condição funcional da comunidade de mamíferos não voadores são explicadas por variáveis associadas as seguintes métricas de paisagem: configuração das manchas florestais (área, perímetro, forma, e isolamento) e/ou associadas a permeabilidade da matriz/qualidade do hábitat (cobertura e uso da terra);

- II. Analisar a diferença na permeabilidade das unidades de paisagem (floresta, corpos d'água, agricultura, áreas não vegetadas) por meio da adequabilidade de habitat de espécies com diferentes requerimentos;
 - A. Gerar modelos de distribuição potencial de espécies considerando diferentes abordagens de gestão territorial para dois cenários: i) recuperação de áreas críticas para a conservação definidas pelo Plano Municipal da Mata Atlântica de Florianópolis (PMMA, 2020) e ii) transformação das mesmas áreas definidas em áreas não vegetadas.

HIPÓTESES

A presente dissertação compreenderá duas hipóteses de pesquisa. A primeira delas (H1) referente ao primeiro artigo e a segunda (H2) referente ao segundo artigo.

H1. Devido à defaunação de mamíferos de médio e grande porte, as espécies remanescentes são generalistas, sendo esperado elevada redundância de funções ecológicas e ausência de outras, assim como uma baixa relação com variáveis associadas a configuração da paisagem, elevada permeabilidade das diferentes unidades da paisagem e conectividade entre as manchas florestais.

H2. Devido a cada grupo funcional apresentar uma resposta específica ao componente da paisagem, espera-se que os padrões de conectividade sejam diferentes entre os grupos. Não seguindo exclusivamente métricas espaciais das manchas florestais, e que sejam influenciados conforme a permeabilidade das diferentes unidades da paisagem (resistências das diferentes unidades de paisagem e barreiras) do entorno destas.

REFERÊNCIAS

- AHUMADA, Jorge A. et al. Community structure and diversity of tropical forest mammals: data from a global camera trap network. **Philosophical Transactions of the Royal Society B: Biological Sciences**, v. 366, n. 1578, p. 2703-2711, 2011.
- BEIROZ, Helio. Zonas de amortecimento de Unidades de Conservação em ambientes urbanos sob a ótica territorial: reflexões, demandas e desafios. **Desenvolvimento e Meio Ambiente**, v. 35, 2015.
- EISENBERG, John F.; THORINGTON JR, Richard W. A preliminary analysis of a Neotropical mammal fauna. **Biotropica**, p. 150-161, 1973.
- FIGUEIRÓ, Adriano S.; NETTO, Ana L. Coelho. Análise da variabilidade térmica em zonas de bordas florestais com interface urbana no maciço da Tijuca Rio de Janeiro-RJ. **Ciência e Natura**, v. 29, n. 2, p. 173-186, 2007.
- GODEFROID, Sandrine; KOEDAM, Nico. Distribution pattern of the flora in a peri-urban forest: an effect of the city–forest ecotone. **Landscape and Urban Planning**, v. 65, n. 4, p. 169-185, 2003.
- GRAIPEL, Maurício E.; CHEREM, Jorge J.; XIMENEZ, Alfredo. Mamíferos terrestres não voadores da Ilha de Santa Catarina, sul do Brasil. *Biotemas*, v. 14, n. 2, p. 109-140, 2001.
- GUEDES, F. B.; SEEHUSEN, S. E. Pagamento por Serviços Ambientais na Mata Atlântica. Fátima Becker Guedes e Susan Edda Seehusen (Org.). Brasília: MMA, 2014. 276p.
- HIJMANS, R.J., *et al.* Very high-resolution interpolated climate surfaces for global land areas. **International Journal of Climatology**. 25: 1965-1978, 2005.
- LIMA-RIBEIRO, Matheus de Souza. Efeitos de borda sobre a vegetação e estruturação populacional em fragmentos de Cerradão no Sudoeste Goiano, Brasil. *Acta Botanica Brasilica*, v. 22, n. 2, p. 535-545, 2008.
- METZGER, J.P. Estrutura da paisagem: o uso adequado de métricas. In: CULLEN JR.L.; RUDRAN, R.; VALLADARES-PÁDUA, C. (Ed) Métodos de estudos em biologia da conservação e manejo da vida silvestre. Curitiba: Ed. UFPR, 2003. p.423-538
- MILAN, A. E.; MORO, Rosemeri S. O conceito biogeográfico de ecótono. *Terr@ Plural*, Ponta Grossa, v. 10, n. 1, p. 75-88, 2016.
- MITTERMEIER, R. A., *et al.* Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions. Cemex. Washington, DC, 2004.

MYERS, N., R. A. Mittermeier, C. G. Mittermeier, G. A. B. Fonseca & J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.

NEVES, J., ORNON, A., VOIRON-CANICIO, C., & HORN FILHO, N. O. Mapeamento do uso e da cobertura da terra na Ilha de Santa Catarina, Brasil, com base em imagem de alta resolução espacial. **Geosul**, 32(65), 213-238., 2017.

ODUM, E.P.; BARRETT, G.W. Fundamentos de ecologia. São Paulo: Cengage Learning, 2008. 612p

PARRY, Luke; BARLOW, Jos; PERES, Carlos A. Large-vertebrate assemblages of primary and secondary forests in the Brazilian Amazon. **Journal of Tropical Ecology**, v. 23, n. 6, p. 653-662, 2007.

PAVOINE, Sandrine; BONSALL, Michael B. Measuring biodiversity to explain community assembly: a unified approach. **Biological Reviews**, v. 86, n. 4, p. 792-812, 2011.

PETERSON, A. Townsend; SOBERÓN, Jorge. Species distribution modeling and ecological niche modeling: getting the concepts right. **Natureza & Conservação**, v. 10, n. 2, p. 102-107, 2012.

PETERSON, A. Townsend et al. **Ecological niches and geographic distributions (MPB-49)**. Princeton University Press, 2011.

PINTO, L. P.; HIROTA, M. M. 30 anos de **Conservação do Hotspot de Biodiversidade da Mata Atlântica: desafios, avanços e um olhar para o futuro**. São Paulo: Fundação SOS Mata Atlântica, 2022.

PIRES, Alexandra S.; FERNANDEZ, Fernando AS; BARROS, Camila S. Vivendo em um mundo em pedaços: efeitos da fragmentação florestal sobre comunidades e populações animais. **Biologia da Conservação: Essências. São Carlos, São Paulo, Brazil**, p. 231-260, 2006.

PLANO MUNICIPAL DA MATA ATLÂNTICA: Florianópolis – Santa Catarina / Realização: Prefeitura de Florianópolis; Floram; IPUF. – Florianópolis: Prefeitura de Florianópolis, 2020.

QUEIROZ, Maike H. et al. Avaliação do grau de implementação das unidades de conservação da Ilha de Santa Catarina. In: **CONGRESSO BRASILEIRO DE UNIDADES DE CONSERVAÇÃO**. 2002. p. 405-414.

RIDLEY, M. Evolução. 3 ed. Porto Alegre: Artmed, 2006.

SILVA, Guilherme Henrique Pereira da. Instrumento para Avaliação da Sustentabilidade de Unidades de Conservação Urbanas. 2019, 101f. – Dissertação (Mestrado em Sustentabilidade) - Programa de Pós-Graduação em Sustentabilidade, Pontifícia Universidade Católica de Campinas, Campinas, 2019.

UN ENVIRONMENT (2019). Global Environment Outlook – GEO-6: Healthy Planet, Healthy People. Nairobi. DOI 10.1017/9781108627146.

WIENS, John A. et al. Ecological mechanisms and landscape ecology. **Oikos**, p. 369-380, 1993.

ARTIGO 1

LANDSCAPE-SCALE PREDICTORS OF MAMMAL DIVERSITY THROUGHOUT THE SANTA CATARINA ISLAND, SOUTHERN BRAZIL

Journals Target: Landscape Ecology.

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Abstract

Urban expansion has been intensifying globally, reducing natural terrestrial habitats and making them highly fragmented, which threatens biodiversity. Understanding the response patterns in fragmented areas based on a functional approach can bring important contributions to effective landscape management. In this work, we evaluated the influence of the heterogeneous landscape on the non-volant mammal community among nine forest sites on Santa Catarina Island (ISC) that presented variations in their structure (richness, abundance, and composition) and functional attributes. Data collected by camera traps of non-flying mammals between 2019-2022 and landscape metrics were used. In the 22 sampling points we recorded 11 species - including a single group of small non-flying mammals - across the forest sites. The greatest species richness occurred in forest sites with the largest area and proximity to each other, while smaller and more isolated forest sites showed lower richness and greater abundance of generalist species, such as *Didelphis aurita* and small non-flying mammals. The main landscape metric responsible for variations in richness was the surrounding's urbanized area, for variations in abundance were the distance from the centroid, the patch shape, and the surrounding's urbanized area. Variations in composition were the distance from the centroid, the patch shape, and the successional stage of the sampled point. Herbivorous species are positively associated with area and shape metrics. Terrestrial species are negatively associated with urbanized environments, while scansorial species are negatively associated with more preserved environments. There is the presence of a single carnivore trophic guild species, without association with the analysed metrics. These results evidenced the situation of the defaunated community studied in the face of past anthropic actions, the current condition, and the future changes in habitat, that may profoundly affect the ISC ecosystem functions.

Key words: mastofauna, conservation ecology, habitat fragmentation, landscape.

Resumo

Nos últimos anos a expansão urbana vem se intensificando globalmente, reduzindo os habitats naturais terrestres e os tornando altamente fragmentados, sendo um processo de ameaça à biodiversidade. Compreensões dos padrões de respostas em áreas fragmentadas a partir de uma abordagem funcional podem trazer importantes contribuições para uma gestão efetiva da paisagem. Neste trabalho nós avaliamos a influência da paisagem heterogênea sobre a comunidade de mamíferos não voadores entre nove manchas florestais na Ilha de Santa Catarina (ISC) que apresentaram variações na sua estrutura (riqueza, abundância e composição) e nos atributos funcionais. Utilizou-se dados coletados por armadilhas fotográficas de mamíferos não voadores entre 2019-2022 e métricas de paisagem. Nos 22 pontos amostrais nós registramos 11 espécies - incluindo um único grupo de pequenos mamíferos não voadores - ao longo das manchas. A maior riqueza de espécies ocorreu nas manchas de maior área e proximidade uma das outras, enquanto manchas menores e mais isoladas apresentaram menor riqueza e maior abundância de espécies generalistas, como *Didelphis aurita* e pequenos mamíferos não-voadores. A principal métrica de paisagem responsável pelas variações da riqueza foi a área (km²) urbanizada do entorno, pelas variações de abundância foi a distância do centroide, o formato das manchas, e também a área urbanizada no entorno. Já para as variações da composição foram a distância do centroide, o formato das manchas florestais, e o estágio sucessional do ponto amostrado. Espécies herbívoras estão associadas positivamente com as métricas de área e forma. Espécies terrestres estão associadas negativamente a ambientes urbanizados, enquanto as escansoriais estão negativamente associadas a ambientes mais preservados. Há a presença de uma única espécie da guilda trófica carnívora, sem associação às métricas analisadas. Esses resultados evidenciam a situação da comunidade defaunada estudada diante das ações antrópicas pretéritas, a condição atual e as mudanças futuras no habitat que podem afetar profundamente as funções do ecossistema do ISC.

Palavras-chave: mastofauna, ecologia da conservação, fragmentação de habitats

1. Introduction

Habitat loss and fragmentation are two major threats to biodiversity leading both to the local extinction of species once well adapted to the original landscape and to the increase or even colonization of the habitat by other species, generally generalists (HADDAD et al.; 2015; CARO et al., 2022). The fragmentation of natural habitats has led to the formation of landscapes that are increasingly incapable of maintaining the biodiversity of ecosystems since the size of the fragments has decreased and the degree of isolation between them has

increased (MURCIA, 1995; RIBEIRO et al. 2009), as well as the matrix permeability changes to the flow of organisms between fragments that will have significant effects on the community structure.

Urban expansion over natural areas creates a new context in which the original ecosystems are restricted to forest fragments circumscribed by built environments, creating emerging ecosystems with new ecological interactions, normally negative for the biota (AGUIAR, 2017). Because of this process, we have interference in the rate of population growth of species of the fauna and flora, a decrease in the length and diversity of the trophic chain and changes in species interactions, among other negative effects (FORERO-MEDINA and VIEIRA, 2007; ZHAO et al., 2006). Within the pan-tropics, loss in vegetation biomass from areas with a high probability of urban expansion is estimated to be 1.38 PgC (0.05 PgC yr⁻¹), equal to ~5% of emissions from tropical deforestation and land-use change (BACCINI et al., 2012; SETO et al., 2012). Given the urgency for a rational occupation of the landscape towards environmental conservation and consequent maintenance of the quality of life, more precise knowledge about habitat fragmentation and the urbanization background matrix is necessary (GODEFROID and KOEDAM, 2003; FIGUEIRÓ and NETTO, 2007).

The phenomenon of island occupation follows a worldwide trend of occupation and sealing of coastal zones, as highlighted by United Nations Organization reports (PNUD, 2009). Island environments are surrounded by an inhospitable matrix for many terrestrial species. About continental areas, these environments are more vulnerable to the structuring conditions of assemblies given that the species move along the habitat according to the permeability gradient of the matrix (POWELL; STOUFFER; JOHNSON, 2013). Thus, while fragmented continental areas are generally considered less isolated, in island environments the lower permeability of the matrix reinforces the filters on which species and specific functional traits will persist in these places (KEDDY, 1992).

In this context, our study was carried out at Santa Catarina Island, a continental island that is undergoing increasing anthropogenic disturbance with this ever-growing coastal urbanization. Currently, ISC is in the process of natural

forest regeneration, showing recovery of 68.27% of the native vegetation -Atlantic Forest- in a secondary successional stage (NEVES et al., 2017). Despite the importance of this process, it is known that their depleted habitats may have lost many important faunal elements (GRAIPEL et al., 2001) for the maintenance of ecological interactions. However, the fraying of the urban fabric on the legally protected areas (PAs), or even unprotected natural areas - such as marshes with hygrophilous vegetation -, of this territory is continuously observed. This contemporary process of production of urban space, allowed through legal instruments, has been causing a strong deterioration in the quality of life because of the degradation of the original habitats that are now inserted in this anthropized environment, and compromising ecological integrity (BEIROZ, 2015).

Non-flying mammals have been widely used as biological indicators to assess environmental quality, as their response patterns to deforestation and environmental degradation are idiosyncratic (WIENS et al., 1993). Mainly, both for its ecology and for the patterns of habitat use that are diverse, including from small to large species, different trophic guilds from herbivores to carnivores with different strategies (from generalists to specialists), and species with different dispersion (EISENBERG and THORINGTON JR., 1973). Furthermore, the ecological tolerance for the different anthropogenic land uses is also widely variable in this group, as some species can freely move, and even use resources, through the modified matrix, while other species are strictly in the forests (specialists) and hardly use the degraded areas (PARRY et al., 2007). Thus, the ecological diversity of this group may reflect both on the species' responses to habitat loss and fragmentation and on the effects associated with the ecosystem functions performed by these species' traits, including seed dispersal and top-down control of prey populations (AHUMADA et al. 2011; PAVOINE and BONSALL, 2011).

Issues that have gained increasing attention in recent years in landscape ecology studies. In this direction, our research aims to improve the understanding of the triggering of these ecological processes from the analysis of the connectivity between forest sites and their background permeability, between urban areas and multiple uses at ISC. The ISC was intensely exploited, both

through hunting and through the extraction of wood for fuel and land use for agriculture (CARUSO, 1983), which led to land-use change processes that resulted in a mosaic of patches of vegetation generating highly fragmented areas, intersected by open areas, agriculture, forestry, and urban matrix (FERRETTI, 2013). ISC exploitation history has resulted in a severe impact on mammalian diversity, as the local extinction of species such as *Puma concolor*, *L. pardalis*, *Alouatta guariba* and *Tapirus terrestris* stands out (LIMA-SILVA, 2022; GRAIPEL; CHEREM; XIMENEZ, 2001).

Here we evaluate the heterogeneous landscape influence on non-flying mammals community at ISC forest sites using camera trap video data and landscape metrics, that were used to investigate the environmental relationships with the community structure and the influence of these metrics through traits of non-flying mammal species. Through our driven question "What predictive patterns can be observed in community structure on a fragmented island?", we predicted that due to the defaunation of non-flying mammals, the remaining species are generalists, being expected to have high redundancy of ecological functions and absence of others, as well as a low relationship with variables associated with landscape configuration, high permeability of different landscape units and connectivity between forest sites.

2. Methods

2.1 Study Area

The ISC is located between latitudes 27°22'S and 27°50'S and longitudes 48°25'W and 48°35'W (Fig. 1), it has an area of 42,440 ha, and is part of the Atlantic Forest domain, with formations of Dense Ombrophilous Forest (FOD) and associated ecosystems. The climate is humid mesothermic, with an indefinite dry season, rainfall distributed throughout the year and hot summers. The annual averages of rainfall and temperature are around 1467.8 mm and 20.5° C, respectively (WREGE et al., 2012).

2.2 Mammal surveys

Non-volant mammals were surveyed in 22 sampling sites nested in eight forest sites ranging in size between 151 ha and 4,678 ha. These forest sites were delimited according to its political delimitation as protected areas (Fig. 1) of Santa Catarina Island Government (conservation units shapefile was available at <https://geoportal.pmf.sc.gov.br/downloads/camadas-em-sig-do-mapa>). Except for Patch A and Patch C, they were considered distinct forest sites due to the border that connected them is a demarcated dirt road used for many years by the rural community, and today it is intensively used also by tourism.

Mammals were surveyed using the camera traps (CTs) - Bushnell Essential E3 and Bushnell Aggressor No-Glow models - during the period of Oct/2019 - Dec/2021. The CTs had a minimum distance of 1 km and they were set at a height of 40 cm above the ground. Cameras were set to record videos with 30 sec of duration, with a delay between consecutive videos of 3 sec and CTs were operating 24h a day. Each CT covered a minimum period of three months of sampling in each season of the year per site and a minimum of two CTs per forest site (Fig. 1)

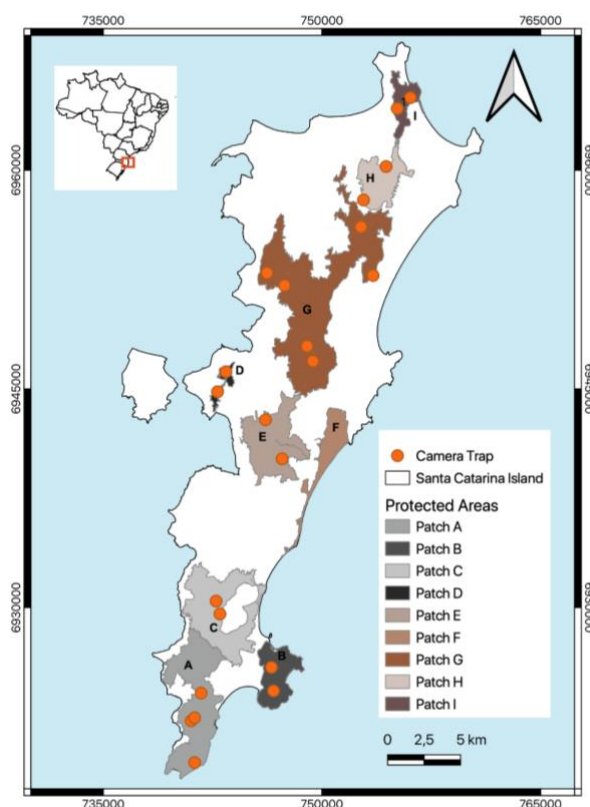


Figure 1 Santa Catarina Island, Brazil, study area. The nine forest patches highlighted (A-I) with 22 CT sampling points (dark orange).

which totalled an effort of 6,569 trap days. As seen in Figure 1, CT points were sampled at eight forest sites, although a ninth forest site (Patch F) was included in our analyses due to it could potentially be used as a connection for species from other forest sites.

Videos were analysed by Fauna Floripa Project (PFF) trained observers and were considered independent records of the same taxon those with a

minimum interval of 60 minutes in the same sampling site (O'BRIEN, 2011), and excluded exotic (*Callithrix* spp.) and domestic species (cats and dogs), totaling 4,151 independent records. For non-flying mammal taxa identifications, we considered species-level medium and large adult mammals weighing more than 1 kg (SRBEK-ARAUJO and CHIARELLO 2007, PAGLIA et al., 2012). For small non-flying mammals species (< 1 kg), due to the lack of accuracy to identify them through video CT data, they were classified all as a single taxa, and we assumed that they have similar responses to the landscape metrics (potential small non-flying mammals species could be seen in CHEREM et al., 2004).

2.3 Landscape Data and Scale of Effect

Landscape metrics were calculated with QGIS® software (3.16.8-Hannover), the landscape configuration variables calculated, excluding correlated (Pearson > 0.7), were patch size, perimeter, shape, the shortest distance from the centroid to the forest site edge, the shortest distance from the edge to the closest forest site and altitude (Table 1). For landscape composition variables were used land cover data available from the MapBiomass Project (PROJETO MAPBIOMAS, 2020) with spatial 30-m pixel resolution Landsat imagery. The land cover area classes were reclassified at the upper classes according to MapBiomass classification (Table 1) to reduce the number of fine class variables. We estimated the percentage of land cover area classes within buffers of 0.5km, 1km and 1.5km radius of each CT sampling point considering a multiscale approach, in which a particular landscape attribute needs to properly be considered its scale to measure a biological response (JACKSON and FAHRIG, 2012). We used general linear models (GLMs) to select the abundance proxy, richness, and composition species data best response within the buffer scales determined by Akaike Information Criterion (AIC) in R. For both total abundance, richness and composition data were selected the 0.5km radius buffer. The variable unvegetated area (UNVEG) was highly correlated (Pearson >0.9) with forest site isolation distance, thus to maintain all land cover classes, the forest site isolation distance remained outside of analysis. But it was considered for results interpretation.

Table 1 Description of environmental variables quantified to examine non-flying mammals' community properties within the Santa Catarina Island landscape.

Name (code)	Variable description	Range (median $\pm$ SD)
Patch id (PATCH)	Patch identification of CTs samplings points. Study nested variable.	A-I
Forest site size (AREA)	Total forest site area	151.80 – 4,678.31 ha (1,891.17 $\pm$ 1,679.79)
Forest site shape (SHAPE)	Total forest site area divided by the total patch perimeter	0.07-0.48 (0.41 $\pm$ 0.13)
Centroid distance (CDIST)	Euclidean distance from each centroid patch to the nearest boarder patch	32.75-1,003.13 m (576.21 $\pm$ 336,69)
Altitude (ALT)	Altitude from each CT sampling point	27-410 m (221.5 $\pm$ 116.08)
Forest vegetation class (FORCLAS)	Atlantic forest vegetation classification from each CT sampling point area: Primary forest (1) and Secondary forest (2)	1-2 (2 $\pm$ 0.29)
Stages of Forest Succession (FORSTA)	Stages of Atlantic forest succession classification from each sampling point area: Initial (1), Middle (2), Advanced (3) and Primary (4).	1-4 (2 $\pm$ 0.90)
Land cover and use area: MapBiomass land cover and use major classes (collection 6, 2020) area calculated of 0.5 km radius buffers from each CT sampling point		
Forest (FORE)	Total forest class (1) area	0.28-0.77 km ² (0.71 $\pm$ 0.17)
Agriculture (AGRI)	Total agriculture class (3) area	0-0.21 km ² (0.04 $\pm$ 0.06)
Unvegetated area (UNVEG)	Total unvegetated class (22) area	0-0.55 km ² (0 $\pm$ 0.13)
Water body (WATER)	Total water body class (26) area	0-0.30 km ² (0 $\pm$ 0.08)

2.4 Species Traits

Traits hypothesized to be related to the ability of non-flying mammals species to persist within ISC forest patches were (1) trophic guild - omnivores, herbivores and carnivores - based on ABREU et al. (2021), GRAIPEL et al.

(2017), PAGLIA et al. (2012), PARERA e ERIZE (2002), and REIS et al. (2006); (2) body mass calculated based on an average proposed by PAGLIA et al. (2012), PARERA and ERIZE (2002), and REIS et al. (2006); and (3) locomotor habits - terrestrial, scansorial and semiaquatic - based on MAGIOLI (2018), CANDELA et al. (2017), CASSANO et al. (2014), and MORGAN and ALVAREZ (2013) - Table 2. Locomotor habit species were classified as belonging to a single lifestyle considering substrate preferences, they may occasionally also show other locomotor behaviours.

Table 2 List of non-flying mammals species traits used to establish the relationship between those traits and the landscape metrics: trophic guild, body mass (kg) and locomotor habit. (Om= omnivores; He= herbivores; Ca= carnivores; Te= terrestrial; Sc= scansorial; Aq= semiaquatic).

Taxa (code)	Trophic Guild	Body Mass (kg)	Locomotor Habit
Order Didelphimorphia <i>Didelphis aurita</i> (Diau)	Om	1.25	Te
Order Cingulata <i>Dasybus novemcinctus</i> (Dano)	Om	3.76	Te
Order Pilosa <i>Tamandua tetradactyla</i> (Tate)	Om	6.23	Sc
Order Rodentia <i>Cuniculus paca</i> (Cupa)	He	9.38	Te
<i>Coendou spinosus</i> (Cosp)	He	1.47	Sc
<i>Dasyprocta azarae</i> (Daaz)	He	3.5	Te
<i>Hydrochoerus hydrochaeris</i> (Hyhy)	He	52.5	Aq
Small non-flying mammals (Smma)	Om	>1	Sc
Order Carnivora <i>Cerdocyon thous</i> (Ceth)	Om	6.8	Te
<i>Eira Barbara</i> (Eiba)	Om	6	Sc
<i>Nasua nasua</i> (Nana)	Om	5.81	Sc
<i>Lontra longicaudis</i> (Lolo)	Ca	8	Aq

2.5 Data Analysis

Generalized hierarchical models were used to further investigate the effect of heterogeneous landscapes on the non-flying mammal community. This analysis determined the relationship between the richness, abundance proxy and

composition within the forest sites and the eleven explanatory environmental variables (Table 1). Due to the data collection methodology used in this work not being appropriate for arboreal species, independent records of primates (*Cebus nigritus* and *Callithrix* spp.) were only used for richness and composition analyses, and abundance proxy was excluded from analyses to avoid these species underestimation.

Multivariate patterns of species composition were investigated using a Nonmetric Multidimensional Scaling (NMDS) ordination based on a Bray-Curtis similarity matrix including all 22 surveyed CTs sampling sites at the forest patches using R package *vegan* (OKSANEN et al., 2013). Due to differential sampling effort per forest site, species abundance proxy was previously *Hellinger* transformed to reduce large abundance proxy effects (BORCARD et al., 2011). The NMDS1 scores (stress=0.085, and Shepard Plot AdjustedR=0.97) were then used as a measure of species composition in subsequent analyses. Additionally, *Ward Cluster* analysis was performed to assess how this community composition is grouped along the patches. Abundance proxy data were again *Hellinger* transformed before using Ward's hierarchical, agglomerative clustering process using the co-efficient of co-phenetic correlation to measure the goodness of fit (MURTAGH and LEGENDRE, 2014). All possible sets obtained from the Ward cluster were examined by analysis of variance (ANOVA) to determine that the trophic groups were statistically different based on p-values.

We used linear, generalized mixed effects (GLMM) in R packages *dplyr* (YARBERRY, 2021) and *mass* (VENABLES and RIPLEY, 2013) with the patch (id) as a random effect considered the nested structure of the data (CTs sampling points within forest sites). The response variables – abundance proxy, richness, and composition - were checked for data distribution for model distribution type selection. The explanatory variables (Table 1) were tested for collinearity (Spearman collinearity test), and only uncorrelated ($p < 0.7$) variables were included in the same model (LEATHWICK et al. 2006), also they were previously standardized ($x = 0$, $\sigma = 1$) to place coefficient estimates on the same scale. The choice of model was selected using all additive combinations through the *MuMIn* R package (BARTOŃ, 2014), which ranks the models based on their AIC

corrected for small sample sizes (AICc: ANDERSON and BURNHAM, 2004). A model averaging was performed using only the most plausible models to account for model uncertainty in multi-model inference, (i.e., $0 < \Delta AICc < 2$, $\Delta AIC = AIC_i - AIC_{min}$ in which i = i th model). Assumptions of heterogeneity, normality (if applicable) and linearity were checked using residual plots in all final models.

To assess how species with different traits respond to gradients of spatial metrics, we conducted RLQ and fourth-corner analyses using the R package *ade4* (DRAY and DUFOUR, 2007). This multivariate analysis provides ordination scores to summarize the joint structure among three matrices – site by environmental variables (matrix R), site by species abundance (matrix L), and species by traits (matrix Q) – (DRAY et al, 2003; DRAY and LEGENDRE, 2008). The total amount of variation explained by RLQ analysis is limited to the variance explained by the separate ordinations of each matrix. For all 22 CTs sites, species abundance proxy data *Hellinger* transformed (matrix L) were ordered using Correspondence Analysis (CA; TENENHAUS and YOUNG, 1985); we performed for environmental variables and species traits a Hill-Smith Principal Component Analysis (PCA) as our R and Q matrices contained a combination of both numerical and categorical variables (DRAY and DUFOUR, 2007). Fourth-corner analysis was performed to confirm the interpretation of the relationship between functional traits with the environment, once it tested these associations in all bivariate correlations between each trait category or their combination and each environmental variable (ter BRAAK et al., 2012). Given that there are many traits and even environmental factors that are not strong predictors of this community abundance, we reduced the number of predictor terms in our fourth-corner models using LASSO (Least Absolute Shrinkage and Selection Operator) considering that is an optimization algorithm that performs both variable selection and regularization to enhance the prediction accuracy and interpretability of the statistical model it produces using the R package *mvabund* (WANG et al, 2022). This approach uses penalized regression, and a key point is the selection of the penalty parameter; if it is set very high, no predictor variable enters the model, if it is set to 0 all variables enter (BROWN et al., 2014). All data analyses were performed in R (version 4.2.1, R Development Core Team, 2022).

3. Results

Considering the 4,151 independent records from all 22 CT sites, 11 species were recorded - including one single group as small non-flying mammals - across the eight sampled forest sites. The number of species ranged per CT site from one to nine (mean $\pm$ SD: 5.68 ± 1.98 species), and from three to nine species across the eight forest sites (mean $\pm$ SD: 6.75 ± 1.75 species). *Ward cluster* analysis shows that species composition is grouped into four classes (CC = 0.783 and $p < 0.01$) - Figure 2. The geographic location of 22 CTs areas in Santa Catarina Island, Brazil. Group types were established using Ward's hierarchical clustering procedure (CC = 0.783 and $p < 0.01$). Mammals' images represent a brief description of community composition differences across CT areas. Group 1 represents the CTs located at the two smallest forest sites (150.80 ha and 456.41 ha), it has the lowest richness and has a large abundance of small non-flying mammals (N=58) and *Didelphis aurita* (N=392). Group 2 includes until seven species of all community composition, and the CT18 point together with the CT16 are the only ones without a *Cuniculus paca* record in their forest site (Patch G). Group 3 contains the larger richness (9 species recorded) at Santa Catarina Island, being the only one that contains the record of *Lontra longicaudis*. Group 4 has less abundance of individual species (N=6 > 3 records per CT), being the only one that contains the record of *Coendou spinosus*.

Four Ward Groups

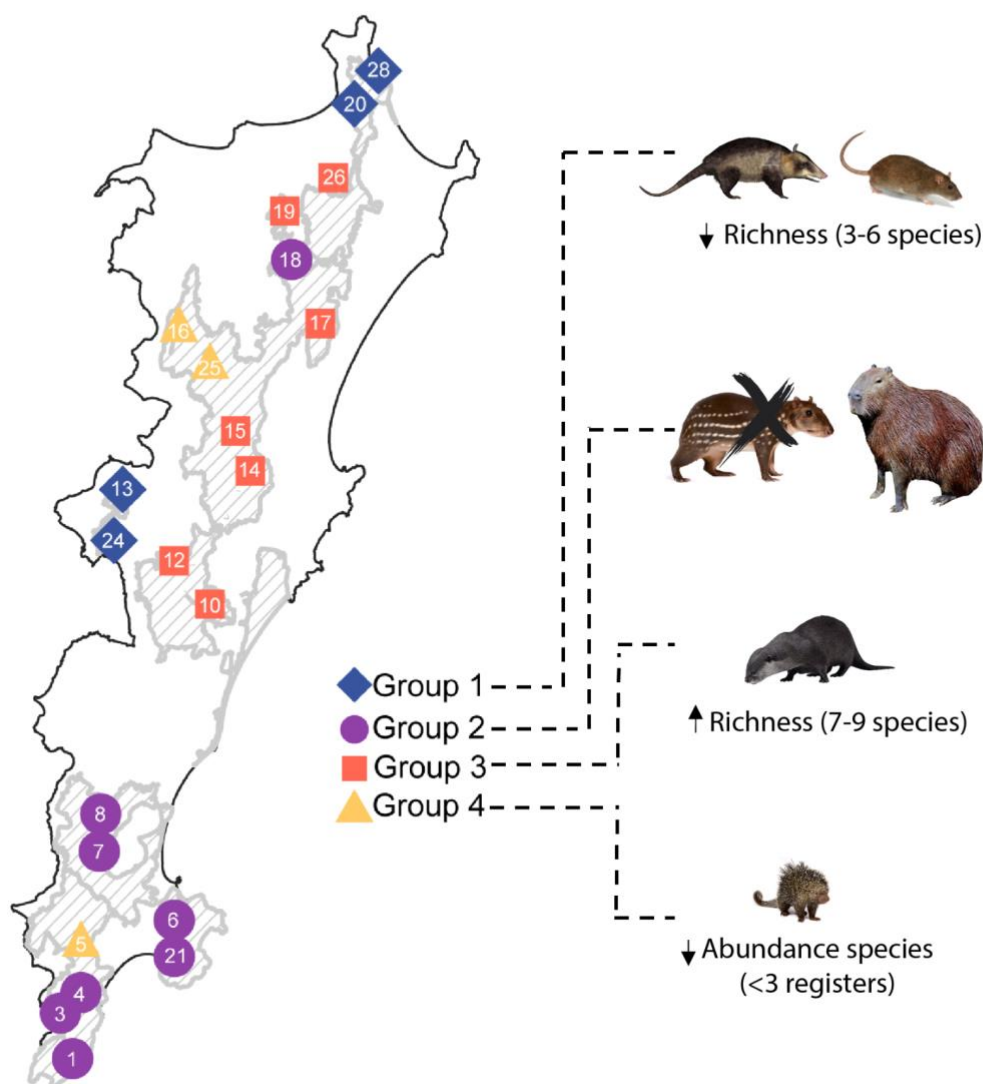


Figure 2 Geographic location of 22 CTs areas in Santa Catarina Island, Brazil. Group types were established using Ward's hierarchical clustering procedure ($CC = 0.783$ and $p < 0.01$). Mammals' images represent brief descriptions of community composition differences across CT areas. *Cuniculus paca* "X" means that do not have this animal in Group 2.

For the richness response variable, the candidate model selected was the normal type distribution with 8 explanatory variables explaining 55.91% of richness community variation, being only negatively significant (<0.05) the unvegetated area (UNVEG) variable - Table 3. Yet, the abundance proxy explanatory variable model selected was the negative binomial distribution with 6 explanatory variables accounting for 37.56% of abundance proxy community

variation. In this model, centroid distance (CDIST) and UNVEG variables were negatively significant (<0.05), while forest site shape (SHAPE) was positively related - Table 3. The model selected for the composition response variable was the normal distribution type with four explanatory variables explaining 84.59% of composition community variation, being significant (<0.05) the variable CDIST positively, although SHAPE and forest stage (FORSTA) were negatively related.

Table 3 Summary of final models to explain non-flying mammals' community richness, abundance proxy and composition (NMDS1 score) according to landscape metrics (see codes in Table 1) in Santa Catarina Island, Brazil. Non-significant covariates that were kept in the final model are greyed out. Adj.SD: standard deviation adjusted.

Model Type: normal		Adj.R2: 55.91%		
Richness	Coefficient	Estimate	Adj.SD	Pr(> z)
	Intercept	6.318	0.370	<0.001
	UNVEG	-1.454	0.512	<0.005
	WATER	0.737	0.452	0.103
	CDIST	0.657	0.396	0.097
	FORE	-0.009	1.148	0.993
	AREA	0.636	0.438	0.146
	FORSTA	-0.483	0.418	0.248
	FLORCLASS	0.448	0.390	0.251
	ALT	-0.466	0.399	0.243
Model Type: negative binominal		Adj.R2: 37.56%		
Abundance	Coefficient	Estimate	Adj.SD	Pr(> z)
	Intercept	5.130	0.139	<0.001
	CDIST	-0.514	0.194	<0.009
	SHAPE	0.540	0.198	<0.007
	UNVEG	-0.427	0.159	<0.008
	AREA	0.266	0.169	0.116
	FORSTA	-0.319	0.230	0.164
	FORCLASS	0.211	0.156	0.177
Model Type: normal		Adj.R2: 84.59%		
	Coefficient	Estimate	Adj.SD	Pr(> z)

Composition	Intercept	-1.364e-10	0.027	1.000
	CDIST	0.072	0.309	<0.018
	SHAPE	-0.218	0.041	<0.001
	FORCLAS	-0.061	3.651e-05	0.0938
	FORSTA	-0.090	0.040	<0.027

The Patches D, I, and H, unvegetated areas had a strong positive correlation with the first axis, whereas forest site shape, forest site size, forest areas and forest stage had strong negative correlations (Appendix 1. Figure A1), contributing 25,89% to the formation of this axis. Terrestrial and herbivore had a negative association with the first axis, whereas scansorial and omnivore had a positive correlation (Appendix 1. Figure A1), contributing 49.39% to this axis formation. The first axis of the RLQ explained 87.92% of the total variation in non-flying mammals' functional abundance that links the environmental characteristics and species traits. Most of the variation in non-flying mammals' functional abundance was captured by the first axis, which suggests that this axis represents an environmental gradient determining patterns of functional abundance across the heterogeneous landscape at Santa Catarina Island. The second axis of the RLQ explained 9.42% of the total variation and the main environmental variables that contributed to this axis (18.33%) were Patch A and altitude, negatively, and positively were Patch B and water (Appendix 1. Figure A1). The main traits associated with the second axis (27%) were semiaquatic and body mass, positively. Moreover, RLQ strong correlations (>0.5 , see COHEN, 1992), were the traits terrestrial (+) and scansorial (-) with Patch A; body mass (+), semiaquatic (+), and scansorial (-) with Patch B; herbivore (-), terrestrial (-), omnivore (+), and scansorial (+) with Patch D; and herbivore (-), terrestrial (-), omnivore (+) and scansorial (+) with Patch I. However, although these trait–environment associations were robust to environmental characteristics permutation (permutation “model 2,” $p = 0.001$), they were not robust to species traits permutation (“model 4,” $p = 0.167$). This implies that the link between traits (table Q) and environment (table R) was not substantiated, thus to advance our study investigation we considered the trait–environment interaction permutation (“model 5,” $p = 0.001$) to provide this community patterns distribution influence

insights, and we proceed with further analysis to check these findings robustness.

Results from the fourth-corner analysis corroborated that twenty-four interactions of traits along environmental gradients within forest sites were significant (Appendix 1. Figure A2, Table A1). Nevertheless, our statistical alternative test predictive modelling, LASSO, which standardizes coefficients for all environment–trait interaction terms, also presented a significant correlation between them, although it reduces even more these associations (Figure 3).

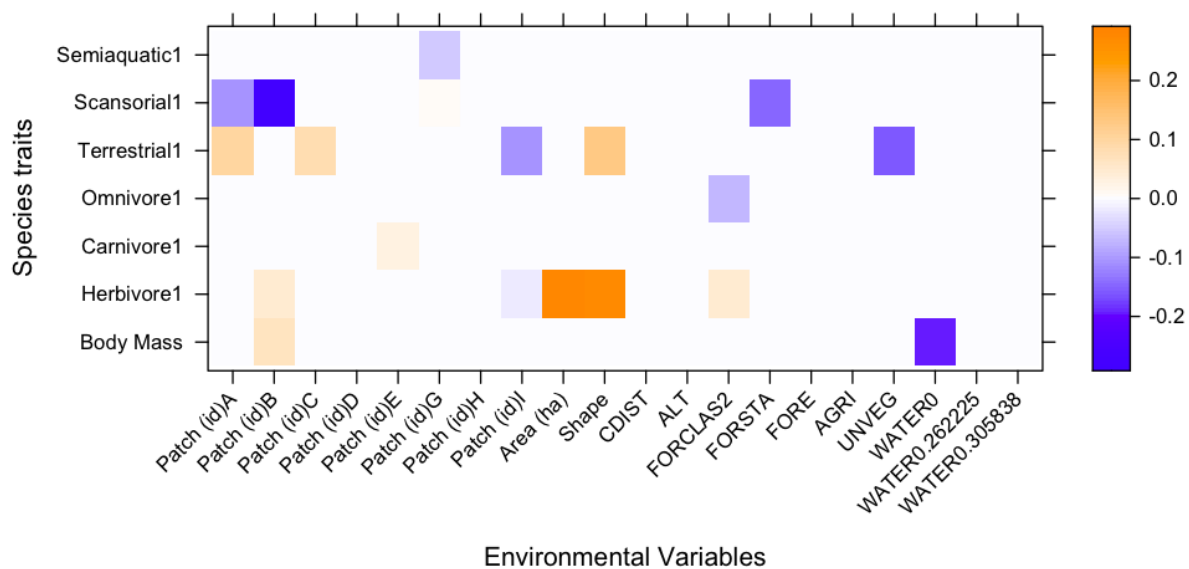


Figure 3 Fourth-corner modelling results. Standardized coefficients for all environment–trait interaction terms are presented, from LASSO model. Brighter squares show stronger associations than paler ones, positive associations are orange and negative associations are blue.

4. Discussion

Our results show a greater division in the species grouping in the south of the ISC, contrasting with three subdivisions in the north of the ISC, suggesting predictive patterns of differentiation between smaller and more isolated forest sites. Although we recorded semi-aquatic species, such as *Lontra longicaudis* and *Hydrochoerus hydrochaeris*, and more strictly arboreal species, such as *Coendous spinosus*, their detection rates were almost certainly hindered by our CTs sampling methodology. Therefore, these results that include semi-aquatic

and arboreal species in ISC non-flying mammals' assemblages would require caution. However, there is a complexity of interactions between the community structure and species traits across the environmental variables evaluated in this heterogeneous landscape of multiple uses.

Santa Catarina Island has been suffering from the urban expansion process in recent years and is currently reviewing the Master Plan, which could further intensify this process, making the urban matrix potentially more impermeable, and putting pressure on, or even reducing, the Protected Areas edges (our study forest sites). Managers need to consider the impact of these changes on biological communities and ecosystem services. In this work, together with the Fauna Floripa Project, we confirmed that there is no longer the presence of large non-flying mammals, as well as the rare presence of species of higher trophic guilds - the carnivores ones - in the ISC, evidencing a defaunated community (LIMA-SILVA, 2022). Therefore, it reinforces that it is necessary to consider that habitat changes can lead to biotic homogenization and consequently alter ecosystem functions (CLAVEL and DEVICTOR, 2011).

Community abundance and richness along environmental gradients

Species richness only showed a significant negative relationship with non-vegetation areas, which was also significantly negative for the abundance proxy of non-flying mammal species. Contrary to the assumption of the Islands Biogeography Theory (MACARTHUR and WILSON, 1967), the best predictor variable - forest site area - was not significant in our study, but the second-best predictor, the forest site isolation variable was negatively significant for both richness and abundance proxy, since UNVEG was highly related to the forest site distance variable. These results suggest that the depleted environments of the ISC, and the multiple uses of the background matrix of the PAs produce a low relationship associated with landscape configuration variables, as initially hypothesized.

Nonetheless, considering the significance of the distance between the forest sites (UNVEG variable, Table 3) and the cluster analysis (Figure 2), it can be noticed that the permeability of the background matrix affects the success of

dispersion, as observed in the gap between the clustering of the north and south of the island indicating a possible barrier that influences the dispersion and consequently the colonization rates of the patches that support small populations (OPDAM et al., 2003). Clearly, the two smaller, more peripheral forest sites and with larger unvegetated areas in the surroundings - Patches D and I (Group 1, Figure 2) - exhibit lower richness, and greater abundance of generalist species, such as *Didelphys aurita* and small non-flying mammals. The preservation of native biota in the forest sites depends on a reduction of pressure vectors, which depends on the level of habitat fragmentation. At the same time, restoration of the ecosystem and maintenance of genetic flows between existing patches depends on the quality of the matrix for the species of interest (SISK et al., 1997).

Also, regarding the abundance proxy of non-flying mammals, the variable patch shape was positively significant, corroborating with other studies that the more compact shape is the patch, the greater the abundance of species will be in the place (RIITTERS et al. 1995; HELZER and JELINSKI, 1999).

Despite the last significant environmental gradient of abundance associated with the centroid distance from the edge (CDIST) negatively, it could probably be a mask of species response effects related to sampling bias select location, in which most of the CTs were installed closer to the edge, due to the difficulty of access to the areas core, an issue also discussed in sampling methods of not only non-flying mammal species, as well as other groups of species (SCHOWALTER and GANIO, 1998; PHILLIPS et al., 2009).

Community composition and species traits along environmental gradients

The significant negative variation in species composition assemblages along the forest site shape, in which more convoluted shapes are positive for species composition (Table 3) could be explained, mainly by the association of the increased influence of shape with these patches' local edge effects, given the increase of more opportunistic and generalist species that benefit from this location (LAURANCE and YENSEN, 1991). This is noticed in Figure 3, where herbivorous and terrestrial species, such as *Cuniculus paca* and *Dasyprocta azarae*, are positively related to shape variables.

Likewise, the stages of Atlantic Forest succession classification of the Atlantic Forest (FORSTA) variable, which presented a significant negative relationship in the species composition, also indicates that in more advanced successional stages the non-flying mammal's assemblage may be closer to equilibrium (KUHNEN, 2012), thus presenting species related to more preserved environments and more abundant (Table 3), yet with a reduction of more opportunistic species. This fact is also demonstrated in Figure 3 with a negative relationship of scansorial species with FORSTA, such as small non-flying mammals and *Nasua nasua*. In others, medium and large mammals in the Atlantic Forest studies report that the highest values of functional diversity recorded for these species are related to areas with large forest cover, greater environmental heterogeneity, and low levels of anthropic disturbance (Magioli et al., 2015).

Observing the results obtained in which the patch factor (id) showed significant interactions with the functional species (Figure 3, Appendix 1, Figure A1 and A2), together with the GLMs and cluster analyses, it is noted that there is no high connectivity between forest sites, contrary to what we predicted. In this context, the landscape can be considered as a spatial and functional entity of living spaces, which add to the structural changes that occur in the landscape, as well as its functional changes (FORMAN and GODRON, 1986) and that reflect on the heterogeneity within the landscape.

Our findings also reveal functional gaps (Figure 3), and it is observed the redundancy of functional groups and the absence of others, such as carnivores. This indicates mesopredators release effects, in which there are no carnivorous species and others of greater body mass to occupy distinct niches evidencing defaunation in the Santa Catarina Island, and reinforcing that carnivorous mammals are particularly vulnerable to extinction in fragmented areas (PALOMARES et al., 1995). As well, as the responses of opportunistic species in fragmented habitats, which have trophic plasticity from both accessing and taking advantage of the surrounding matrix resources (SANTOS-FILHO et al., 2012; PALMEIRIM et al., 2018).

Management Conservation Considerations

Santa Catarina Island is a large insular area in which it mixes both water barriers, and presents complex patterns of continental areas fragmentation effects, as seen in the responses of the structure and functional groups of the non-flying mammal community. This makes this ecosystem even more vulnerable to human pressures, as the maintenance (or increase) of diversity through the rescue effect is less likely in insular environments (VAN SCHMIDT and BEISSINGER, 2020; LIMA-SILVA, 2022). Medium and large mammals are especially sensitive to habitat loss and fragmentation, with the consequences of these threats being aggravated by synergistic effects with other factors, such as hunting, forest fires and other anthropogenic impacts on isolated populations (Canale et al., 2012).

From the planning point of view, the definition of the scope will determine the expected result of the conservation action, that is, if the protected areas must restore and maintain ecological processes, how to maintain and improve ecosystem services, or if the areas must maintain the representativeness of community species, maximizing biological diversity, protecting a particular species or group of species. Our results show that for both situations, planning strategies to identify priority areas for conservation and recovery, as well as reintroduction of species are urgent, given the situation of defaunation of the ISC and the functional gaps presented. The absence of effective territorial planning may amplify the ISC vulnerability and could increase the fragility of the ecosystems, posing clear threats to the island's unique biodiversity, as seen in other island studies (ZHAO et al., 2006).

Landscape planning for nature conservation should focus on the configuration of habitat and relevant elements of the matrix. The impacts of this current situation need to be monitored and considered in the long term to reduce the chances of further extinctions, as well as the recovery of environmental integrity and the effective conservation of biodiversity providing resilience and expanding exchanges of biological flows.

References

- ABREU, E. F. et al. Lista de Mamíferos do Brasil. 23 dez. 2021.
- AGUIAR, Gabriel Lima de. Mamíferos não-voadores do Parque do Cocó, Fortaleza-CE: composição e impactos associados. 2017.
- AHUMADA, Jorge A. et al. Community structure and diversity of tropical forest mammals: data from a global camera trap network. *Philosophical Transactions of the Royal Society B: Biological Sciences*, v. 366, n. 1578, p. 2703-2711, 2011.
- ANDERSON, D.; BURNHAM, K. Model selection and multi-model inference. Second. NY: Springer-Verlag, v. 63, n. 2020, p. 10, 2004.
- BACCINI, A. G. S. J. et al. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. *Nature climate change*, v. 2, n. 3, p. 182-185, 2012.
- BARTÓN, K. R package “MuMIn”: Multi-model inference (version 1.10. 5). URL [http://CRAN.R-project.org/package= MuMIn](http://CRAN.R-project.org/package=MuMIn), 2014.
- BEIROZ, Helio. Zonas de amortecimento de Unidades de Conservação em ambientes urbanos sob a ótica territorial: reflexões, demandas e desafios. *Desenvolvimento e Meio Ambiente*, v. 35, 2015.
- BORCARD, Daniel; GILLET, François; LEGENDRE, Pierre. *Numerical ecology with R*. New York: Springer, 2011.
- ter BRAAK, Cajo JF; CORMONT, Anouk; DRAY, Stéphane. Improved testing of species traits–environment relationships in the fourth-corner problem. *Ecology*, v. 93, n. 7, p. 1525-1526, 2012.
- BROWN, Alexandra M. et al. The fourth-corner solution–using predictive models to understand how species traits interact with the environment. *Methods in Ecology and Evolution*, v. 5, n. 4, p. 344-352, 2014.
- CANDELA, Adriana M.; MUÑOZ, Nahuel A.; GARCÍA-ESPONDA, César M. The tarsal-metatarsal complex of caviomorph rodents: Anatomy and functional-adaptive analysis. *Journal of Morphology*, v. 278, n. 6, p. 828-847, 2017.
- CANALE, Gustavo R. et al. Pervasive defaunation of forest remnants in a tropical biodiversity hotspot. 2012.
- CARO, Tim et al. An inconvenient misconception: Climate change is not the principal driver of biodiversity loss. *Conservation Letters*, p. e12868, 2022.
- CASSANO, C. R.; BARLOW, J.; PARDINI, R. Forest loss or management intensification? Identifying causes of mammal decline in cacao agroforests. *Biol. Conserv.*, 169, pp. 14-22. 2014.
- CHEREM, Jorge J. et al. Lista dos mamíferos do estado de Santa Catarina, sul do Brasil. *Mastozoología neotropical*, v. 11, n. 2, p. 151-184, 2004.
- CLAVEL, Joanne; JULLIARD, Romain; DEVICTOR, Vincent. Worldwide decline of specialist species: toward a global functional homogenization?. *Frontiers in Ecology and the Environment*, v. 9, n. 4, p. 222-228, 2011.

COHEN, Jacob. Set correlation as a general multivariate data-analytic method. *Multivariate Behavioral Research*, v. 17, n. 3, p. 301-341, 1982.

DRAY, Stéphane; DUFOUR, Anne-Béatrice. The ade4 package: implementing the duality diagram for ecologists. *Journal of statistical software*, v. 22, p. 1-20, 2007.

DRAY, Stéphane; CHESSEL, Daniel; THIOULOUSE, Jean. Co-inertia analysis and the linking of ecological data tables. *Ecology*, v. 84, n. 11, p. 3078-3089, 2003.

DRAY, Stéphane; LEGENDRE, Pierre. Testing the species traits–environment relationships: the fourth-corner problem revisited. *Ecology*, v. 89, n. 12, p. 3400-3412, 2008.

EISENBERG, John F.; THORINGTON JR, Richard W. A preliminary analysis of a Neotropical mammal fauna. *Biotropica*, p. 150-161, 1973.

FIGUEIRÓ, Adriano S.; NETTO, Ana L. Coelho. Análise da variabilidade térmica em zonas de bordas florestais com interface urbana no maciço da Tijuca Rio de Janeiro-RJ. *Ciência e Natura*, v. 29, n. 2, p. 173-186, 2007.

FORERO-MEDINA, German; VIEIRA, Marcus Vinícius. Conectividade funcional ea importância da interação organismo-paisagem. *Oecologia Brasiliensis*, v. 11, n. 4, p. 493-502, 2007.

FORMAN, Richard TT; GODRON, Michel. *Landscape ecology* John Wiley & Sons. New York, v. 4, p. 22-28, 1986.

GODEFROID, Sandrine; KOEDAM, Nico. Distribution pattern of the flora in a peri-urban forest: an effect of the city–forest ecotone. *Landscape and Urban Planning*, v. 65, n. 4, p. 169-185, 2003.

GRAIPEL, M. E. et al. Mamíferos da Mata Atlântica. In: *Revisões em Zoologia: Mata Atlântica*. [s.l.] Editora UFPR Curitiba, 2017. p. 391–482.

GRAIPEL, Maurício E.; CHEREM, Jorge J.; XIMENEZ, Alfredo. Mamíferos terrestres não voadores da Ilha de Santa Catarina, sul do Brasil. *Biotemas*, v. 14, n. 2, p. 109-140, 2001.

HADDAD, Nick M. et al. Habitat fragmentation and its lasting impact on Earth's ecosystems. *Science Advances*, v. 1, n. 2, p. e1500052, 2015.

HELZER, Christopher J.; JELINSKI, Dennis E. The relative importance of patch area and perimeter–area ratio to grassland breeding birds. *Ecological Applications*, v. 9, n. 4, p. 1448-1458, 1999.

JACKSON, Heather Bird; FAHRIG, Lenore. What size is a biologically relevant landscape?. *Landscape ecology*, v. 27, n. 7, p. 929-941, 2012.

KEDDY, Paul A. Assembly and response rules: two goals for predictive community ecology. *Journal of vegetation science*, v. 3, n. 2, p. 157-164, 1992.

KUHNEN, Vanessa Villanova. Diversidade de mamíferos e a estrutura do hábitat: Estudo da composição da mastofauna terrestre em diferentes estágios sucessionais de regeneração da Floresta Ombrófila Densa, Santa Catarina, Brasil. 2012.

LEATHWICK, J. R.; ELITH, J.; HASTIE, T. Comparative performance of generalized additive models and multivariate adaptive regression splines for statistical modelling of species distributions. *Ecological Modelling*, v. 199, n. 2, p. 188-196, 2006.

LIMA-SILVA, Barbara. O efeito da insularidade sobre o padrão de montagem de assembleias de mamíferos de médio e grande porte em Floresta Ombrófila Densa do Sul do Brasil. 2022.

MACARTHUR, Robert H.; WILSON, Edward O. The theory of island biogeography Princeton University Press. Princeton, NJ, v. 203, 1967.

MAGIOLI, Marcelo. Ecologia trófica, funcional e isotópica de mamíferos terrestres da Mata Atlântica. 2018. Tese de Doutorado. Universidade de São Paulo.

MAGIOLI, Marcelo et al. Thresholds in the relationship between functional diversity and patch size for mammals in the Brazilian Atlantic Forest. *Animal Conservation*, v. 18, n. 6, p. 499-511, 2015.

MORGAN, Cecilia Clara; ALVAREZ, Alicia. The humerus of South American caviomorph rodents: shape, function and size in a phylogenetic context. *Journal of Zoology*, v. 290, n. 2, p. 107-116, 2013.

MURCIA, Carolina. Edge effects in fragmented forests: implications for conservation. *Trends in ecology & evolution*, v. 10, n. 2, p. 58-62, 1995.

MURTAGH, Fionn; LEGENDRE, Pierre. Ward's hierarchical agglomerative clustering method: which algorithms implement Ward's criterion?. *Journal of Classification*, v. 31, n. 3, p. 274-295, 2014.

NEVES, J., ORNON, A., VOIRON-CANICIO, C., & HORN FILHO, N. O. Mapeamento do uso e da cobertura da terra na Ilha de Santa Catarina, Brasil, com base em imagem de alta resolução espacial. *Geosul*, 32(65), 213-238., 2017.

O'BRIEN, Timothy G. Abundance, density and relative abundance: a conceptual framework. In: *Camera traps in animal ecology*. Springer, Tokyo, 2011. p. 71-96.

OPDAM, Paul; VERBOOM, Jana; POUWELS, Rogier. Landscape cohesion: an index for the conservation potential of landscapes for biodiversity. *Landscape ecology*, v. 18, n. 2, p. 113-126, 2003.

OKSANEN, Jari et al. Package 'vegan'. *Community ecology package*, version, v. 2, n. 9, p. 1-295, 2013.

PAGLIA, A. P. et al. Lista Anotada dos Mamíferos do Brasil/Annotated Checklist of Brazilian Mammals. (2nd Edition). *Occasional papers in conservation biology*, 6, 1-82. v. 6, p 1-82, 2012.

PALMEIRIM, Ana Filipa et al. Small mammal responses to Amazonian forest islands are modulated by their forest dependence. *Oecologia*, v. 187, n. 1, p. 191-204, 2018.

PALOMARES, Francisco et al. Positive effects on game species of top predators by controlling smaller predator populations: an example with lynx, mongooses, and rabbits. *Conservation Biology*, v. 9, n. 2, p. 295-305, 1995.

PARERA, A.; ERIZE, F. Los mamíferos de la Argentina y la región austral de Sudamérica. 2002.

PARRY, Luke; BARLOW, Jos; PERES, Carlos A. Large-vertebrate assemblages of primary and secondary forests in the Brazilian Amazon. *Journal of Tropical Ecology*, v. 23, n. 6, p. 653-662, 2007.

PAVOINE, Sandrine; BONSALE, Michael B. Measuring biodiversity to explain community assembly: a unified approach. *Biological Reviews*, v. 86, n. 4, p. 792-812, 2011.

PHILLIPS, Steven J. et al. Sample selection bias and presence-only distribution models: implications for background and pseudo-absence data. *Ecological Applications*, v. 19, n. 1, p. 181-197, 2009.

POWELL, Luke L.; STOUFFER, Philip C.; JOHNSON, Erik I. Recovery of understory bird movement across the interface of primary and secondary Amazon rainforest. *The Auk*, v. 130, n. 3, p. 459-468, 2013.

PROGRAMA DAS NAÇÕES UNIDAS PARA O DESENVOLVIMENTO - PNUD. Relatório de Desenvolvimento Humano 2009: ultrapassar barreiras: mobilidade e desenvolvimento humanos. New York, 2009.

PROJETO MAPBIOMAS – Collection 6. da Série Anual de Mapas de Cobertura e Uso da Terra do Brasil, 2020. Access in 11/06/2021 from <https://plataforma.brasil.mapbiomas.org/>

R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL [Http:// www.R-Project.Org/](http://www.R-Project.Org/). 2022.

REIS, N. R. et al. Mamíferos do Brasil. In: Mamíferos do Brasil. [s.l: s.n.]. 2006. p. 437.

RIBEIRO, Milton Cezar et al. The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation. *Biological Conservation*, v. 142, n. 6, p. 1141-1153, 2009.

RIITTERS, Kurt H. et al. A factor analysis of landscape pattern and structure metrics. *Landscape ecology*, v. 10, n. 1, p. 23-39, 1995.

SANTOS-FILHO, Manoel et al. Habitat patch and matrix effects on small-mammal persistence in Amazonian forest fragments. *Biodiversity and Conservation*, v. 21, n. 4, p. 1127-1147, 2012.

SCHOWALTER, T. D.; GANIO, L. M. Vertical and seasonal variation in canopy arthropod communities in an old-growth conifer forest in southwestern Washington, USA. *Bulletin of Entomological Research*, v. 88, n. 6, p. 633-640, 1998.

SETO, Karen C.; GÜNERALP, Burak; HUTYRA, Lucy R. Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, v. 109, n. 40, p. 16083-16088, 2012.

SISK, Thomas D.; HADDAD, Nick M.; EHRLICH, Paul R. Bird assemblages in patchy woodlands: modeling the effects of edge and matrix habitats. *Ecological Applications*, v. 7, n. 4, p. 1170-1180, 1997.

SRBEK-ARAUJO, Ana C.; CHIARELLO, Adriano G. Armadilhas fotográficas na amostragem de mamíferos: considerações metodológicas e comparação de equipamentos. *Revista Brasileira de Zoologia*, v. 24, p. 647-656, 2007.

STRATFORD, Jeffrey A.; STOUFFER, Philip C. Local extinctions of terrestrial insectivorous birds in a fragmented landscape near Manaus, Brazil. *Conservation Biology*, v. 13, n. 6, p. 1416-1423, 1999.

TENENHAUS, Michel; YOUNG, Forrest W. An analysis and synthesis of multiple correspondence analysis, optimal scaling, dual scaling, homogeneity analysis and other methods for quantifying categorical multivariate data. *Psychometrika*, v. 50, n. 1, p. 91-119, 1985.

VAN SCHMIDT, Nathan D.; BEISSINGER, Steven R. The rescue effect and inference from isolation–Extinction relationships. *Ecology Letters*, v. 23, n. 4, p. 598-606, 2020.

VENABLES, William N.; RIPLEY, Brian D. Modern applied statistics with S-PLUS. Springer Science & Business Media, 2013.

ZHAO, Shuqing et al. Ecological consequences of rapid urban expansion: Shanghai, China. *Frontiers in Ecology and the Environment*, v. 4, n. 7, p. 341-346, 2006.

WANG, Yi et al. Package 'mvabund'. 2022.

WIENS, John A. et al. Ecological mechanisms and landscape ecology. *Oikos*, p. 369-380, 1993.

WREGGE, Marcos Silveira et al. Atlas climático da região sul do Brasil: estados do Paraná, Santa Catarina e Rio Grande do Sul. Pelotas: Embrapa Clima Temperado; Colombo: Embrapa Florestas, 2012., 2012.

YARBERRY, William. DPLYR. In: CRAN Recipes. Apress, Berkeley, CA, 2021. p. 1-58.

APPENDIX 1

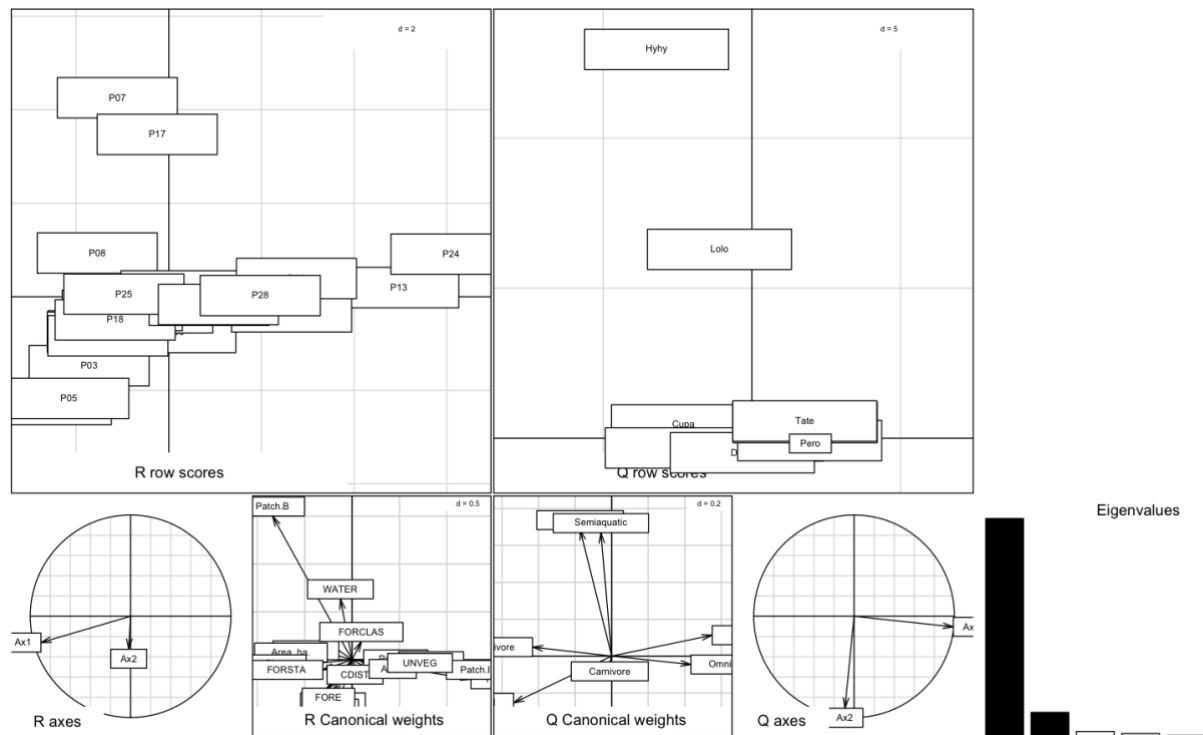


Figure A 1 RLQ plot. Ordination showing relative contributions of environmental variables and species traits to the RLQ axes (Axis 1–87.92%, Axis 2–9.42%).

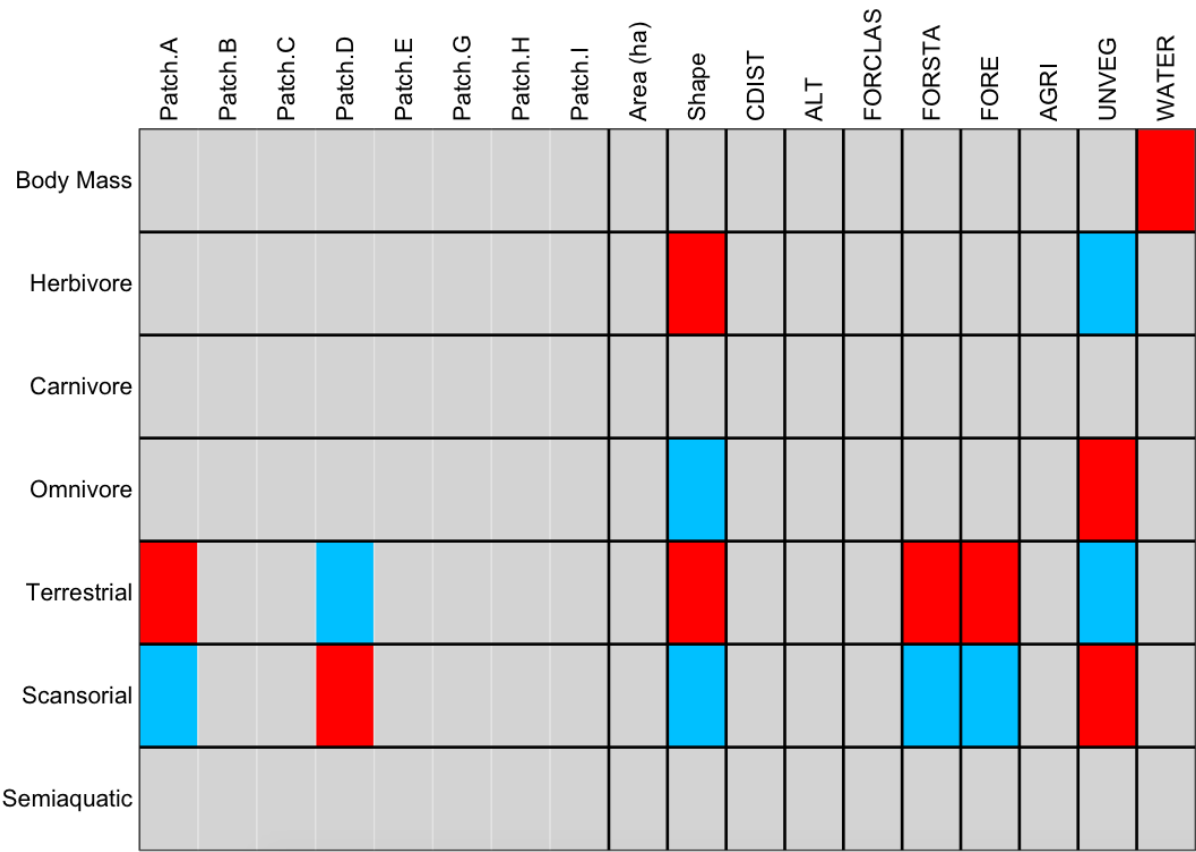


Figure A 2 Four-corner analysis plot showing significant interactions with the environment and species traits variables. Red were positive correlations, blue were negative correlations.

Table A 1 Significant correlations values of environmental and species traits interaction from four-corner analysis across Santa Catarina Island patches. Std. Obs= Standard observation. Adj. p= adjusted p values. For environmental variables code see Table 1.

Variables Interactions	Std. Obs	Adj. <i>p</i>
WATER / Body Mass	3.653	0.047
SHAPE/ Herbivore	4.403	0.021
UNVEG/ Herbivore	-3.202	0.042
Patch D/ Omnivore	-3.706	0.037
Patch I/ Omnivore	-2.897	0.047
SHAPE/ Omnivore	-4.372	0.021
UNVEG / Omnivore	3.181	0.036
SHAPE/ Terrestrial	5.234	0.021
FORSTA/Terrestrial	3.872	0.037
FORE/ Terrestrial	3.278	0.042
UNVEG/ Terrestrial	-4.174	0.021
Patch D/ Scansorial	-3.131	0.047
SHAPE/ Scansorial	-5.197	0.021
FORSTA/Scansorial	-3.873	0.037
FORE/ Scansorial	-3.001	0.047
UNVEG/ Scansorial	4.186	0.021

ARTIGO 2

NON-FLYING MAMMALS COMMUNITY DISTRIBUTION AT SANTA CATARINA ISLAND: WHAT ARE THE EXPECTED SCENARIOS WITH MANAGEMENT PLANNING CHANGES?

Journals target: Natureza & Conservação - Brazilian Journal for Nature Conservation

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Abstract

Habitat change studies provide critical baseline information for conservation planning and decision-making. However, in many study regions in a local scale approach, such data are lacking for many species. Here, we used ecological niche modelling to model distributions of non-flying mammal species and to evaluate protected areas' habitat distance across Santa Catarina Island, a continental island of Brazil south. We estimated the current island distributions of four distinct non-flying mammals species requirements (trophic guild, body mass and locomotor habits) across the region and evaluated the connectivity in the seven conservation units established for the actual scenario, and for two possible future scenarios: i) urban expansion, and ii) recovery and conservation of the priority areas defined by the Municipal Plan for the Atlantic Forest of Florianópolis. We used species occurrence data from 34 sites distributed throughout the island collected between 2019 and 2021 using camera-trapping. Land use and land cover data were extracted from the most updated GIS available. Our predictive models had a good fit ($AUC > 0.7$) for the three scenarios investigated. Of the suitable areas in an urban scenario, for possums (*Didelphis aurita*), was possible to observe less potential impact of a critical protected area connectivity. This study identifies priority areas for biodiversity conservation and forest connectivity in the region and reemphasizes the practicality of these tools to optimize conservation planning and implementation.

Key word: mammals, land-use management, species distribution modelling, urban expansion.

Resumo

Estudos de alterações de habitat fornecem informações críticas para tomadas de decisões e conservação da biodiversidade. No entanto, em muitos locais de estudo, onde são necessários uma abordagem de escala local, esses dados não estão em escala apropriada. Neste trabalho, usamos modelagem de nicho ecológico para modelar distribuições de espécies de mamíferos não voadores e avaliar a conectividade de áreas protegidas na Ilha de Santa Catarina, uma ilha continental ao sul do Brasil. Estimamos as distribuições atuais de quatro espécies de mamíferos não voadores com diferentes requerimentos (guildd trófica, massa corporal e hábitos locomotores) em toda ilha e avaliamos a conectividade em sete unidades de conservação estabelecidas para o cenário atual e para dois possíveis cenários futuros: i) expansão urbana e ii) recuperação e conservação. Usamos dados de ocorrência para o período de 2019–2021 de armadilhas fotográficas e dados de uso e cobertura da terra. Os modelos preditores apresentaram bom ajuste ($AUC > 0.7$) para os três cenários investigados. No cenário urbano, nas áreas adequadas para gambás (*Didelphis aurita*) foi possível observar um menor impacto potencial em uma área crítica para a conservação e recuperação, sobre a conectividade entre áreas protegidas. Este estudo identifica áreas prioritárias para conservação da biodiversidade e conectividade florestal na ISC e reforça o uso de MDEs a fim de otimizar o planejamento e tomadas de decisão em prol da conservação.

Palavras-chave: mastofauna, gestão territorial, ecologia de paisagem, expansão urbana.

1. Introduction

The Atlantic Forest represents one of the most biodiverse terrestrial biomes on the planet, being responsible for providing essential ecosystem services for the maintenance of all forms of life, such as regulating the microclimate, controlling erosion and silting, maintaining the volume and quality of water, tourism, among others (GUEDES and SEEHUSAN, 2014). At the same time, it is one of the biomes most threatened by anthropic action, with around 8% of its original coverage remaining, thus being considered one of the planet's biodiversity hotspots (MYERS et al., 2000; MITTERMEIER et al., 2004). In the last 50 years, due to the efforts of several works in conservation, this scenario is

a little optimistic, resulting in about 25% of its original coverage (PINTO and HIROTA, 2022), with new challenges, and still a long way to go. to recover.

The Atlantic Forest vegetation and its associated ecosystems previously formed continuous areas, which over time have been altered by human action through changes in land cover and use, which negatively impact its natural vegetation, restricting its connectivity, increasing the effects of edge, decreasing the area of native fragments and increasing the isolation due to land use in the matrix that surrounds the fragment (ODUM and BARRETT, 2008; METZGER, 2003). This process is known as habitat fragmentation, and it is directly associated with one of the greatest threats to maintaining the ecological integrity and health of ecosystems (PIRES et al., 2006; UN ENVIRONMENT, 2019).

Thus, the effects related to the redistribution of local communities need to be better understood to support the assessment of these ecological systems and ensure the protection of biodiversity. With the advent of geographic coordinate systems and technology, spatial modelling using bioindicators can be great allies to assist in these studies.

Species distribution models (SDMs), or ecological niche models, are one of the most used methods in ecology to assess environmental similarities between regions and, consequently, stimulate species distribution (PETERSON and SOBERON, 2012). Also, they are important tools used for the development of management and conservation strategies with applications ranging from the identification of biophysical characteristics of the habitat of a certain species to the detection of environmental changes (PETERSON et al., 2011), which may create action plans at distinct scales.

Planning laws are used to ensure the protection of natural and cultural heritage and function as formal local designation systems, which act as useful tools to delimit areas of interest in the landscape (JENKINS, 2018). The main territorial ordering instrument of Santa Catarina Island - the state capital located on an island of great diversity and environmental fragility - is a Master Plan, which since 2006 has been periodically undergoing trials and revisions to comply with federal legislation (SIQUEIRA et al., 2020) to fit into the City Statute (BRASIL, 2001). In addition, there is a legal framework referring to environmental legislation

that should be integrated into the preparation of these plans to effectively address not only biodiversity conservation but also environmental issues and losses of ecosystem services and their associated benefits, as enacted by the National Civil Defense and Protection Policy (PNPDEC) (BRASIL, 2012). These national policies' fundamental principles are mapping and prevention actions in areas susceptible to phenomena and processes in the physical environment whose dynamics can generate natural disasters. Also, the PNPDEC aims to integrate with other sectoral policies, with emphasis on territorial planning, urban development, and the environment (CPRM & IPT, 2014). In this way, the Municipal Plan for the Atlantic Forest of Florianópolis (PMMA, 2020) was prepared in compliance with Law nº 11.428/06 (BRASIL, 2006) aiming to be in line with innovative environmental management that includes the participants of public management and social control in the conservation and recovery of the Atlantic Forest biome (DUTRA, 2013).

In this context, we applied species distribution models to four species of non-flying mammals, given their typically contrasting response patterns to deforestation and environmental degradation (WIENS et al., 1993). These species have been widely used as biological indicators for assessing environmental quality. We used data from camera traps collected from 2019 to 2022 to project alternative scenarios: (1) optimistic scenario and (2) pessimist scenario of land cover classes changes in environmental variables of non-vegetated areas and forested areas according to the PMMA. Our work aims to answer the following questions: a) do species with different habitat requirements respond similarly to urban pressure? b) Is it possible to identify, through the modelling of habitat suitability, the impact of changes in land use and land cover in the areas identified by the PMMA? Respectively, we hypothesized that: a) greater potential losses could be observed with the increase in urban areas associated with more sensitive groups, and lower potential losses to more opportunistic groups such as *Didelphis aurita*; b) as Islands Biogeography Theory (MACARTHUR and WILSON, 1967) the impact of changes in land use and land cover could be observed according to the size and isolation of the PMMA polygons areas from the distinct land use and land cover classes.

2. Methods

2.1 Study Area

Santa Catarina Island is located between latitudes 27°22'S and 27°50'S and longitudes 48°25'W and 48°35'W comprises an area of 42,440 ha, and it is inserted in the domain of the Atlantic Forest with dense ombrophilous forest formations and associated ecosystems of mangroves, restinga, beaches, dunes, and forests of Quaternary plains (CARUSO, 1990). The climate is humid mesothermal, with an indefinite dry season, rainfall distributed throughout the year and hot summers. Annual average rainfall and temperature are around 1467.8 mm and 20.5° C, respectively (WREGE et al., 2012). We selected 34 sampling sites, each of them surveyed with one camera trap (CT) of the Fauna Floripa Project¹. Part of the sampling sites (N = 24) was distributed across nine protected areas (PAs) (Figure 2.1) that comprise seven conservation units: Serra do Tabuleiro State Park (STSP), Lagoa do Peri Municipal Natural Monument (LPMM), Lagoinha do Leste Municipal Natural Park (LLMP), Morro da Cruz Municipal Natural Park (MCMP), Maciço da Costeira Municipal Natural Park (MCoMP), Lagoa da Conceição Dunes Municipal Natural Park (LCMP) and Meiembipe Municipal Wildlife Refuge (MMWR). The other 10 sampling sites were in patches of vegetation identified between the PAs. The study areas have predominant dense ombrophilous forest vegetation, with only 2 sampling points

with arboreal restinga vegetation, 2 points with anthropic vegetation and 1 sampling point with hygrophilous vegetation.

2.2 Species data collection

Species occurrence data from the Fauna Floripa Project (PFF) for the period 2019-2020 were collected by AFs (Bushnell Essential E3 and Bushnell Agressor No-Glow models) installed with a minimum distance of 1 km between them, and with a minimum of two CTs per protected area. The videos were analysed by PFF specialists and those with a minimum interval of 60 min at the same sampling point were considered independent records of the same species (O'BRIEN, 2011), excluding exotic and domestic species. For non-flying mammal taxa identifications, we considered the species-level medium and large mammals weighing more than 1 kg (SRBEK-ARAUJO and CHIARELLO 2007, PAGLIA et al., 2012). Due to the lack of accuracy to identify smaller non-

flying mammals at the species level through the video graphics records, species typically weighing less than 1kg were classified within only single taxa, as small non-flying mammals.

Further, for species record selection to distribution modelling, we take into account the distinct environmental requirements - through species functional traits - and the quantity difference that species appear in distinct protected areas. Traits hypothesized to be related to the ability of non-flying mammals species

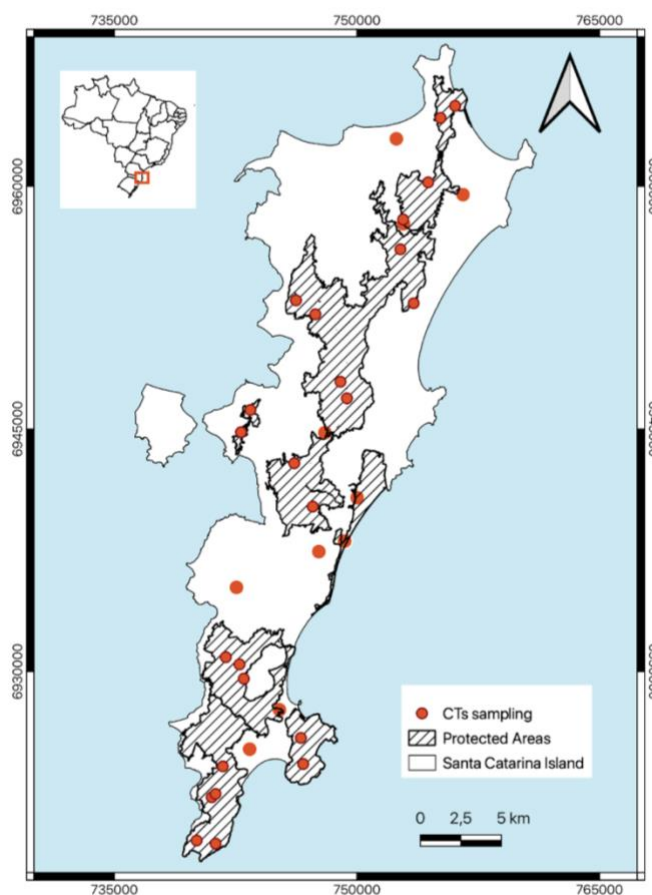


Figure 2. 1 Santa Catarina Island, Brazil, study area. The nine forest protected areas highlighted with the 34 camera trap sampling points (dark orange).

persist within ISC forest patches were (1) trophic guild - omnivores, herbivores and carnivores - based on ABREU et al. (2021), GRAIPEL et al. (2017), PAGLIA et al. (2012), PARERA e ERIZE (2002), and REIS et al. (2006); (2) body mass calculated based on an average proposed by PAGLIA et al. (2012), PARERA and ERIZE (2002), and REIS et al. (2006); and (3) locomotor habits - terrestrial, scansorial and semiaquatic - based on MAGIOLI (2018), CANDELA et al. (2017), CASSANO et al. (2014), and MORGAN and ALVAREZ (2013). Locomotor habit species were classified as belonging to a single lifestyle considering substrate preferences, they may occasionally also show other locomotor behaviours - Appendix A.

2.3 Cartographic Preparation for Different Environmental Scenarios

The land use map matrix file with a spatial resolution (LANDSAT) of 30 meters – is available from the Mapbiomas Project (2020) in Collection 6.0. with the cut-out for Santa Catarina Island - was reclassified in the QGIS® software (3.16.8-Hannover) with the *reclassify* tool by grouping it into higher classes according to the classification of MapBiomas in five categories (Table 2.1.) for a better representation of the results of this work.

Table 2. 1 Description of land cover and use major classes reclassified from MapBiomas (2020, collection 6) as codes reclassification available from <https://mapbiomas.org/codigos-de-legenda>.

Land cover and use area:		MapBiomas land cover and use major classes (collection 6, 2020)
Forest (FORE)		Total forest class (1) area
Agriculture (AGRI)		Total agriculture class (3) area
Unvegetated area (UNVEG)		Total unvegetated class (22) area
Water body (WATER)		Total water body class (26) area
Non-forest natural formation (NFOR)		Total non-forest natural formation class (2) area

After reclassification, the raster file was converted into a vector (Figure 3). With QGis *symmetrical difference* tool, the polygons of the PMMA shapefile (available at <https://geoportal.pmf.sc.gov.br/downloads/camadas-em-sig-do-mapa>) were extracted, which did not overlap the polygons of the protected areas in the municipality of Florianopolis, assuming that these areas are already consolidated as conservation areas and will not undergo urban intervention (Figure 2). Next, the layer of polygons extracted from critical conservation areas was inserted into the reclassified vector layer of land use and land cover with the *union* tool. The land cover and land areas polygons that overlapped with the new layer were reclassified again in a binary way - into natural and anthropized areas - to create the matrix data in the two management scenarios: a) in which this entire area is forest (recovery and conservation scenario) and b) in which the entire area becomes urbanized (environmental degradation and urban expansion scenario) (Figure 2.2).

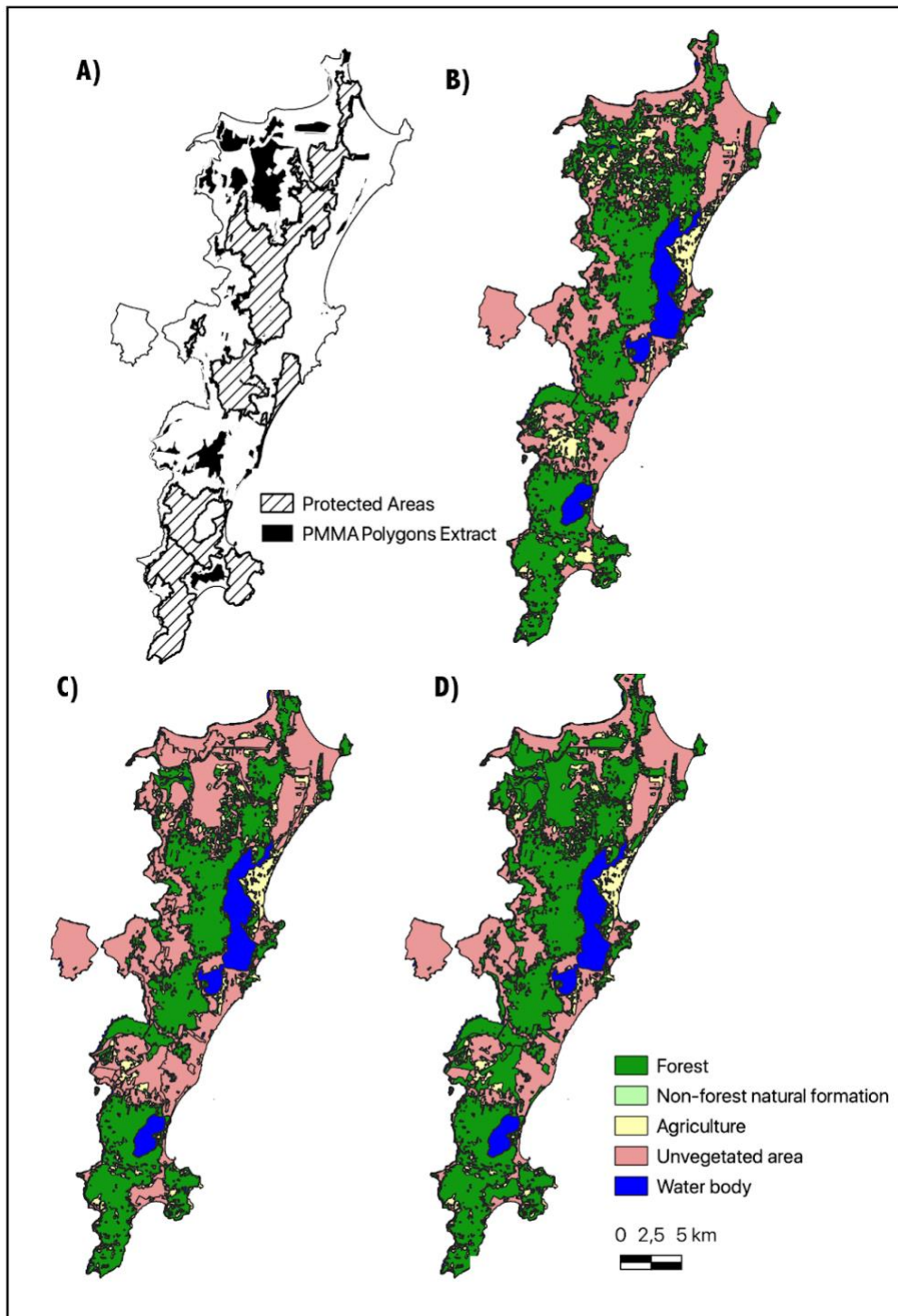


Figure 2. 2 Santa Catarina Island land cover and use maps. A) highlighted protected areas polygons with the PMMA polygons extracted of critical areas for recovery and conservation that do not overlap with the PAs; B) land cover and use reclassified major classes map from MapBiomas (2020); C) land cover and use with the PMMA extracted polygons converted into unvegetated areas (urban expansion scenario); D) land cover and use with the PMMA extracted polygons converted into forest areas (recovery and conservation scenario).

2.4 Species Distribution Modelling

All procedures for preparing the models were performed using the free software R in its R studio interface (version 4.1.0, 2021). Additional packages were installed: *dismo* (HIJMANS et al., 2017), *sdm* (NAIMI et al., 2016), *usdm* (NAIMI, 2015), *rgdal* (BIVAND, 2015) and *ssdm* (SCHMITT et al., 2017). Figure 2.3 summarizes the main methods used for modelling with the *ssdm* package.

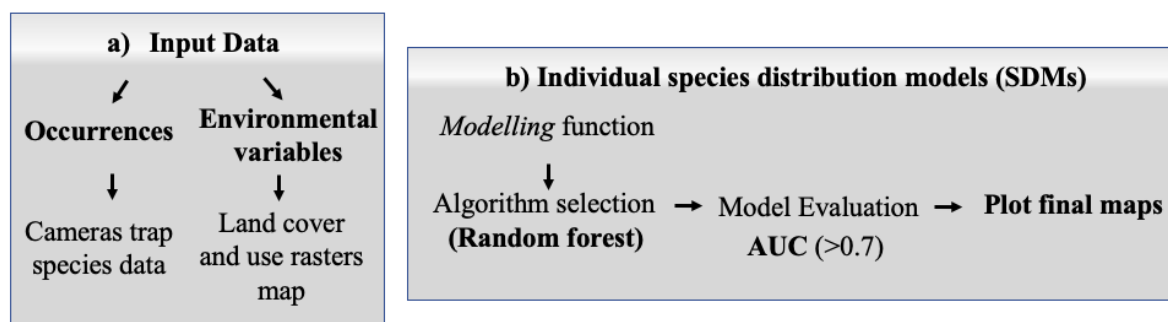


Figure 2. 3 Methodology procedures summary for individual species distribution models buildings through SSDM package.

3. Results

Considering the 4,356 independent records from all 34 CT sites, 15 species were recorded - including one single group as small non-flying mammals - across the Santa Catarina Island protected areas and forest remnants (Table 2.2).

Table 2. 2 Recorded species across Santa Catarina Island from cameras traps during the 2019-2021 period. Species found by conservation units, and the total recorded by protected areas. STSP= Serra do Tabuleiro State Park, LPMM=Lagoa do Peri Municipal Natural Monument, LLMP=Lagoinha do Leste Municipal Natural Park , MCMP= Morro da Cruz Municipal Natural Park, MCoMP= Maciço da Costeira Municipal Natural Park , LCMP= Lagoa da Conceição Dunes Municipal Natural Park, and MMWR= Meiembipe Municipal Wildlife Refuge.

Species	Conservation Unit Recorded	Total Protect Areas Recorded
Order Didelphimorphia <i>Didelphis aurita</i>	LCMP, LLMP, LPMM, MCMP, MCoMP, MMWR, STST, Non-protected area	7
Order Cingulata <i>Dasypus novemcinctus</i>	LCMP, LLMP, LPMM, MCoMP, MMWR, STST	6

Order Pilosa		
<i>Tamandua tetradactyla</i>	LLMP, LPMM, MCoMP, MMWR, STST, Non-protected area	5
Order Rodentia		
<i>Cuniculus paca</i>	MMWR	1
<i>Coendou spinosus</i>	MMWR	1
<i>Dasyprocta azarae</i>	LLMP, LPMM, MCoMP, MMWR, STST, Non-protected area	5
<i>Hydrochoerus hydrochaeris</i>	LLMP, LPMM, MMWR, STST, Non-protected area	4
Small non-flying mammals	LCMP, LLMO, LPMM, MCMP, MCoMP, MMWR, STST, Non-protected area	7
Order Carnivora		
<i>Cerdocyon thous</i>	LCMP, LLMP, LPMM, MCMP, MCoMP, MMWR, STST, Non-protected area	7
<i>Galictis cuja</i>	LCMP	1
<i>Eira Barbara</i>	MMWR	1
<i>Nasua nasua</i>	LCMP, LLMP, LPMM, MCoMP, MMWE, STST	6
<i>Lontra longicaudis</i>	MCoMP	1
Order Primates		
<i>Cebus nigrinus</i>	MMWR	1
<i>Callithrix</i> spp.	STST, MCMP, MCoMP, MMWR, LLMPM, Non-protected area	5

The areas identified by the PMMA as critical for the conservation and recovery of the extracted polygons that did not overlap conservation units represent 5922.86 ha of Santa Catarina Island (Figure 2.2 - A). The conversion of the use and land cover of these areas to urbanized areas (Figure 2.2 - C) represents a loss of 2922.4 ha of forest in the current scenario and an increase of 5186.5 ha of the urbanized area (Figure 2.2-C). While in a recovery and conservation scenario (Figure 2.2-D), it represents an increase of 2989.4 ha of forest area and a decrease of 725.4 ha of urbanized area in the current scenario.

For distribution model selection were selected species with different habitat requirements to evaluate if they present distinct responses on habitat suitability through land-use change. The omnivore species guild was selected *Didephis aurita* and *Tamandua tetradactyla*, once they have, respectively, the smallest and largest body mass and they also have distinct locomotor habits (Appendix A). In the herbivore guild the species *Cuniculus paca* and *Dasyprocta azarae* were selected, the first one has only recorded at Meiembipe Municipal Wildlife Refuge (MMWR) protected area, while the second was the most frequently herbivore species recorded - in five protected areas and at the camera traps points between them (Table 2). The carnivore guild was not distribution modelled due to the only carnivore species recorded at ISC was *Lontra longicaudis*, which did not have sufficient records to proceed with distribution modelling premises.

For *Dasyprocta azarae*, distribution models of all three scenarios investigated presented a good fit according to the statistical test area under the curve (AUC) with the cut-off value $AUC > 0.7$ (PHILLIPS et al, 2006). Mainly variable's importance contribution to the actual scenario suitable habitats model were forest (72.57%) and agriculture class (14.08%). For the urban scenario were agriculture class (39.14%), forest (35.89%) and urban class (24.33%). While in the conservation scenario were forest (55.19%), urban (22.90%) and agriculture class (21.37%) (Figure 2.4).

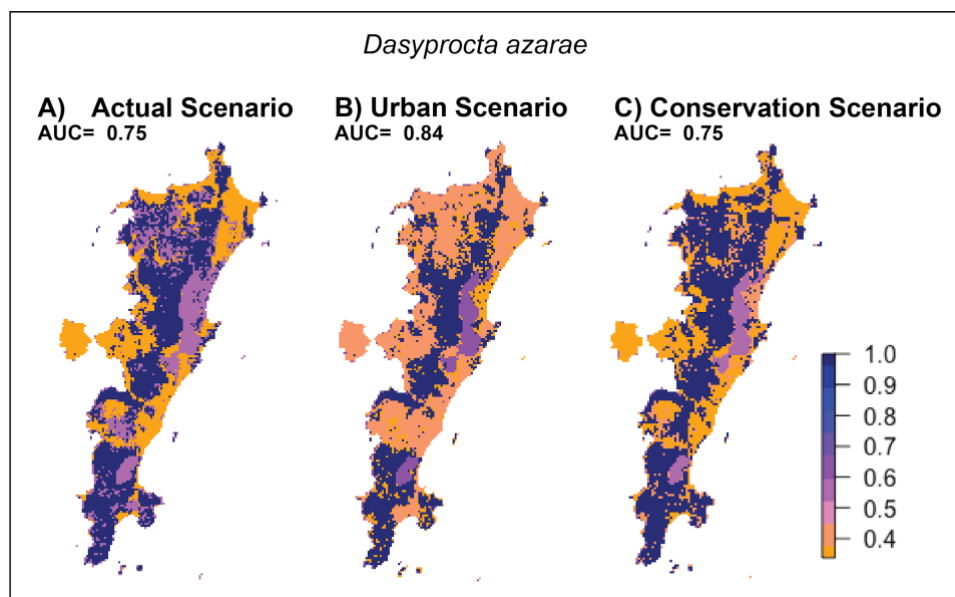


Figure 2. 4 Distribution maps within the three scenarios at Santa Catarina Island for *Dasyprocta azarae*. AUC= area under the curve. Blue to light orange = suitable (1) to unsuitable (0) areas.

The three distribution models of *Cuniculus paca* also presented a good fit with the agriculture class variable having the most important contribution (59.11%) for the actual scenario, followed by agriculture class (50.81%) and urban class (49.16%) for urban scenarios. And, in the conservation scenario was forest class with 78.52% contribution (Figure 2.5).

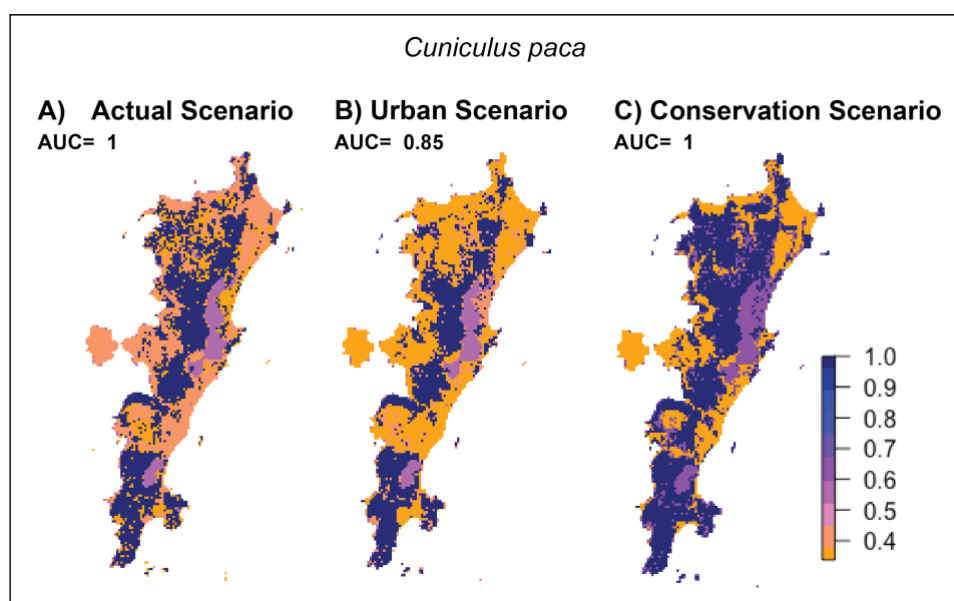


Figure 2. 5 Distribution maps within the three scenarios at Santa Catarina Island for *Cuniculus paca*. AUC= area under the curve. Blue to light orange = suitable (1) to unsuitable (0) areas.

Didelphis aurita suitable areas niche modelling showed only good fit models for actual and urban scenario projection. The variable with more important contributions were urban class (52.44%) and forest class (45.01%) for the actual scenario, and forest class (55.76%) and urban class (26.05%) for the urban scenario –Figure 2.6.

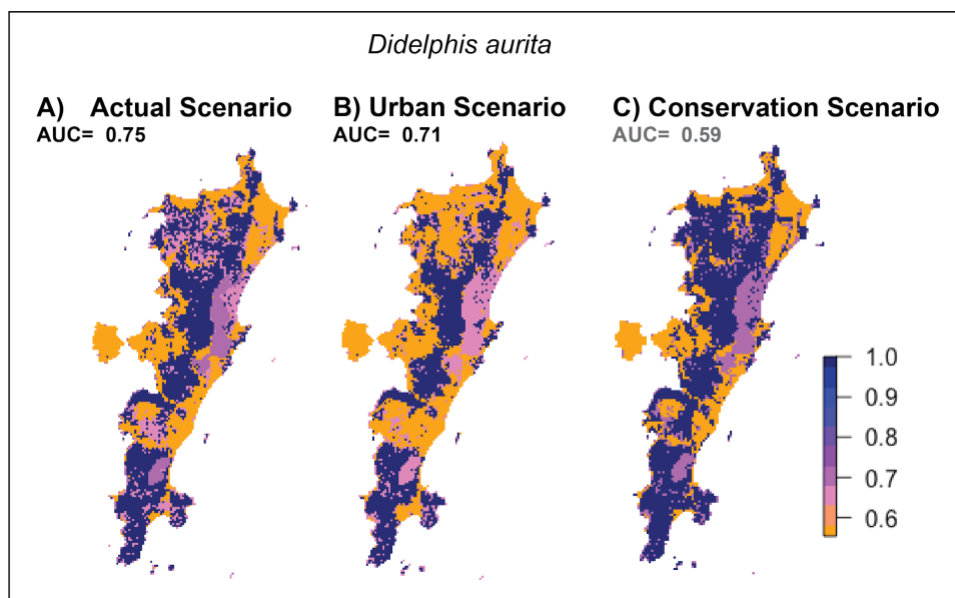


Figure 2. 6 Distribution maps within the three scenarios at Santa Catarina Island for *Didelphis aurita*. AUC= area under the curve. Blue to light orange = suitable (1) to unsuitable (0) areas.

For *Tamandua tetradactyla*, all distribution models had a good fit. The main variable importance contribution of the three scenarios was forest class (actual= 86.94%, urban=50.2%, and conservation= 74.2%), for the urban scenario also agriculture class was important (50.2%) (Figure 2.7).

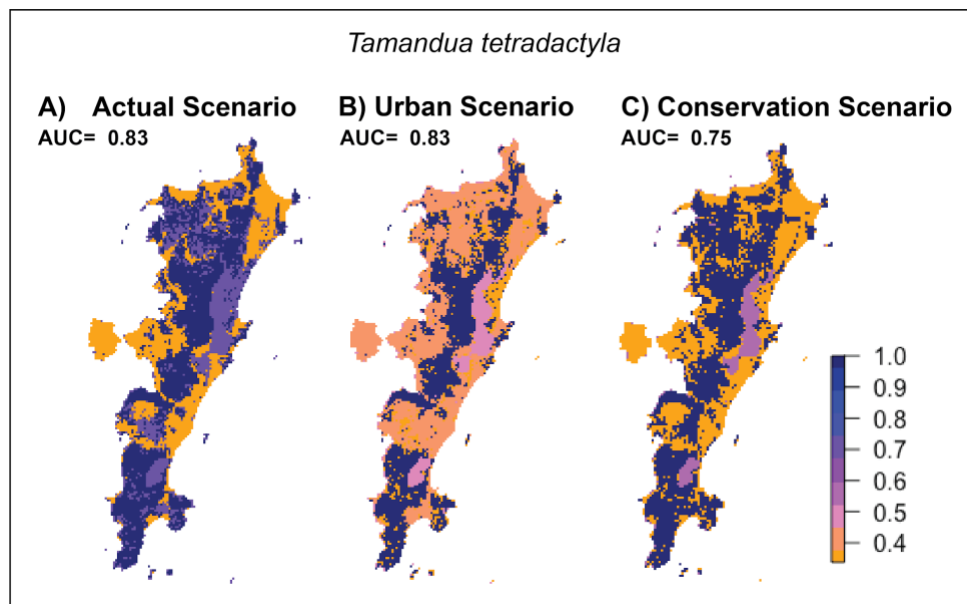


Figure 2. 7 Distribution maps within the three scenarios at Santa Catarina Island for *Tamandua tetradactyla*. AUC= area under the curve. Blue to light orange = suitable (1) to unsuitable (0) areas.

4. Discussion

Our results present the first habitat suitability scenarios of the influence of land-use change classes on the distribution of four species of non-flying mammals' distinct guilds in Santa Catarina Island. Our findings, therefore, comprise key information to be used by managers in the decision-making process that takes place along with the urban expansion in the region, as predicted in the current version of the corresponding Master Plan. Our predictions are further in agreement with previous studies showing that detrimental anthropogenic attributes influence mammal communities throughout the Brazilian Atlantic Forest (Galetti et al. 2009, Suzart de Albuquerque et al. 2011). Our results exhibit that areas of suitable habitats for non-flying mammals' community SDMs are similar between the four analysed species across the three distinct scenarios investigated indicating that these assemblages are mostly composed of forest-dependent species and possibly are confined to these areas. Also, is perceived the impact of land use change in the areas identified by the PMMA as our initial question. Although it is possible to identify a lower potential loss in the urban scenario of *Didelphis aurita*, which in Figure 2.5.B is seen as a more rose colour (more suitable habitat) within the South Island portion and centre portion, this is subtly distinct from another species area, that is represented with orange colour

(less suitable habitat), as we initially hypothesized. The dominant species of our study, the small non-flying mammal group, *Didelphis aurita* and *Cerdocyon thous* (Table 2), are in the majority omnivores species considered opportunistic and small to midsized generalist mammals (OLIVEIRA et al., 2019; ROCHA et al. 2008; GRAIPEL and SANTOS-FILHO, 2006).

SDMs aim to identify areas suitable for the occurrence of a given target species, and therefore have a strong predictive capacity of the potential species-environment distribution (PEARSON et al., 2006; PHILLIPS et al. 2006). Predictive distribution models have been used as input data in conservation analyses, including public policy tools, such as the National Action Plans (MMA, 2014) for endangered species in Brazil. Despite their increasingly frequent use of SDMs, when applied to biodiversity conservation, it presents basic problems, such as the lack of consensus on the best way to validate them. In this direction, our study takes into account a local scale and we used empirical methodological collected data (from 2019-2021) of non-flying mammals' assemblages across Santa Catarina Island.

Nonetheless, when sensitive responses on a local or regional scale are desired, it is essential to introduce variables with high spatial resolution, such as those related to geomorphology (NEZER et al., 2017), and such as the case of the present study, which used environmental variables of land use and land cover in a spatial resolution of 30 m Landsat (MabBiomass 2020). These variables can add sensitive information on a spatial scale, considering the abrupt morphological modification of the soil and cover used at distances less than 1 km, spatial resolution scale of bioclimatic variables, usually used in larger scale SDMs. This option aims to better represent the occurrence of target species in contexts that demand knowledge in greater spatial detail, as in the case of species habitats inserted in human communities (MATIAS, 2022).

Predictive distribution models from fine variables can have practical uses, such as defining priority areas for use, conservation, and restoration of areas where species occur, and allocation of infrastructure that supports the use of these species. Through habitat suitability for the four species analysed, it is feasible to identify the impact of changes in land use and land cover in the areas

identified by the PMMA observing the urban expansion scenario versus the conservation and recovery scenario. Considering the urban expansion scenario maps, a critical area is identified between the south and centre island portion (labelled as an "inter-seas plain corridor" area on the PMMA), where it is an unsuitable habitat species-area and, as a consequence, the consolidation of a barrier that blocks the structural connectivity between adjacent forest areas for the non-flying mammal's community. Despite of *Didelphis aurita* distribution map (Figure 2.6) being more evident than in the urban scenario, the major area of connection between the south and central island portion ("inter-seas plain corridor" area) still has suitable habitats areas, for both *Tamandua tetradactyla* and *Dasyprocta azarae* it is observed that the urban scenario, in general presents, less unsuitable habitat (light orange) areas than other species. This could be explained by that *Tamandua tetradactyla* omnivore habits may take advantage of other non-forest land-use classes, and that *Dasyprocta azarae* were frequently recorded (across five protected areas), which may be an indicator of mesopredator release due to the top-prey absence (CROOKS and SOULÉ, 1999).

Unlike, for recovery and conservation scenarios the "inter-seas plain corridor" connection could be restored. And thus, it could revert this situation that is already perceived in the actual scenario avoiding the long-term isolation of the present populations, improving the genetic flows, and guaranteeing the colonization of natural areas. As seen through the *Cuniculus paca* distribution map (Figure 2.5), where this terrestrial large-body mass mammal was recorded at only one ISC-protected area, may have a suitable habitat area in the "inter-seas plain corridor" in the conservation scenario. Although, at the location on the border that could connect these two areas appears a light orange line (unsuitable habitat), where it is located the highway "Rod. Baldicero Filomeno", at this point more studies are recommended to identify areas to install fauna road-crossing structures.

Urbanization has a direct impact on the transformation of the environment, changing land occupation and generating a complex spatial pattern of patches of natural vegetation that are increasingly isolated and smaller, inserted in an

inhospitable matrix for many species (PICKETT, 2001). The continuum process of urbanization generates a homogeneous landscape with a high degree of habitat fragmentation, causing the loss of biodiversity, processes and ecological functions and dynamics and, consequently, a decrease in the availability of ecosystem services (STEINER, 2011; GRIMM et al., 2008). The herbivorous Rodentia - *Dasyprocta azarae* and *Cuniculus paca* - help maintain plant diversity via seed dispersal, thus going the direction of an urban scenario it may have a tremendous impact (CAMARGO-SANABRIA et al., 2015) on ISC flora richness and biodiversity. In practice, reducing forest areas would increase the edge effect, which would directly affect the production of seeds and fruits of the trees and, consequently, the availability of food for this food dependent groups, in addition to the reduction of habitat to maintain minimal amounts of individuals in the landscape (GALETTI et al., 2010).

The preservation of native biota in the remaining fragments depends on a reduction of pressure vectors, which depends on the level of fragmentation of species habitats. At the same time, ecosystem restoring and maintaining genetic flows between existing fragments depends on the quality of the matrix for the species of interest (SISK et al., 1997). Landscape connectivity is not only important because of environmental protection, but it also has social and cultural goals (Ahern, 1995), once that its insights help the understanding of horizontal relations about spatial interactions between landscape units.

To conclude, we must recognize that humans are the main driver of habitat loss. However, as some species are more or less adapted to these changes, it is crucial to study the mechanisms that enable wildlife species to coexist with us, describe their environmental requirements and how they respond to changes in their habitat, that is today our anthropogenic matrix surrounded. For then, we have the chance to make better decisions, not only for ourselves but also for all forms of life.

References

ABREU, E. F. et al. Lista de Mamíferos do Brasil. 23 dez. 2021.

AHERN, Jack. Greenways as a planning strategy. **Landscape and urban planning**, v. 33, n. 1-3, p. 131-155, 1995.

BIVAND, Roger et al. Package 'rgdal'. **Bindings for the Geospatial Data Abstraction Library**. Available online: <https://cran.r-project.org/web/packages/rgdal/index.html> (accessed on 15 October 2017), p. 172, 2015.

BRASIL. Lei Federal nº 12.608, de 10 de abril de 2012. Institui a Política Nacional de Proteção e Defesa Civil - PNPDEC; dispõe sobre o Sistema Nacional de Proteção e Defesa Civil - SINPDEC e o Conselho Nacional de Proteção e Defesa Civil - CONPDEC; autoriza a criação de sistema de informações e monitoramento de desastres; altera as Leis nos 12.340, de 1º de dezembro de 2010, 10.257, de 10 de julho de 2001, 6.766, de 19 de dezembro de 1979, 8.239, de 4 de outubro de 1991, e 9.394, de 20 de dezembro de 1996; e dá outras providências.. Brasília: DOU de 11.04.2012. Brasil, 2012.

BRASIL. Lei nº 11.428, de 22 de dezembro de 2006. Dispõe sobre a utilização e proteção da vegetação nativa do Bioma Mata Atlântica, e dá outras providências. Diário Oficial da República Federativa do Brasil. Poder Executivo, Brasília, 2006. Disponível em: <http://www.planalto.gov.br/ccivil_03/_ato2004_2006/2006/lei/l11428.htm>.

BRASIL. Lei nº 10.257, de 10 de julho de 2001. Regulamenta os arts. 182 e 183 da Constituição Federal, estabelece diretrizes gerais da política urbana e dá outras providências. Presidência da República Casa Civil: Subchefia para Assuntos Jurídicos. Brasília, 2001 (Estatuto da Cidade)

CAMARGO-SANABRIA, Angela A. et al. Experimental defaunation of terrestrial mammalian herbivores alters tropical rainforest understorey diversity. *Proceedings of the Royal Society B: Biological Sciences*, v. 282, n. 1800, p. 20142580, 2015.

CANDELA, Adriana M.; MUÑOZ, Nahuel A.; GARCÍA-ESPONDA, César M. The tarsal-metatarsal complex of caviomorph rodents: Anatomy and functional-adaptive analysis. *Journal of Morphology*, v. 278, n. 6, p. 828-847, 2017.

CARUSO, M. M. L. O desmatamento na Ilha de Santa Catarina de 1500 aos anos atuais. UFSC, Florianópolis, 1990.

CASSANO, C. R.; BARLOW, J.; PARDINI, R. Forest loss or management intensification? Identifying causes of mammal decline in cacao agroforests. *Biol. Conserv.*, 169, pp. 14-22. 2014.

CPRM – Serviço Geológico do Brasil; IPT – Instituto de Pesquisas Tecnológicas. 2014. Cartas de suscetibilidade a movimentos gravitacionais de massa e inundações:1:25.000 (livro eletrônico): nota técnica explicativa. Coordenação: Bitar, O. Y. São Paulo: IPT – Instituto de Pesquisas Tecnológicas do Estado de São Paulo; Brasília, DF : CPRM – Serviço Geológico do Brasil, 2014.

CROOKS, Kevin R.; SOULÉ, Michael E. Mesopredator release and avifaunal extinctions in a fragmented system. *Nature*, v. 400, n. 6744, p. 563-566, 1999.

DUTRA, Cláudia Martins et al. Roteiro para a elaboração dos Planos Municipais de Conservação e Recuperação da Mata Atlântica. Brasília: MMA, 2013.

GALETTI, Mauro et al. Mudanças no Código Florestal e seu impacto na ecologia e diversidade dos mamíferos no Brasil. *Biota Neotropica*, v. 10, p. 47-52, 2010.

GALETTI, Mauro et al. Priority areas for the conservation of Atlantic forest large mammals. *Biological Conservation*, v. 142, n. 6, p. 1229-1241, 2009.

GRAIPEL, M. E. et al. Mamíferos da Mata Atlântica. In: *Revisões em Zoologia: Mata Atlântica*. [s.l.] Editora UFPR Curitiba, 2017. p. 391–482.

GRAIPEL, Maurício Eduardo; DOS SANTOS FILHO, Manoel. Reprodução e dinâmica populacional de *Didelphis aurita* Wied-Neuwied (Mammalia: Didelphimorphia) em ambiente periurbano na Ilha de Santa Catarina, Sul do Brasil. *Biotemas*, v. 19, n. 1, p. 65-73, 2006.

GRIMM, Nancy B. et al. The changing landscape: ecosystem responses to urbanization and pollution across climatic and societal gradients. *Frontiers in Ecology and the Environment*, v. 6, n. 5, p. 264-272, 2008.

HIJMANS, Robert J. et al. Package 'dismo'. **Circles**, v. 9, n. 1, p. 1-68, 2017.

JENKINS, Victoria. Protecting the natural and cultural heritage of local landscapes: Finding substance in law and legal decision making. *Land use policy*, v. 73, p. 73-83, 2018.

MACARTHUR, Robert H.; WILSON, Edward O. The theory of island biogeography Princeton University Press. Princeton, NJ, v. 203, 1967.

MAGIOLI, Marcelo. Ecologia trófica, funcional e isotópica de mamíferos terrestres da Mata Atlântica. 2018. Tese de Doutorado. Universidade de São Paulo.

MATIAS, Renan Augusto Miranda. Modelagem da distribuição, densidade e potencial produtivo de espécies de interesse agroextrativista no bioma Cerrado. 2022.

MMA - Ministério do Meio Ambiente (2014) Programa Nacional de Conservação das Espécies Ameaçadas de Extinção - Pró-Espécies. Portaria nº 43, de 31 de janeiro de 2014. Brasília: Diário Oficial da União, 05 de fevereiro de 2014, Seção 1, p. 53.

MORGAN, Cecilia Clara; ALVAREZ, Alicia. The humerus of South American caviomorph rodents: shape, function and size in a phylogenetic context. *Journal of Zoology*, v. 290, n. 2, p. 107-116, 2013.

NAIMI, Babak et al. Package 'sdm'. 2016.

NAIMI, Babak. USDM: Uncertainty analysis for species distribution models. R package version 1.1–15. **R Documentation** <http://www.rdocumentation.org/packages/usdm>, 2015.

OLIVEIRA, Angele Tatiane Martins et al. Primate and ungulate responses to teak agroforestry in a southern Amazonian landscape. *Mammalian Biology*, v. 96, p. 45-52, 2019.

PAGLIA, A. P. et al. Lista Anotada dos Mamíferos do Brasil/Annotated Checklist of Brazilian Mammals. (2nd Edition). *Occasional papers in conservation biology*, 6, 1-82. v. 6, p. 1-82, 2012.

PARERA, A.; ERIZE, F. Los mamíferos de la Argentina y la región austral de Sudamérica. 2002.

PEARSON, Richard G. et al. Model-based uncertainty in species range prediction. **Journal of Biogeography**, v. 33, n. 10, p. 1704-1711, 2006.

PETERSON, A. Townsend; SOBERÓN, Jorge. Species distribution modeling and ecological niche modeling: getting the concepts right. *Natureza & Conservação*, v. 10, n. 2, p. 102-107, 2012.

PETERSON, A. Townsend et al. Ecological niches and geographic distributions (MPB-49). In: *Ecological Niches and Geographic Distributions (MPB-49)*. Princeton University Press, 2011.

PHILLIPS, S. J., ANDERSON, R. P., SCHAPIRE, R. E. Maximum entropy modeling of species geographic distributions. *Ecological Modelling*. 190(3-4), 231-259, 2006.

PICKETT, Steward TA et al. Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. **Annual review of ecology and systematics**, v. 32, n. 1, p. 127-157, 2001.

PINTO, L. P.; HIROTA, M. M. 30 anos de Conservação do Hotspot de Biodiversidade da Mata Atlântica: desafios, avanços e um olhar para o futuro. São Paulo: Fundação SOS Mata Atlântica, 2022.

PMMA, Plano Municipal da Mata Atlântica: Florianópolis – Santa Catarina / Realização: Prefeitura de Florianópolis; Floram; IPUF. – Florianópolis: Prefeitura de Florianópolis, 2020. Disponível em: <http://www.pmf.sc.gov.br/sistemas/pmma>

PROJETO MAPBIOMAS – Collection 6. da Série Anual de Mapas de Cobertura e Uso da Terra do Brasil, 2020. Access in 11/06/2021 from <https://plataforma.brasil.mapbiomas.org/>

REIS, N. R. et al. Mamíferos do Brasil. In: Mamíferos do Brasil. [s.l: s.n.]. 2006. p. 437.

ROCHA, Vlamir J. et al. Feeding habits of the crab-eating fox, *Cerdocyon thous* (Carnivora: Canidae), in a mosaic area with native and exotic vegetation in Southern Brazil. *Revista Brasileira de Zoologia*, v. 25, p. 594-600, 2008.

SISK, Thomas D.; HADDAD, Nick M.; EHRLICH, Paul R. Bird assemblages in patchy woodlands: modeling the effects of edge and matrix habitats. *Ecological Applications*, v. 7, n. 4, p. 1170-1180, 1997.

SCHMITT, Sylvain et al. ssdm: An r package to predict distribution of species richness and composition based on stacked species distribution models. **Methods in Ecology and Evolution**, v. 8, n. 12, p. 1795-1803, 2017.

SIQUEIRA, Marina Toneli; CHAVES, Larissa Siqueira; GONÇALVES, Ana Leticia Saquete. O desafio da participação popular no planejamento urbano brasileiro: o caso do Plano Diretor de Florianópolis: O desafio da participação popular no planejamento urbano brasileiro: o caso do Plano Diretor de Florianópolis. *Revista Brasileira de Direito Urbanístico| RBDU*, p. 37-62, 2020.

STEINER, Frederick. Landscape ecological urbanism: Origins and trajectories. *Landscape and urban planning*, v. 100, n. 4, p. 333-337, 2011.

SUZART DE ALBUQUERQUE, Fabio; GÁLVEZ BRAVO, Lucía; CAYUELA, Luis. Identification of critical areas for mammal conservation in the Brazilian Atlantic Forest Biosphere Reserve. 2011.

WIENS, John A. et al. Ecological mechanisms and landscape ecology. *Oikos*, p. 369-380, 1993.

APPENDIX A

Table A 2 List of non-flying mammal species traits used to compare distinct habitat requirements: trophic guild, body mass (kg) and locomotor habit. (Om= omnivores; He= herbivores; Ca= carnivores; Te= terrestrial; Sc= scansorial; Aq= semiaquatic)

Taxa (code)	Trophic Guild	Body Mass (kg)	Locomotor Habit
Order Didelphimorphia			
<i>Didelphis aurita</i> (Diau)	Om	1.25	Te
Order Cingulata			
<i>Dasypus novemcinctus</i> (Dano)	Om	3.76	Te
Order Pilosa			
<i>Tamandua tetradactyla</i> (Tate)	Om	6.23	Sc
Order Rodentia			
<i>Cuniculus paca</i> (Cupa)	He	9.38	Te
<i>Coendou spinosus</i> (Cosp)	He	1.47	Sc
<i>Dasypsecta azarae</i> (Daaz)	He	3.5	Te
<i>Hydrochoerus hydrochaeris</i> (Hyhy)	He	52.5	Aq
Small non-flying mammals (Smma)	Om	>0.5	Sc
Order Carnivora			
<i>Cerdocyon thous</i> (Ceth)	Om	6.8	Te
<i>Eira Barbara</i> (Eiba)	Om	6	Sc
<i>Nasua nasua</i> (Nana)	Om	5.81	Sc
<i>Lontra longicaudis</i> (Lolo)	Ca	8	Aq

Considerações Finais

Através do desenvolvimento dos dois artigos que contemplam a presente dissertação, fica evidente a influência potencial de processos de mudança do uso na paisagem (dentre as diferentes variáveis ambientais analisadas) sobre a comunidade de mamíferos não voadores na Ilha de Santa Catarina, bem como sobre a fauna e flora associada a estes como um todo, e consequentemente, a alteração dos serviços ecossistêmicos a estas comunidades associadas.

Nesta pesquisa realizada em um laboratório vivo de “ilhas em uma ilha”, apesar de desafios e limitações, apresentamos resultados que podem diretamente subsidiar a gestão na ISC e servir como base de estudos em outras áreas naturais não apenas como ciência teórica, mas também aplicada. Fazer ciência é superar desafios em busca de respostas que possam nos auxiliar na compreensão/caracterização das dinâmicas de comunidades biológicas e sua relação com aquilo que queremos responder em prol da organização social de um mundo em constante mudanças e necessidades em suas diferentes escalas e contextos, sejam locais, regionais ou mesmo globais.

O primeiro artigo desse trabalho permitiu identificar padrões nas variações das métricas de paisagem sobre a estrutura da comunidade estudada, em que o *isolamento* (representado pela variável correlacionada da *área urbana*) afeta negativamente a riqueza e abundância da comunidade de mamíferos não voadores. Enquanto a variável *forma* das áreas naturais remanescentes afeta positivamente a abundância das espécies, mas afeta negativamente a composição destas assembleias, uma vez que essas áreas, quanto mais complexas e menos arredondadas, podem estar associadas aos efeitos de borda e o aumento de espécies generalistas e oportunistas que podem se beneficiar destes locais, enquanto florestas mais maduras que sofrem menos influência de efeitos de borda apresentam menos espécies generalistas. Não obstante, também se verificou as relações dos atributos funcionais das espécies dentre as variáveis ambientais analisadas. Evidenciando lacunas funcionais em que espécies de mamíferos carnívoros e de grande porte não estão presentes na ISC, como a ausência das espécies já registradas *Puma concolor*, *L. pardalis*, *Alouatta guariba* e *Tapirus terrestres*, reforçando o estado de defaunação em

que a ISC se encontra. Sendo este estado uma ameaça, pois a ausência do desempenho de distintos papéis ecológicos de uma comunidade no ecossistema, o leva mais distante do seu equilíbrio, integridade e saúde ecológica a médio e longo prazo.

No segundo artigo da dissertação, observou-se através de mapas de distribuição potencial de espécies de mamíferos não-voadores herbívoros e onívoros que ocupam nichos e estratos distintos, e que atualmente se distribuem desigualmente nas unidades de conservação amostradas, como a mudança na permissão do uso da terra com a revisão do Plano Diretor pode afetar esta comunidade em um cenário pessimista (em que se libere o aumento da urbanização), e um cenário otimista (em que se conserve e recupere as áreas prioritárias definidas pelo Plano Municipal de Conservação e Recuperação da Mata Atlântica de Florianópolis). Com isso, pode-se identificar a necessidade e importância de uma dessas áreas já definidas, o *corredor entre mares* que conecta a porção centro-sul ao sul da ISC, da tomada de ações de recuperação e conservação desta área a fim de garantir o aumento de conectividade entre as áreas naturais remanescentes, pois o *corredor entre mares* apresenta atualmente uma grande barreira de dispersão e fluxo de espécies. Ainda, foi possível observar a necessidade recuperação de outras áreas, e a necessidade de avaliar instalações de estrutura de passa fauna para garantir a passagem dos indivíduos das diferentes espécies, e consequentemente garantir a viabilidade das populações presentes ou mesmo a recolonização de áreas que não ocorram ou venham a desaparecer, e futuras que deveriam ser reintroduzidas.

Enfatiza-se, a partir daqui, a necessidade urgente não só de tomadas de ações pelos órgãos gestores responsáveis pelo cuidado, desenvolvimento, e melhoria da qualidade de vida da cidade na ISC, que está intrinsecamente associada à manutenção de diversas formas de vida (não somente humana). Mas, também a necessidade do delineamento e continuidade de estudos futuros que incluam outras variáveis para além das ambientais e outros grupos faunísticos, para que aos poucos possam responder e tornar mais robustas as infinitas questões que abarcam a complexidade da comunidade biológica a qual todos nós estamos inseridos. Para, quem sabe com esperança, ficar tão explícito

a importância da conservação natureza. Para que assim consigamos tomar ações individuais/coletivas direcionadas para um mundo mais sustentável. Temos a opção de caminhar para um cenário mais integrado com os ecossistemas naturais, restaurando, trazendo de volta o que foi perdido, ou voltar a degradar, destruir e extirpar espécies, indo na contramão de tudo que avançamos nas últimas décadas na ISC.